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TENSIOMETERS AS A MANAGEMENT TOOL FOR MICRO-IRRIGATED TOMATOES IN SOUTHWEST FLORIDA

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INTRODUCTION

Irrigation of tomatoes produced on the sandy soils of southwest Florida is primarily accomplished by means of a seepage irrigation system. This method of irrigation involves perching a water table at 15- to 18-inches below the bed surface. The water table is maintained throughout the growing season by supplying water to lateral ditches either through a main supply ditch or more commonly through a buried PVC manifold. Irrigation water requirements range from 5 to 13 gallons per minute (gpm) per acre to maintain the aforementioned water table levels. Some systems may require slightly more water due to varying field conditions.

Micro irrigation (formerly drip or trickle) allows precise and controlled water applications to the active root zone of the crop. In addition, fertilizer solutions can be injected into the irrigation system such that nutrients can be supplied to the crop throughout the season, thereby reducing the potential level of nutrients which may be leached. Because water is applied to the crop, row middles are not maintained wet nor is a water table imposed which would promote deep percolation.

The major problem that exists with micro-irrigation of vegetables is that the sandy soils have low water holding capacities and the relatively large pore spaces (capillaries) restrict lateral movement of water to about 9 to 12 inches. Therefore, management of micro systems for use with bedded, mulched vegetable crops on sandy soils requires a detailed knowledge of the water holding characteristics of the soil, the current water status of the soil in the crops root zone, and the water requirements of the crop. This paper will discuss the use of tensiometers as a management tool on two irrigation research/demonstration sites which used micro-irrigation systems in the production of tomatoes in southwest Florida.

RUSKIN SITE

Crop establishment and irrigation.

Five acres of tomatoes consisting of 54-500 foot long rows were provided by Atresian Farms in Ruskin, Florida. The treatments consisted of two levels of water management by using switching and manually read tensiometers. Tomato transplants were placed in the field on January 31, 1987. All nitrogen and potassium fertilizer was applied in liquid form through the micro-irrigation system. A 4-0-8 liquid fertilizer was used for this purpose. Fertilizer was applied each morning.

The tomatoes were established with water from an existing seepage system. Following establishment the tomatoes were irrigated with a micro-irrigation system for the remainder of the season. The micro irrigation laterals were placed on the surface of each tomato bed under the mulch and 4-6 inches off of the plant row.

Initial irrigations were scheduled once each day to apply the fertilizer. Tensiometers were read to help manage the irrigation schedules which were to maintain bed soil moisture levels in the -10 to -15 centibar (cb) range. As the tensiometer gauge levels reached -15 cb, the irrigation application amounts were increased. As water demands increased through the season, an additional irrigation was applied in the afternoon.

Three of the treatments received water every day, while the other three treatments received water only if the tensiometer switches were closed indicating a need for additional moisture. The tensiometers were placed at 6 and 12 inches and wired in series such that both tensiometers had to read -15 cb before an irrigation was initiated. The irrigation levels were adjusted in each treatment throughout the season. Daily application levels are provided in Table 1.

Results.

Yield data is only available from the first harvest. Subsequent harvests were made by the grower. All plot fruit were placed into one transportation bin rendering those yield data unusable. Because subsequent yield data was lost, few conclusions can be made from this study. Total yield was not very different for the two irrigation management treatments. Marketable fruit (pink and mature green) averaged 88 cartons (25-lb.) per 1000 bed feet from the tensiometer switched plots, and averaged 101 cartons per 1000 bed feet from the manually read, regular schedule plots. The percentage of large marketable mature green fruit averaged 21 % of marketable green fruit for the tensiometer switched plots to 25 % for the regular schedule plots. However, this was only for the first harvest and cannot

be inferred as the general case for other harvests.

Because tomato root systems are maintained shallow and sandy soils have such low water holding capacities, depletion of available water within the root zone is rapid. This process was observed on the plots which used the switching tensiometers. The 12-inch depth tensiometer consistently indicated moist soil conditions, but because this was not in the primary root zone, afternoon irrigations were not initiated in these plots, even though the 6 inch tensiometer indicated a need for water. In addition, rapid drying was observed in the top portion of the soil profile in these plots. If the 6- and 12-inch tensiometers had been wired in parallel, the afternoon irrigations would have been initiated as they should have been. Therefore, while the tensiometers proved to be a useful tool for monitoring the bed moisture levels associated with a particular irrigation schedule, placement and method of wiring can be critical to the success of this management tool.

GCREC - SITE

Crop establishment and irrigation.

The experimental site was relocated at the Gulf Coast Research and Education Center (GCREC) in Bradenton, Florida, in the Fall of 1987. This allowed close observation and control of management and data collection. Tomatoes were grown under both seepage and micro irrigation systems in separate plots. This provided a comparison of the two irrigation and fertilizer management systems. The field was arranged with ditches on 41 foot centers and six production beds between ditches. This corresponds to 6375 bedded feet per acre.

The demonstration (treatment) levels two levels of both nutrition and water control on the micro irrigated plots. Nutrition levels were targeted for a seasonal total 2.8 lb. of N per 100 linear bed feet (lbf) [200 lb. of N per 7260 lbf bedded acre].

Seepage irrigated plots were maintained with a water table at a 15 to 18 inch depth from the bed surface. Water control within the micro irrigation plots was based upon the soil water potential within the soil bed by means of tensiometer readings. One level was to be managed to maintain the soil moisture such that the tensiometers would not indicate gauge readings drier than 8 to 10 centibars, and the other level was to be maintained no drier than the 13 to 15 cb range. The tensiometers were read daily, morning and afternoon, if the target range (8-10 or 13-15 cb) was observed, the daily irrigation level was increased. The second, drier range (13 to 15 cb) was difficult to achieve during the fall season.

Results.

Seepage irrigation was required to establish the plants in the micro-irrigated plots for the first 10 days following transplanting. These plots received about 32000 gallons per 1000 feet of bed from the initial seepage irrigation used for plant establishment. Subsequent daily irrigation levels ranged from 100 to 300 gallons per 1000 bed feet during the next 45 days. During the remaining 50 days the 13-15 cb treatments received from 170 to 300 gallons per 1000 bed feet per day, and the 8-10 cb treatments received from 350 to 700 gallons per 1000 bed feet per day. The wetter micro-irrigated plots received approximately 1.6 times the level of water that was applied to the drier micro-irrigated plots during the period that the micro-irrigation system was used.

It is necessary to point out that the water applied represents that which was required to maintain the desired bed moisture levels and does not represent the total water required, nor used by the crop. Rainfall and shallow water table levels will provide some of the water needed by the crop. The water table will probably provide a contribution even at a depth of 4 feet.

Tensiometer readings for the different treatments were similar and ranged from 0 to 5 cb in the morning and from 6 to 10 cb in the afternoon. These data indicate that moisture levels were quite wet in the morning for both treatments, while drying out slightly in the afternoon. During the last 50 days of the season, afternoon readings ranged from 5 to 7 cb in the drier treatment and ranged from 2 to 4 cb in the wetter treatment. These wetter than targeted conditions are probably due to rainfall and low water demand conditions during the fall season.

The results from the first harvest (11-16-88) indicated that the micro-irrigated plots generally had a greater early yield than the seepage irrigated plots. First harvest marketable yields were 72-, 68-, and 48-25 lb. cartons per 1000 bed feet for the 8-10 cb, 13-15 cb, and seepage irrigated treatments, respectively. The total yield of all three harvests was 240, 220, and 240 cartons per 1000 bed feet for the 8-10, 13-15, and seepage irrigated treatments, respectively. Therefore, the additional water supplied in the 8-10 cb treatments had no real effect on total yield. Moreover, the micro-irrigated plots had essentially the same yield and similar distribution in fruit size as the seepage irrigated plots. Therefore, the reduction in water applied did not affect total yield for the fall 1987 season.

SUMMARY

This report summarizes the irrigation and water management related data and results of the spring and fall 1987 production seasons. Total yields were not affected by high or low micro-irrigation management levels nor by seepage irrigation. However the use of the micro-irrigation system resulted in significant water savings over the seepage system.

Tensiometers are useful for monitoring soil moisture conditions associated with particular crop, climatic, and management conditions. Target ranges for optimal management are still being studied. As a general recommendation for sandy soil, micro-irrigated tomato production in southwest Florida, tensiometers should be placed at 6 and 12 inches and maintained at gauge readings of 8 to 10 cb. The 6-inch depth tensiometer will be in the most active portion of the root zone and should be closely monitored for any rapid changes. Irrigations may need to be scheduled for several short duration cycles during the day to maintain the root zone at the desired moisture level without over-irrigation.

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

Table 1. General irrigation schedule used at the Ruskin site in the spring of 1987.

Daily Application Levels (Gallons/1000 Bed Feet)				
Period	Tensiometer Treatments			
	Manually Read		Switching	
	Morning	Afternoon	Morning	Afternoon
2/23-4/17	88.8	0	88.8	0
4/18-4/28	88.8	88.8	88.8	88.8 *
4/29-5/4	88.8	133.3	88.8	88.8 *
5/5 -5/8	88.8	222.2	88.8	222.2 *
5/9 -5/21	177.7	222.2	177.7	222.2 *

* These amounts were only applied if the tensiometers had switched.

EVALUATING PLANT N STATUS WITH PLANT SAP QUICK-TEST KITS

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Tomatoes account for about 40% of the total farm value of vegetables grown in Florida. Most of the tomato production occurs on the sandy soils of southern Florida. Traditionally, large amounts of water and fertilizer are used to produce tomatoes because growers feel these inputs are needed to insure successful crops. In a recent survey of commercial growers, nitrogen (N) applications ranged from 275 to 500 lb. N per acre with the most common rate being about 350 lb. N per acre (4). Research in Florida, however, has shown that tomato yields can be maximized with much less N. In a study on seep-irrigated tomatoes at Immokalee, yields were maximized at about 108 lb. N and 124 lb. potassium (K) per acre (7,260 linear bed feet of crop per acre) in 3 out of 4 seasons (4). At Bradenton, levels of fertilizer above 130 lb. N and 150 lb. K per acre did not improve fruit size or increase tomato yields (3).

In demonstrations of fertilizer management for tomatoes it was pointed out that excess fertilizer only contributes to larger plants with the same yields compared to those properly fertilized and that excess fertilizer levels in the soil only contribute to increased amounts of soluble salts (6). The objectives of the studies reported herein were to evaluate and demonstrate water and fertilizer combinations for optimum tomato production. The following reports the results of the calibration of two sap quick tests for determining plant N status.

MATERIALS AND METHODS

Tomatoes, cultivar 'Sunny' were grown at the Gulf Coast Research and Education Center in Bradenton, Florida in the Fall of 1987 and Spring of 1988.

The Bradenton site was an Eugallie fine sand. Prior to establishing plots each season, soil samples were collected from each projected plot area and analyzed for lime requirement and several nutrients using the Mehlich-I (double-acid) extractant. Beds for tomatoes were formed on 54-inch centers. Phosphorous (P) was incorporated into the beds at the rate of 500 lb. per acre of P_2O_5 from normal super phosphate (0-20-0) containing micronutrients. Beds were outfitted with the drip irrigation system and covered with black polyethylene mulch. Prior to mulching, beds were fumigated with methyl-bromide. Five-week old tomato transplants were planted in a single row on each bed with 30 in. between plants and 54 in. between beds. Planting dates were August 24, 1987, and February 19, 1988.

Fertilizer treatments were 200 and 300 lb. N per acre (based on 7260 linear bed feet per acre). This is 2.8 and 4.2 lb. N per 100 feet of bed. A fertilizer solution of 4-0-8 (N- P_2O_5 - K_2O) was used to supply the nutrients. Even though K rate varied with N rate, K_2O amounts were high enough in both treatments so that K supply was ample in both situations.

Fertilizer solution was injected on a schedule approximating plant growth so that small amounts were applied early in the growth cycle but were increased as the plants developed. The fertilizer schedule is shown in Table 1.

Subsurface (seepage) plots were established in the same manner with P incorporated at rate of 500 lbs. per acre of P_2O_5 . However, for the seepage plots, fertilizer was applied in 2 bands in grooves on the shoulders of the beds. These bands contained all N and K fertilizer and the same 2 treatments of 200 and 300 lb. per acre were used.

Leaf samples were collected through the season and analyzed for N content. Most-recently matured leaves were selected on a 2-week interval, dried, and analyzed for N by micro-Kjeldahl procedures.

Fresh plant petiole sap also was analyzed for N by two "quick-test" procedures, Quant nitrate test strips and the Hach hand-held colorimeter. Most-recently-matured leaves were removed from the plant and all leafy material and petioles separated from the main petiole and midrib. Petioles from 20 leaves were chopped and minced in a garlic press to extract the sap. Fresh sap was diluted with distilled water to allow nitrate readings within the scale of the particular test kit.

For the Quant strips, one test strip was dipped into the diluted sap for about two seconds then read for nitrate after 60 seconds. Color development on the test panel on the strip was compared to a calibrated color chart and ppm nitrate determined.

For the Hach test, a viewing tube was filled with five ml of diluted sap. Contents of one NitraVer-5 reagent pillow was dispensed into the tube and the mixture vigorously shaken for 60 seconds. The sample was allowed to stand 60 seconds and then placed into the colorimeter. A second viewing tube was filled with five ml of diluted sap from the same source and placed in the second chamber in the colorimeter. The dial-disc in the colorimeter was rotated until the colors in the two tubes matched and the resulting nitrate-N value in ppm was determined from the scale window. These readings can be converted to ppm nitrate by multiplying by 4.4.

Sampling dates for the quick tests are presented in Table 2. Sampling began about 6 weeks after transplanting both seasons.

RESULTS

Results of pre-fertilization Mehlich-I soil testing showed low amounts of phosphorus (P) and potassium (K) in 1987 (Table 3). In 1988, residual amounts of P and K were present in the soil. Soil pH and other nutrients were considered to be in ample supply for tomatoes in both seasons.

Petiole sap nitrate-N levels were slightly lower in the fall crop compared to the spring crop (Tables 4,5,6,7). In general, sap nitrate-N levels in these experiments were lower than those reported elsewhere (1,2). In studies in Hawaii, about 800 ppm nitrate-N was proposed as a

critical level for determining N deficiency (1). In our tests, yields were excellent in both seasons, about 250 25-lb cartons per 1000 linear bed feet (LBF). The difference between the two locations (Hawaii and Florida) probably is related to cultivar differences and the fact that the Hawaii study was with greenhouse tomatoes.

Results of leaf-N content by Kjeldahl analyses for the fall crop is shown in Table 6. Leaf-N content for all treatments started out at about 5.5% in September. From October through November, leaf content of the drip-irrigated plots remained constant at about 3.8% for the 200 lb. N per acre plots and at about 4.1% for the 300 lb. N per acre plots. Leaf-N content of about 2.5 to 3.0% is considered adequate for tomatoes (5). By the end of the season, leaf-N content began to lower in response to reduced N applications. The levels shown in the tissue of the plants in the 200 lb. N per acre treatment reveals that we were successful in optimizing N application to these plots. The plants had adequate N through the season but were reduced to the critical level of about 2.7% at the end of the season when harvesting was ending. The N contents in the 300 lb. treatment plants remained slightly higher throughout the season indicating possible luxury consumption of N.

N content of leaves from the seep plants started out equal to those from the drip plots but soon began a steady reduction in N content through the season. The N levels in the leaves at the end of the season were about the same as the drip plots. The results of the leaf N analyses clearly show the benefits of drip irrigation (fertigation) for maintaining more constant levels of nutrient status in the plants through the season.

Results of the fall sap tests also show the maintenance of more uniform levels of nutrition in the plants by fertigation with drip compared to the seepage system (Tables 4,5). The 2 test methods are comparable for amounts of nitrate determined. Since both techniques are only semi-quantitative, some variability of 60 to 80 ppm is not unexpected.

In the spring crop, levels of sap nitrate-N were comparable among fertilizer levels (Tables 7,8). Sap nitrate-N levels fell dramatically during May and only trace amounts were present in the plant at the end of the season.

Yields in both studies were not affected by fertilizer treatments. Yields from 200 and 300 lb N per acre were similar. Since yields were excellent in both seasons, it appears some value can be placed in the calibration of these nitrate tests. It appears that levels of sap nitrate-N in the range of 800 to 1000 ppm through the first 10 weeks of growth would indicate adequate N fertility. Levels of nitrate-N could then be lowered to 400 to 600 ppm. The specific fertilizer injection schedule used in these studies increases N fertilizer rate as the plants grow and then tapers off the N rate toward the end of the season.

Both quick-test kits appear to be similar in the amounts of nitrate-N detected. The Quant strips appeared to detect only slightly more nitrate-N. The major difference between the two tests lies in their ease of use. The Quant strips are slightly faster to use in the field and require less equipment and supplies. The Hach test appears to be slightly more

quantitative due to the manner in which the nitrate-N readings are made.

These two quick tests appear to have promise as a tool for monitoring plant N status during the growth cycle. They appear to be able to provide semi-quantitative guidelines for diagnosis of plant N status and provide a tool to make fertilizer N injection decisions during the season.

Based on our work, drip irrigated tomatoes should contain 800 to 1000 ppm of nitrate-N during the first 10 weeks of growth. This level should provide adequate N for early growth although this level could be revised once responses of tomatoes to N rates lower than 200 are evaluated.

Test kits used in these studies are available from sources listed below. Delivery of the Quant strips has been slow in our experience. If a grower is interested in evaluating these kits, he is encouraged to contact IFAS personnel for help, if needed.

SOURCES FOR PLANT SAP QUICK TESTS

1. Nitrate test strips.
 - a. EM Science
111 Woodcrest Rd.
P.O. Box 5018
Cherry Hill, NJ 08034-0395
 - b. Curtin Matheson Scientific, INC.
7524 Currency Dr.
P.O. Box 13930
Orlando, FL 32809
 - c. VWR Scientific
P.O. Box 13007
Atlanta, GA 30376
2. Colorimeter and miscellaneous kits.
 - a. HACH Company
P.O. Box 389
Loveland, CO 80537

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Table 1. Fertilizer schedule for injection for Fall, 1987 and Spring, 1988 tomato demonstrations at Bradenton, FL.

Total N (lb/A) ²	Injection week										
	1	2	3	4	5	6	7	8	9	10	11
	lb										
200	10	10	12	16	18	22	24	24	24	22	18
300	15	15	18	24	27	33	36	36	36	33	27

²based on 7260 linear bed feet of crop in 43560 sq. ft.

Table 2. Planting, sap test tissue sampling, and harvesting dates for Fall 1987 and Spring 1988 tomato crops, Bradenton.

Fall, 1987			Spring, 1988		
Planting	Sampling	Harvest	Planting	Sampling	Harvest
Aug. 24	Oct. 14	Nov. 16	Feb. 19	March 28	May 19
	Nov. 12	Nov. 30		Apr. 18	May 31
	Dec. 4	Dec. 10		May 18	June 8
				June 6	

Table 3. Preplant soil-test indices (Mehlich-I) for tomatoes at Bradenton, FL.

Season	Soil test index								
	pH	P	K	Ca	Mg	Fe	Zn	Mn	Cu
	ppm								
Fall, 1987	7.0	10	15	618	150	6	5	4	3
Spring, 1988	7.2	28	40	623	102	-	6	4	4

Table 4. Petiole sap nitrate -N levels for Fall tomato crop as determined by Quant strips, Bradenton, 1987.

Treatment		Sap $\text{NO}_3\text{-N}$ levels (ppm)		
Fertilizer (lb/A)	Water (-cb)	Oct. 14	Nov. 12	Dec. 4
200	10	420	340	410
	15	300	270	390
300	10	770	390	340
	15	820	640	590
200	Seep	860	300	90
300	Seep	770	640	80

Table 5. Petiole sap nitrate -N levels for Fall tomato crop as determined by Hach colorimeter, Bradenton, 1987.

Treatment		Sap $\text{NO}_3\text{-N}$ levels (ppm)		
Fertilizer (lb/A)	Water (-cb)	Oct. 14	Nov. 12	Dec. 4
200	10	280	390	390
	15	250	360	340
300	10	450	390	390
	15	520	550	500
200	Seep	660	340	300
300	Seep	750	520	230

Table 6. Leaf-N content (Kjeldahl) of Fall (1987) tomatoes at Bradenton, FL.

Treatment		Date					
Fertilizer (lb/A)	Water (-cb)	Sept. 24	Oct. 8	Oct. 22	Nov. 5	Nov. 19	Dec. 3
		%					
200	10	5.4	3.8	3.9	3.8	4.0	2.8
	15	5.4	3.7	4.0	3.8	3.4	2.7
300	10	5.3	4.3	4.1	4.1	3.6	2.6
	15	5.5	4.1	4.1	4.2	4.0	3.1
200	Seep	5.5	4.7	3.9	3.5	3.3	2.7
300	Seep	5.8	4.7	4.7	4.1	3.3	2.2

Table 7. Petiole sap nitrate-N levels for Spring tomato crop as determined by Quant strips, Bradenton, 1988.

Treatment		Sap NO ₃ -N levels (ppm)			
Fertilizer (lb/A)	Water (-cb)	March 28	April 18	May 18	June 6
200	10	910	630	100	10
	15	880	730	200	15
300	10	910	760	210	10
	15	980	860	500	40
200	Seep	710	800	30	tr ²
300	Seep	820	660	210	tr

²trace

Table 8. Petiole sap nitrate-N levels for Spring tomato crop as determined by Hach colorimeter, Bradenton, 1988.

Treatment		Sap NO ₃ -N levels (ppm)			
Fertilizer (lb/A)	Water (-cb)	March 28	April 18	May 18	June 6
200	10	930	600	210	tr ²
	15	1040	740	280	tr
300	10	940	670	240	tr
	15	980	660	310	tr
200	Seep	700	740	130	tr
300	Seep	850	670	260	tr

²trace

UNDER-BED TRENCHING FOR MULCHED TOMATOES ON CALCAREOUS SOILS

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Traditional farming practices for Rockdale soils in Dade County involve multiple scarification or scraping about a one inch layer of oolitic calcium carbonate rock per pass until the loose soil is 5 to 6 inches deep. When bedded and mulched the root zone depth is limited to 7 to 8 inches. The shallow root zone results in a predominantly horizontal, shallow root system instead of a much deeper root structure which would develop for tomatoes grown in soil with an unrestricted root zone (2).

Trenches have been used under tropical fruit tree crops since the 1940's (1). Trenches 12 to 20 inches wide and 18 to 20 inches deep into the oolitic rock are generally mechanically dug for each row. Perpendicular cross trenches are also dug at each plant location. Trenches are refilled with a mixture of loose top soil and the rock aggregate excavated from the trenches. Plants are transplanted at each intersection made by the perpendicular trenches. The plant root systems penetrate deep into trenches resulting in more effective irrigation and fertigation with drip irrigation systems due to the concentration of roots in the narrow, deep trenches. The trenches also provide a larger area for roots to pick up moisture from the cut surface of the undisturbed rock subsoil.

Refilled trenches for tomatoes could be dug 12 to 18 inches wide and 10 to 20 inches deep into the rock subsoil as shown in Fig. 1. Costs could range from \$1000 to \$1500 per acre if they are positioned under beds 6 feet apart.

The initiation of stakes in tomato production on rock soils in 1986 and 1987 and the instability of wooden stakes in the shallow soil led to extensive use of iron construction rods for vine supports on over 1500 acres in Dade County in 1987-88. The iron rods cost about \$1200 to \$1500 per acre, depending on the spacing used.

Trenching under tomato beds would allow use of wooden stakes at about 25% the material cost of iron stakes.

Three seasons of data on Rockdale soil at TREC, Homestead since 1985 have shown that tomatoes grown on mulched beds with drip irrigation over trenches have more vigorous plants than those grown with no trenches. This could lead to an extended harvest period which would be an advantage for staked tomatoes. Yields of marketable fruits were greater when plants were grown over trenches than yields of tomatoes grown with no trenches.

A commercial field test in 1987 showed a first harvest yield more than 20% larger from tomatoes grown over trenches on mulched beds with drip irrigation than yield of tomatoes from untrenched beds.

Under-bed trenching for tomatoes is expensive. The cost, however, can

be amortized over several years. The benefits of more efficient irrigation, higher yields, and increased number of harvests and yield would ensure profitability.

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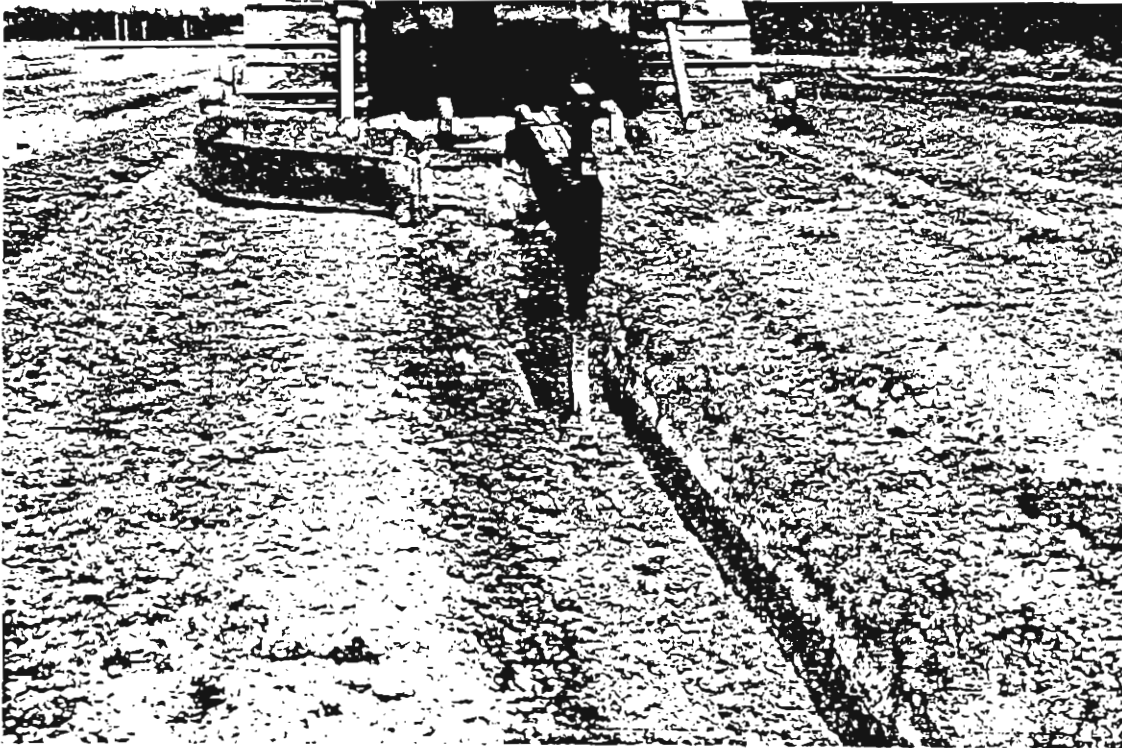


Fig. 1. Trenching Rockdale Soil with a Trench Plow on Front of a D-10 Tractor.

SIZE DISTRIBUTION IN FLORIDA TOMATOES: PRELIMINARY RESULTS

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Florida tomato growers produced a record crop in the 1986-87 season for the second consecutive year with a value of almost \$516 million (Florida Agricultural Statistics, 1988). During this period the Florida and California tomato industries petitioned the USDA to create a nationwide standard for fresh market tomato sizes and grades. Currently the USDA tomato standards do not allow an overlap between sizes, while the Florida Tomato Marketing Order permits a 2/32 inch overlap as part of its overall quality control program. Tomatoes are dimensionally sized using a series of perforated belts with successively larger perforations. Since the fruits are randomly oriented on the belts, differences in shape will affect sizing accuracy.

Previous studies have been conducted regarding size distribution of Florida tomatoes. Showalter (1972) sampled unsized tomatoes representing two cultivars and two production areas and classified them by size according to five then-current and proposed standards. Marlowe and Cornell (1983) determined the size, weight and volume characteristics of four cultivars for two production areas.

The overall objective of this study is to determine the effect of the following parameters on the size distribution of commercially sized tomatoes from the four major production areas of Florida (which account for 96% of the volume): tomato shape, cultivar, number of harvests of a field and season.

PROCEDURE

Sampling Method.

Packinghouses were identified in the four production districts. Visits were made to each of the packinghouses, at which time the overall objectives of the study were discussed with the managers and flow charts of the packing line components and configuration were made. Packinghouses invited to participate in the study were selected to represent low and high packing volume and the most widely grown cultivar(s) in the district.

A summary of the district sampling information is as follows:

District	Cooperating Inspection Office	Cultivars	Sampling Period	# of Cooperating Packinghouses
1	Florida City	'FTE-12', 'Duke'	Jan. 20 - Feb. 27	3
2	Pompano Beach	'Sunny'	Mar. 24 - Apr. 23	3
3	Immokalee	'Sunny'	Mar. 16 - Apr. 28	4
4	Palmetto	'Sunny'	May 4 - 28	4

This study is on-going and sampling will be continued during the fall and winter seasons of this year.

For each packinghouse a particular field of tomatoes was identified. Samples were taken from each picking of the field as the lot was being run through the packing line. Inspection personnel from the Florida Department of Agriculture & Consumer Services were contacted under the direction of Mr. Gordon W. Brown, Chief, Bureau of Vegetable Inspection, and the four district supervisors for the production areas. The inspectors collected the samples for each picking and performed the measurements. This permitted a large number of samples to be taken with accurate measurements and also the return of the samples to the packinghouse inventory.

Samples were taken near the beginning and toward the end of each particular lot. One hundred tomatoes were taken from the float tank while 50 tomatoes were taken from packed cartons for each of the three sizes (6x7, 6x6, 5x6 and larger, all U.S. No. 1 combination grade). Thus for each picking of a particular field, the sample totaled 500 fruits. Most fields were picked twice; in a few cases there were 3 pickings.

Measurements

The U.S. Standards for tomato grades states that minimum size shall be the "largest diameter of the tomato measured at right angles to a line from the stem end to the blossom end" (U.S.D.A., 1976). The maximum diameter is determined by the smallest dimension of the tomato which passes through a designated size round opening in any position. Current tomato size standards are presented in Table 1.

In order to describe size distribution three diameters were measured on each fruit: the widest and narrowest measured perpendicular to the stem end and the height measured from the blossom to the stem end. Defects scoreable against grade were also noted. In some cases individual weights were also measured. Sliding scale measuring devices were made to measure the diameters in millimeters. Score sheets for each sample were then mailed to the Vegetable Crops Department in Gainesville for entry into a computer database for analysis.

PRELIMINARY RESULTS: COMMERCIAL SIZE SAMPLES

Combined Districts

A total of 9600 tomatoes were sampled during the winter and spring seasons this year from packed cartons of the three size classifications (3200 fruits per size). From Figure 1 and Table 2, percent in-size was 95.4%, 97.7% and 97.7% for 6x7, 6x6 and 5x6 and Larger sizes, respectively. For the 6x7 size, 3.3% were undersize, 1.3% were oversize, and for those in-size, 13.2% were in the upper overlap range of 2/32 inches. For the 6x6 size, 1.7% were undersize and 0.6% were oversize. As to those tomatoes in the overlap range, 34.4% were in the lower overlap and 10.0% were in the upper overlap. For the 5x6 and Larger size, 2.3% were undersize and 33.3% were in the lower overlap range.

In order to investigate the potential for sizing into a larger classification, the 5x6 and Larger sample was arbitrarily divided into 5x6, and 5x5 and Larger (Figure 2). After assigning the 5x6 size from 2 24/32 - 3 2/32 inches, and the 5x5 and Larger size from 3+ inches, 72.1% were classed as 5x6 and 13.8% as 5x5 and Larger. The overlap range between these two sizes was 11.8%. Thus, if all those tomatoes in the overlap were included in the 5x5 and Larger size, 25.6% of the tomatoes from this sample would have been in this latter size.

Cultivar

'Duke' tomatoes were sampled from two packinghouses in District 1, measuring 500 fruits from each size classification (Table 3, Figures 3-5). 'FTE-12' tomatoes were sampled from one packinghouse in District 1, measuring 200 fruits per size (Table 3). 'Sunny' tomatoes were sampled from all houses in Districts 2, 3 and 4, for a total of 2500 fruits per size.

There was little difference between cultivars in the percent of under- and oversized tomatoes; the range was from 0.0% to 5.5%. The percent of tomatoes in the lower overlap range was from 32.0% to 36.8% for 'Duke' and 'Sunny', while 'FTE-12' had a higher percentage, at 40.5% and 43.0%. In the upper overlap range, 'Duke' and 'FTE-12' were very low, from 0.5% to 5.2%. 'Sunny' had a higher number of fruits in this overlap, 16.0% for 6x7 size and 11.7% for 6x6 size.

The effect of tomato shape, number of pickings and season will be discussed at a later date.

ACKNOWLEDGEMENTS

The authors wish to thank the Florida Tomato Committee for funding for this project and Mr. Wayne Hawkins for valuable discussions. The data could never have been collected without the cooperation and thoroughness of the inspectors from the Florida Dept. of Agr. and Consumer Services. Packinghouse managers also provided excellent cooperation for identification and collection of the samples.

Table 1. Current tomato size standards for Florida Tomato Marketing Order and U.S. Department of Agriculture.

1) Florida Tomato Committee Standards

2/32 INCH OVERLAP

<u>Size</u>	<u>Inches</u>	<u>Millimeters</u>
Undersize	<2 8/32	<57
6x7	2 8/32 to 2 18/32	57 to 65
6x6	2 16/32 to 2 26/32	63 to 72
5x6 and larger	2 24/32+ (to 3 2/32)	70+ (to 78)
*5x5 and larger	3 in +	76+

2) U.S.D.A. Standards

Extra Small	1 28/32 to 2 4/32	48 to 54
Small	2 4/32 to 2 9/32	54 to 58
Medium	2 9/32 to 2 17/32	58 to 64
Large	2 17/32 to 2 28/32	64 to 73
Extra Large	2 28/32 to 3 15/32	73 to 88
Maximum Large	3 15/32+	88+

*Hypothetical size

Table 2. Florida tomato size distribution for all districts and cultivars. Spring 1988 sample, commercially sized.

<u> % DISTRIBUTION </u>					
<u>Size</u>	<u>Undersize</u>	<u>Lower Overlap</u>	<u>Mid Range</u>	<u>Upper Overlap</u>	<u>Oversize</u>
6x7	3.3	N.A.	82.2	13.2	1.3
6x6	1.7	34.4	53.3	10.0	0.6
5x6+	2.3	33.3	64.4	N.A.	N.A.

Table 3. Florida tomato size distribution by cultivar. Spring 1988 sample, commercially sized.

<u> % DISTRIBUTION </u>						
<u>Cultivar</u>	<u>Size</u>	<u>Undersize</u>	<u>Lower Overlap</u>	<u>Mid Range</u>	<u>Upper Overlap</u>	<u>Oversize</u>
'Duke'	6x7	2.2	N.A.	93.0	4.2	0.6
	6x6	1.2	36.8	56.8	5.2	0.0
	5x6+	0.4	36.6	63.0	N.A.	N.A.
'FTE-12'	6x7	5.5	N.A.	93.5	0.5	0.5
	6x6	0.0	43.0	55.5	1.0	0.5
	5x6+	0.0	40.5	59.5	N.A.	N.A.
'Sunny'	6x7	3.3	N.A.	79.1	16.0	1.6
	6x6	2.0	33.2	52.4	11.7	0.7
	5x6+	2.9	32.0	65.1	N.A.	N.A.

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Figure 1.

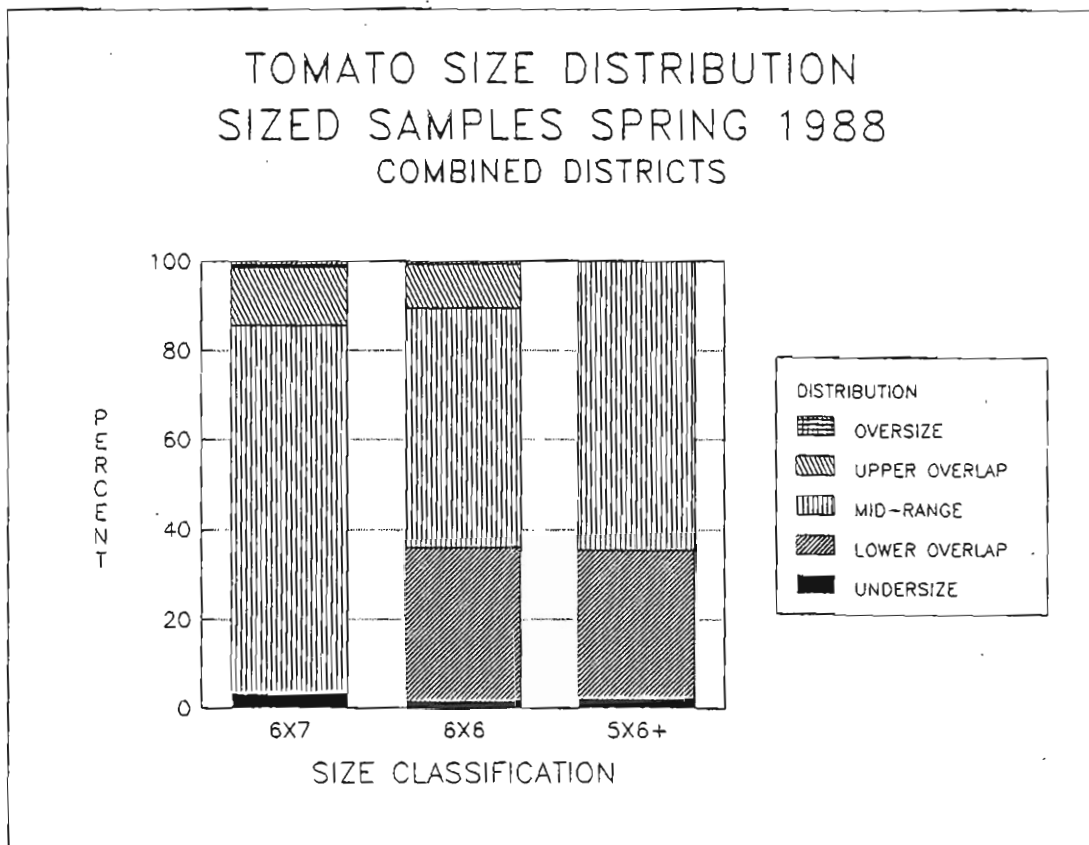


Figure 2.

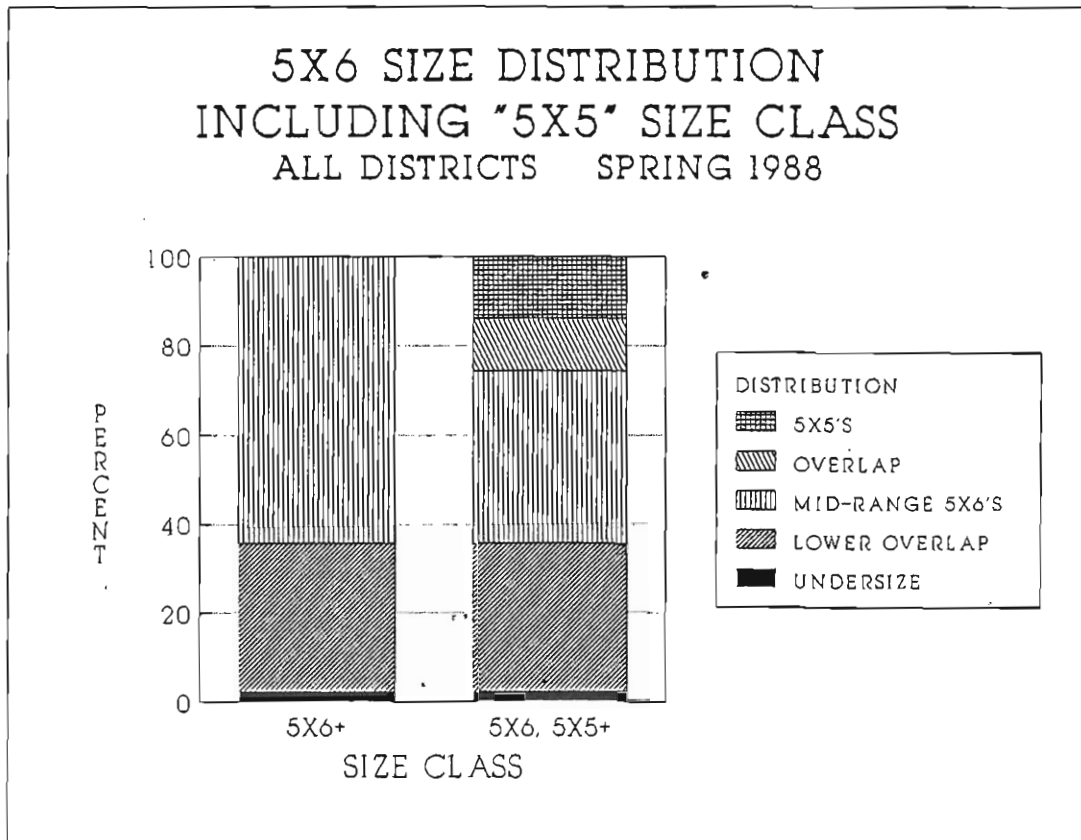


Figure 3

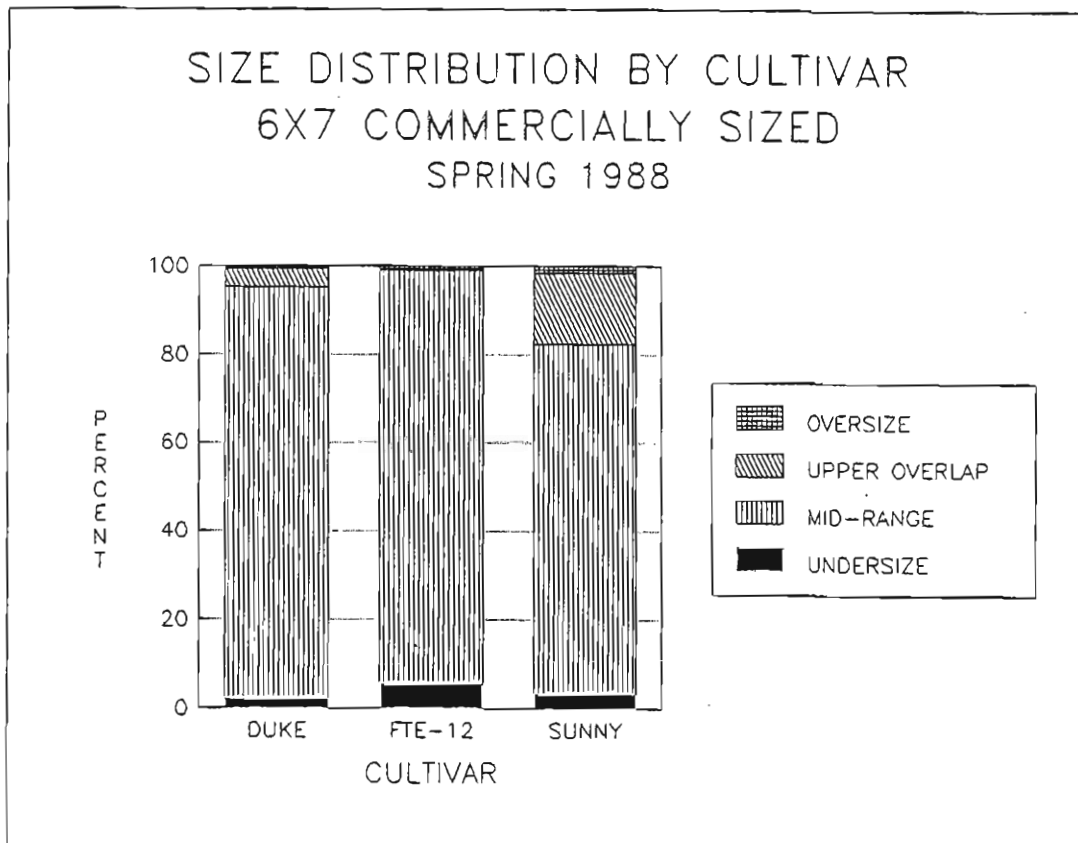


Figure 4.

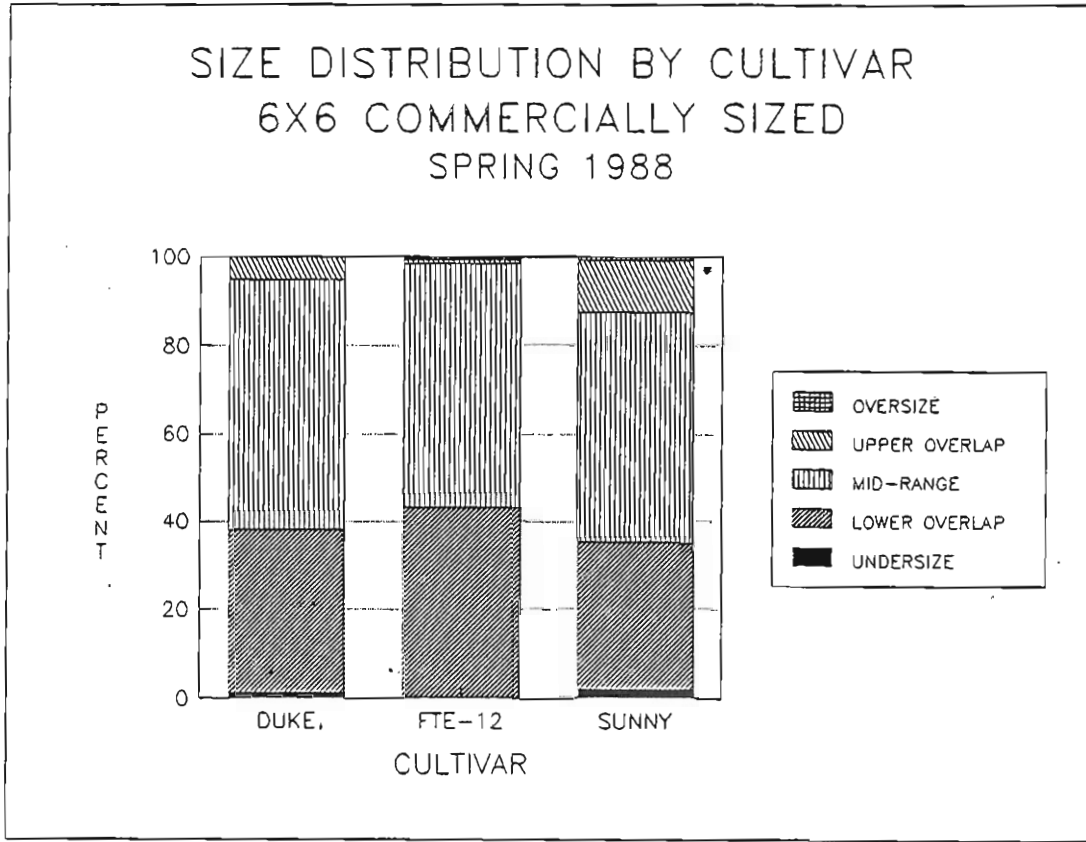
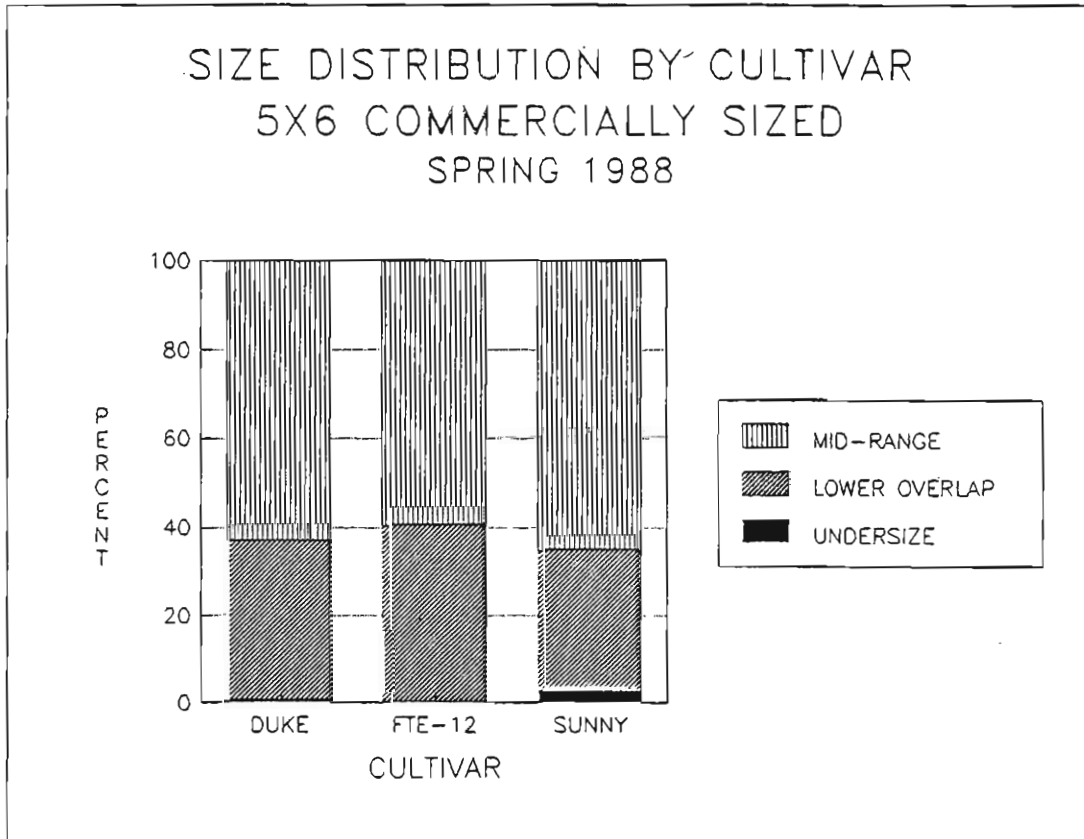


Figure 5



PROBLEMS WITH FLORIDA PRODUCE AT
TERMINAL MARKETS - REAL OR PERCEIVED?

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During the week of April 25, 1988, a group of 6 Extension agents, 2 Extension specialists and a representative from F.F.V.A. participated in a study tour of terminal markets and distribution centers that handle fresh vegetables from Florida. This tour focused on New York City and the surrounding area and was funded jointly by the Florida Tomato Exchange, the Florida Fruit and Vegetable Association and IFAS. The purpose of the trip was to observe the arrival conditions of Florida vegetables at the terminal markets, both at the wholesale and retail levels, and to talk with wholesalers about the packaging and condition of Florida vegetables.

Various reports have indicated problems with produce shipped from Florida, particularly postharvest diseases, disorders and injuries which were found during requested inspections. Buyers and handlers have contended that Florida products are more perishable and nonuniform in pack compared to other shipping areas. Certified inspection of tomatoes at the New York market, however, has not totally supported this contention (2). Our goal was thus to take a first hand look at the situation in hopes of picking up some ideas on how Florida producers and shippers can modify and/or improve the presentation of their products at the terminal market in order to improve our competitive standing with other areas.

We visited several distributors and wholesalers, including Wakefern Distribution Center in Elizabeth, N.J. Wakefern handles vegetables for 90 Shop Rite Supermarkets. We also visited Norristown Wholesale in Norristown, PA. They handle produce for 350 independent supermarkets which do not take any direct shipments. All produce is distributed, usually in mixed pallet loads, from the Norristown facility. King's Supermarket Chain Headquarters, in West Caldwell, N.J. was another tour stop. They do most of their produce buying through brokers, and handle about 275 different produce commodities. A highlight of the trip was a stop at Hunt's Point Terminal Market in the Bronx, N.Y. There we met with the director of public relations and one of the USDA inspectors. Hunt's Point covers about 125 acres and has cleaned up and increased security since New York City sold it to the operators. We talked with several receivers and distributors. We also met with representatives of Campbell's Institute for Research and Technology in Camden, N.J.

A study conducted by F.D.A.C.S. Division of Marketing in 1972 indicated dissatisfaction of handlers and merchandizers with shipping containers and arrival conditions of Florida produce, including Florida tomatoes (1). It was pointed out that a big problem seemed to be a lack of communication between the receivers and shippers. Particular comments on tomatoes in this study included inconsistent sizing, boxes that were easily crushed, and packaging that resulted in damaged or flat sided tomatoes.

With respect to tomatoes, we felt that Florida shippers had improved and had alleviated some of the problems cited in this earlier study. In general, shippers of Florida tomatoes are doing a better job of packaging and labeling their tomatoes in comparison to other commodities. Comments were positive on the use of uniform containers. Most were well identified as to contents, grower, grade, size, weight, etc. Although differences were noted between shippers with regard to quality, level of grading and amount of variation in packs, tomato shippers were generally ahead of the game, with a few notable exceptions where other commodity shippers had gone to preprinted packaging with multi-colors, etc.

Florida tomatoes are still often compared to California tomatoes. At the time of this trip, we did hear reports of a higher percentage of rejections from Florida compared to California. This was most likely due to the irregular ripening problems we were experiencing. A repacker at Hunt's Point Terminal Market brought our attention to the ripening problem in tomatoes they were receiving from the Immokalee/Naples area. Because of the problem, they were getting inspections on all loads as they came to the market and a re-inspection of any tomatoes sent back from the supermarkets.

We did observe a few problems with handling procedures by some wholesalers. At one location, warehouse temperatures were maintained at 38°-42°F. One Wholesaler was doing an excellent job of handling produce, with 5 different areas: 38°F dry room, 38°F wet room, 55°F, 35°F deli cooler and a freezer. Apparently the educational process hadn't reached some of those at the retail level. At one supermarket we visited, pepper and tomatoes were on the refrigerated display while sweet corn was in an uncooled area.

Although we heard several comments that Florida has made definite improvements, at least one wholesaler held the opinion that we were still being limited by past images. He felt we had to go the extra distance to overcome this stigma.

With regard to vegetables in general, most of the warehouse managers we spoke with felt Florida could and should be doing a better job of packaging and presenting their produce. We heard the comment more than once that California growers seem to have a "greater pride of ownership" because their produce is better labeled and identified. They're referring both to grower and location as well as type of vegetable,

grade, size, count, etc. The general complaint was 'Florida uses too many generic cartons for different crops'. We saw crates of sweet corn and cartons of pepper, cucumber and squash which had no labeling to identify either what was in the carton or where it came from. We also saw one instance of a carton preprinted with cucumber and pepper grades, but nothing was marked and upon opening the box, we discovered eggplant. This does not motivate the receiver for repeat business.

We heard a few negative comments about the quality of produce packed in Florida. For example, one wholesaler thought Florida celery was bitter. One distributor at Hunt's Point felt he was getting better consistency and uniformity in peppers run over a machine in the packinghouse as compared to field packed peppers.

There appears to be a greater interest in handling colored peppers--especially red and yellow, and more interest in specialty vegetables. More and more we hear quality stressed as often as price. Wholesalers prefer well-labeled crates and boxes because it makes it easier for them to request produce through their brokers either by brand or grower. There's some controversy over the benefits of preprinted boxes as merchandizing tools. Although an obvious tool for retailers, wholesalers have also found preprinted boxes add color and interest to terminal displays. The main idea is to attract buyer attention. Of course, the important thing is still what's inside the box. You get their attention with a pretty package. You keep their attention and their business based on the quality of the product. Information we received also reinforced our perception that very large companies are becoming more interested in branded vegetables. This ties in to the whole 'quality awareness' movement. Most buyers feel a shipper puts the brand or logo only on his best quality.

In this same vein of emphasizing quality, we visited with representatives from the New Jersey Department of Agriculture where we discussed the 'Jersey Fresh' marketing concept. This program was originated in 1983 with a \$325,000 grant from the state government. By 1988, the grant had reached \$1.25 million. Of this money, \$200,000 was available off the top for a matching fund program available to all commodity groups within the state.

The program combines the use of billboards (over 200 in use), T.V. ads or spots, and visits by the N.J. Secretary of Agriculture to participating supermarket chains as a way to promote N.J. grown products. Point-of-sale material is provided--all with the "Jersey Fresh" logo. In 1987, they expanded out of the local marketing area. The logo is printed with the name and address of the grower on the carton. The logo is only used for U.S. No. 1 or higher graded produce. Box manufacturers supposedly do not charge farmers for logo imprinting. Stick on labels are sold to producers for 1¢ each. The only complaint has been the time and labor required to put the stickers on.

A big part of the Jersey Fresh Program is the Quality Assurance Program. In 1988, 111 growers signed up for the Quality Grading Program at \$30. each. Inspectors spot check unannounced and a list of participating farmers and commodities goes to brokers and buyers. Tomatoes were one of the original commodities included. By the 4th year the program covered 13 crops. Since the program was initiated, consumer awareness has increased from 13-25%. Farmers may receive more for labeled produce. More importantly, however, consumers correctly perceive the logo as being correlated with high quality; thus, they preferentially buy the locally produced commodities. Such a program may be feasible for Florida in the future.

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The authors and the other members of the tour group listed below would like to express their sincere appreciation to the organizations which funded this educational opportunity.

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Dr. Don Maynard, Extension Vegetable Specialist, GCREC, Bradenton
Mr. Chris Meline, Extension Agent, Vegetables, Dade County
Dr. Tom Schueneman, Extension Agent, Vegetables, Belle Glade

IRREGULAR RIPENING: A NEW THREAT TO THE FLORIDA TOMATO INDUSTRY

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Ripening disorders such as graywall or blotchy ripening occur from time-to-time in Florida tomatoes. However, the incidence of these disorders is usually low because of the use of resistant varieties, and often their occurrence can be traced to faulty fertilizer application or some unusual weather situation.

During the 1987-88 season, however, a severe and costly ripening disorder occurred that is apparently distinct from graywall or blotchy ripening. The first indication of the problem is not noticed until after the fruit are removed from the ripening room since fruit while green appear to be normal. After ripening, there is a vivid checkerboard appearance in the carton caused by some fruit that have colored normally and other fruit where color development is incomplete. Color development frequently is lacking in one or more areas of an individual fruit with color often developing along locule septa with intermediate areas remaining green or yellow. Overall, this pattern of ripening produces a star-burst appearance. With sufficient time, sometimes two to four weeks, nearly normal external color develops on most fruit. When cut, however, the fruit are white or yellow inside. Because these symptoms are distinct from graywall or blotchy ripening, this disorder is being called irregular ripening.

Irregular ripening occurred on tomatoes grown in the east coast, Homestead, and southwest Florida in the 1987-88 season. The occurrence of the disorder was much more severe in the Immokalee-Naples area than in the other two areas. No verified report of the disorder came from the Palmetto-Ruskin or Quincy production areas.

In southwest Florida, irregular ripening was first noted in mid-March, and was initially thought to be graywall induced by faulty N:K fertilization. The disorder was soon evident throughout the area, and was recognized as being distinct from graywall. Observations made on irregular ripening include:

1. It is not variety specific since several varieties, including plum and cherry tomatoes were affected.
2. Fruit from any harvest might be affected.
3. Plant foliage appears normal or has virus-like symptoms.

4. Usually, there was an association between sweetpotato whitefly populations and the severity of irregular ripening.

Irregular ripening was observed on Florida tomatoes in northeastern markets in late April during a study tour by Vegetable Extension Agents and Specialists. Because of comments and reports by USDA Inspectors, irregular ripening universally was being called tomato virus in the marketplace.

To develop a strategy for identifying the cause and control of irregular ripening and squash silver leaf, and to determine the status of lettuce infectious yellows in Florida, IFAS administration appointed a special task force in May 1988. The task force was composed of county extension faculty and state research and extension faculty with expertise in plant pathology, entomology, and horticulture.

The task force met for two-full days to exchange information and develop research and extension priorities. Based on our current knowledge, possible causes of irregular ripening are (a) faulty N:K fertilizer ratio, (b) damage caused by simple feeding, devitalization of the plant, or from toxins produced by the sweetpotato whitefly, and (c) a virus, or some other pathogen, possibly vectored by the sweetpotato whitefly.

In the collective judgement of the task force, growers would be well advised to fertilize according to a 1N:2K₂O ratio and to rigorously control the sweetpotato whitefly with registered insecticides and field sanitation procedures as outlined in another paper in this Proceedings. It should be emphasized that these suggestions are based on judgements not research findings. Research underway or to be initiated soon at several locations may well provide more definitive procedures for control of tomato irregular ripening.

Endangered Species and Pesticides - An Update

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In May, 1987 the Environmental Protection Agency announced the implementation of a plan to protect endangered species from pesticides and to bring the Agency into compliance with the Endangered Species Act (ESA). The ESA, which is administered by the U.S. Fish and Wildlife Service, requires all federal agencies to ensure that any action authorized, funded, or carried out by the agency will not jeopardize the continued existence of endangered or threatened species and their habitat. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) provides for the registration and control of the use of pesticides. Since EPA administers FIFRA, the Agency must ensure that any pesticide registration action will not jeopardize endangered or threatened species or their habitat.

As proposed, EPA's labeling strategy had originally required manufacturers to revise labels on pesticide products by February 1, 1988, but the complexities of program development have postponed implementation until at least February 1, 1990. Affected products are those which may jeopardize endangered species in the opinion of the U.S. Fish Wildlife Service (FWS), based on data submitted by the EPA and regional FWS offices. Such labels would refer the user to county information bulletins for specific use restrictions in areas of each county affected. For the most part, the proposed restrictions are in the form of use prohibitions within buffer zones immediately surrounding known habitat areas.

EPA and FWS used a "cluster" approach to give a comprehensive, consistent review to all pesticides with common use patterns. EPA and the U.S. Fish and Wildlife Service had completed the review of four of these clusters when the program was announced in May, 1987. These clusters were forest, mosquito larvacide, rangeland and cropland. The cropland cluster included (corn, cotton, sorghum, soybeans, and small grains) that represented 60 percent of all pesticide use. Clusters representing other use patterns would be added at later dates.

After careful review of the proposed county information bulletins by states, in the Fall of 1987, it was obvious that gross inaccuracies existed relative to habitat locations and the descriptions of necessary buffer zones. California, Florida, New Mexico, Georgia and others requested and now have received authority from the EPA to develop state administered endangered species programs which will more accurately address the needs of individual states and the species of concern. states agreeing to develop their own plan had until February 1, 1988 to submit a work plan to the EPA.

Florida Department of Agriculture and Consumer Services Commissioner Doyle Conner appointed a Task Force with representation by environmentalists, state and federal agencies and the agriculture industry to develop a state plan. The primary tasks to be addressed by this group in developing a state plan are:

1. Generate accurate habitat maps for the endangered species identified for the state;
2. Develop habitat descriptions which clearly and accurately define areas of concern;
3. Review the jeopardy opinions issued by the FWS.
4. Review literature on the listed endangered species relative to population status and susceptibility to pesticides;
5. Develop an appropriate implementation strategy;
6. Submit a workable plan to the EPA for approval.

In early January 1988 EPA announced the delay in the implementation of the of the endangered species labeling program. The decision complied with a congressional mandate ordering EPA not to spend any agency funds to enforce the plan before September 15, 1988. According to John A. Moore, EPA Assistant Administrator for Pesticides and Toxic Substances, basic elements of the program were not developed sufficiently to implement it before the 1988 growing season. EPA subsequently rescinded the requirement for manufacturers to revise their labels to include endangered species restrictions. EPA published the proposed plan in the Federal Register for a 90 day comment period on March 9. The Agency also scheduled a series of public meetings, including one in Orlando on April 14, to solicit comment on the proposed program.

EPA is assessing the written comments and the comments made at the public meetings to determine the future direction of the program. Major comments made include:

- * EPA should demonstrate a cause-and-effect link between the use of a specific pesticide and a threat to an endangered species, prior to placing any limitation on its use.
- * EPA should prepare an economic impact assessment on the program
- * The maps of currently occupied endangered species habitat need to be more accurate, in order to be credible.
- * The cluster approach, simultaneously review groups of pesticides with similar uses for their impact on endangered species, should be abandoned.
- * The program should emphasize education and training, rather than enforcement.

EPA intends to significantly improve their "may effect" analysis. EPA's "may effect" analysis determines which pesticides are reviewed for jeopardy opinions by FWS Office of Endangered Species. EPA has indicated that it will reinstitute consultation with FWS on the pesticides in the forest, cropland, rangeland and mosquito larvacide clusters. Changes in the cluster approach are likely. EPA anticipates issuing a notice to registrants in March 1989 requiring them to modify labeling for the protection of endangered species. Portions of the program may be implemented nationally in the spring of 1990.

Expression of Bacterial Wilt In Tomato
As Influenced By Cultivar And Lime

S. J. Locascio, R. E. Stall, and W. M. Stall

Bacterial wilt (Pseudomonas solanacearum, E. F. Smith) is one of the most destructive bacterial diseases attacking higher plants. Under conditions of high temperature and moisture, the disease can be very devastating on many crops, particularly Solaneous crops such as tomato and potato. The disease is temperature sensitive and causes little loss in tomato grown in late Fall, Winter and early Spring in Florida. Bacterial wilt occurs in most areas in Florida and limits tomato production on soils where it occurs when tomatoes are grown under warm conditions. There are currently no reliable assay methods to determine presence of the bacteria before planting. The disease can be very serious on tomato grown on recently cleared land or following the many other crops and weed species that serve as host to bacterial wilt.

The first observed symptom on tomato is a sudden plant wilt and collapse that occurs at the time of early harvest. Thus, this crop failure is more expensive than losses in the seedling stage or losses from most foliar diseases as it occurs after most of the production costs have been expended.

No research has been conducted to determine the effect of Ca and other macronutrients on the disease development on tomatoes. Past work has shown that tissue Ca concentration is important in the susceptibility of tomatoes to Botrytis, and Fusarium. Bacterial wilt does not occur on tomatoes grown on marl or rockland soils. In addition, some tomato cultivars have been released with reported resistance to bacterial wilt. Control of this disease is essential for continuous

expansion of the tomato industry, particularly into warm season production.

Studies were conducted in Gainesville during the Springs of 1987 and 1988 on bacterial wilt infested soil to determine the effect of tomato cultivar and lime rate on bacterial wilt occurrence on tomato.

Treatments were combinations of two lime rates and six tomato cultivars. Lime rates were 0 and 2000 lb/acre CaCO_3 and cultivars were as follows; Sunny, Capitan, Redlander, Saturn, Rodade, and Florida Breeding Line 860839. Studies were conducted on 2 different sites of an Arredondo fine sand. The preplant soil pH was 6.2. The experiment was set up as a split-plot design with lime rate as main plots and cultivar as sub-plots of 4 x 20 feet. Fertilizer was applied at 180-106-200 lb/acre N-P-K and rototilled into the bed before applying polyethylene mulch. Tomatoes were transplanted 1.5 feet apart in late April of each season.

Symptoms of bacterial wilt were observed on 5% of all plants 4 to 5 weeks after transplanting. By ten weeks, over 60% of the tomato plants were infected. Lime treatment had a very small effect on the rate of development of the disease but had no effect on fruit yield.

The expression of bacterial wilt in both 1987 and 1988 was influenced by cultivar (Table 1). All cultivars in the study, except Sunny, were thought to have bacterial wilt resistance. 'Saturn' exhibited only 2% bacterial wilt in 1987 and 15% in 1988. Wilt expression was much greater with the other cultivars. 'Capitan' with about 40% wilt was the only other cultivar with worthwhile resistance (Table 1).

Fruit yields were low in both seasons but 2 to 3 times higher in 1987 than 1988 (Table 2). In both seasons, total fruit yields were highest with 'Capitan' a moderately susceptible cultivar and lower and similar with the other five cultivars that ranged resistant ('Saturn') to highly susceptible ('Sunny', 'Redlander', 'Rodade', and 'FL 860839'). Although the occurrence of bacterial wilt on 'Saturn' plants was low, yields were also low probably due to its fruit size (Table 2). Most of 'Saturn' fruit was in the medium and small fruit size category in contrast to the fruits of 'Capitan' which were mostly in the large and medium sizes.

These studies indicate that cultivar selection is an excellent means to obtain resistance to bacterial wilt. However, resistance to bacterial wilt has not been easily transferred to horticultural accepted cultivars. Work with a number of soil borne diseases on tomato have shown that manipulation of liming can provide control of some disease. In the present study, application of lime reduced the rate of development of bacterial wilt. In future studies, higher lime rates and deeper incorporation into the soil will be studied with various tomato cultivars in an effort to control this devastating disease.

Table 1. Influence of tomato cultivar on the percentage of plants that exhibited bacterial wilt symptoms at various time after transplanting during two seasons..

Cultivar	Weeks after transplanting					
	1987			1988		
	4	7	10	5	8	10
	Plants, (% bacterial wilt)					
Sunny	10	50	75	5	66	84
Capitan	3	8	45	4	16	37
Redlands	8	39	59	4	66	91
Saturn	0	1	2	0	9	15
Rodade	3	18	59	11	52	78
FL 860839	6	39	87	1	42	74

Table 2. Influence of tomato cultivar on large, medium, small and total fruit yield during 1987 and 1988 seasons.

Cultivar	Yield (cwt/acre)				Yield (cwt/acre)			
	Large	Med.	Small	Total	Large	Med.	Small	Total
	1987				1988			
Sunny	166ab	87b	51c	304b	26b	33b	17b	76b
Capitan	184a	160a	101a	445a	71a	87a	61a	219a
Redlands	114ab	101ab	56c	271b	8b	15b	12b	35b
Saturn	79b	124ab	63bc	266b	22b	35b	29b	86b
Rodade	40b	78b	54c	162b	5b	20b	20b	45b
FL 860839	68b	124ab	99ab	311b	16b	38b	38ab	92b

Mean separation by Duncan's Multiple Range Test, 5% level.

DISPERSAL OF THE BACTERIAL SPOT PATHOGEN DURING TOMATO
THINNING OPERATIONS

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Bacterial spot of tomato, caused by Xanthomonas campestris pv. vesicatoria (XCV), is the most widespread disease affecting Florida tomatoes (12). Heavy losses, especially in large size fruit, occur in crops where epidemics begin before flowering (11).

Chemical control of bacterial spot is often less than satisfactory. As a result, particular emphasis has been placed on integrated control of this disease (9).

For some time, field observations have suggested that XCV is readily spread from plant to plant during routine cultural procedures such as thinning and pruning (10). Recent work in Israel (1) has shown that XCV is carried on the hands of farm workers and is also dispersed by agricultural equipment. Significant farm worker manipulation of plants still widely occurs in the Florida tomato industry. Therefore, these

studies were initiated to determine the role of thinning of direct-seeded tomatoes in the spread of XCV and subsequent disease incidence.

MATERIALS AND METHODS

Tomato plots consisted of raised, plastic-mulched beds produced in accordance with standard grower practices in Dade County (2). 'Duke' tomato was direct-seeded 29 March 1988 into hills spaced 30.5 cm (1 ft) apart on 1.8 m (6 ft) centers. Plots were 15.2 m long (40-50 hills) running in an east-west direction. Plants were drip-irrigated to minimize splash dispersal of bacteria (8). Rainfall was minimal during critical stages of the experiment.

Five thinning regimens were studied for their relationship to dispersal of XCV. In a control treatment, plants were not thinned. These plots were established by hand to ensure precise distribution of seed. Two seed were placed in each hill and covered with ca. 1 g of plug mix which had been moistened just prior to use. All other treatments were machine seeded in plug mix with 5-9 seed per hill. Hand thinning (one plant/hill) of machine-seeded plots was done 26 April 1988, beginning at the east end of plots. In one treatment, plots were thinned without previous exposure to known sources of XCV. In the remaining treatments, workers gently handled naturally infected tomato plants for 10-20 sec. Some plots were thinned immediately after inoculum exposure. In other plots, Betadine

(10% povidone-iodine, equivalent to 1% available I_2) (Purdue Frederick Co.) or 70% freshly prepared ethanol was used to thoroughly wash hands between inoculum exposure and the thinning operation (workers spent 3 sec. or less thinning any one hill).

These five treatments were conducted in the morning (0730-0930) when plants were naturally wet with dew and in the afternoon (1400-1600) when plants were dry. Therefore, the complete experiment consisted of 10 treatments which were replicated five times in a completely randomized design.

Plots were rated for incidence of bacterial spot on 9-10 May 1988. All hills were examined carefully for occurrence of foliar lesions typical of the disease. Hills were simply scored positive or negative for presence of bacterial spot. The percentage of hills positive for bacterial spot was calculated both for the entire row of 40-50 hills and the first 10 hills beginning at the east end of the rows.

Data were analyzed by ANOVA, followed by a series of preplanned single-degree-of-freedom contrasts (4).

Populations of the bacterial spot pathogen on hands of farm workers. Several experiments were conducted to estimate the actual populations of XCV that accumulate on hands of workers. Wet field plants with visible symptoms of bacterial spot were handled for 20 sec. (foliar tissue gently rubbed between hands). Each worker then vigorously rinsed his hands in a 250 ml stream of sterile buffer (6). The wash water was collected in a sterile Nalgene tub (26 x 15 x 6.5 cm),

transferred to a sterile beaker, and kept on ice until processing was completed. Ten-fold dilutions were made in sterile buffer and 0.1 ml of 10^0 , 10^{-1} , and 10^{-2} dilutions was spread over the surface of triplicate plates of Tween medium B (7).

In the same test, the bactericidal properties of Betadine and 70% ethanol applied as hand washes were studied. Immediately after handling diseased plants, small amounts of Betadine or ethanol were poured over workers' hands and thoroughly rubbed over dorsal and ventral surfaces. The excess ethanol was allowed to dry. The excess Betadine was washed off with a gentle stream of deionized water without vigorous rubbing. Preliminary tests showed that the water stream did not remove many XCV cells. Hands were then assayed for XCV populations as described above.

All plates were incubated at 28C for 4-5 days. Populations were calculated as colony-forming units (cfu)/set of hands.

RESULTS AND DISCUSSION

Bacterial spot development was widespread in tomato rows thinned by workers who had handled diseased plants for only 10-20 sec. (Fig. 1 and 2). When plants were thinned wet after exposure to XCV (without an intervening bactericide wash), 100% of the plants in the first 10 hills were diseased (Fig. 3).

The most dramatic reduction in XCV spread was observed

when Betadine or 70% ethanol were used between inoculum exposure and thinning (Fig. 1-4, Table 1). An average of only 8% of the plants were infected when Betadine was used before thinning wet plants. While these compounds may be quite efficacious, their use does not constitute an IFAS extension recommendation at this time. Farm workers might very well object to the sticky, uncomfortable texture of Betadine. More importantly, some people are sensitive to iodine or may become sensitized to it after repeated exposure. Allergic dermatitis may result (Joan Gluck M.D., personal communication).

We hypothesized that due to rapid evaporation the beneficial effects of 70% ethanol might rapidly diminish as workers proceeded down rows. However, ethanol (as well as all other treatments) had about the same percentage of diseased plants based on the first 10 hills or the entire 40-50 hill plots (Fig. 3 & 4). Longer plots are needed to determine how far XCV is spread and for how long the bactericides are effective. Excessive skin dryness and possible consumption are hazards that may be associated with field use of ethanol. At any rate, bactericide hand washes hold promise as a means for controlling mechanical spread of XCV.

Bactericide washes greatly reduced populations of XCV based on direct bacterial assays of workers hands (Table 2). In just 20 sec., workers accumulated about one million pathogenic bacteria on their hands. These populations were reduced 97% or more in most cases after an ethanol or Betadine

wash.

In the absence of bactericide washes, disease incidence can be reduced by thinning hills when plants are dry (Fig. 2-4, Table 1). Disease incidence in 15.2 m of row was reduced 46% simply by waiting until plants were dry (Fig. 4). However, this disease reduction may not be sufficient to lower crop losses to an acceptable level. About 43% of the plants thinned dry but without a bactericide wash were still diseased (Fig. 4). Moreover, it may be extremely difficult to persuade field crews and chiefs that work should be delayed until plants are dry. In the warmer months, crews prefer to work early in the morning to avoid high Florida midday temperatures.

Significantly lower percentages of infected plants were found in those plots which were not thinned (Table 1) compared to thinned plots. Those results were noted despite the generally more favorable disease environment in the two plant/hill unthinned rows compared to one/hill in thinned rows. A precise method for placing one or two seed in a hill that assures the grower of an acceptable stand would eliminate the need for thinning. Such technology might reduce the likelihood of XCV mechanical spread early in the crop. The advantages of other labor-intensive operations, such as staking and tying, should be weighed against potential XCV dispersal.

Some disease increase was noted in plots which were thinned without previous exposure to diseased tomato plants. Epiphytic populations of XCV may have been present on plants (5) and were moved about during thinning. In addition, slight

wounds, as in those causing breakage of trichomes, likely occur during thinning, forming ready portals for pathogen entry (3, 13).

The likelihood of substantial improvement in chemical control of bacterial spot seems remote at this time. Therefore, it is imperative that growers use all means at their disposal to minimize disease severity and/or delay its onset. These measures include clean seed and transplants, drip irrigation (8), and reduction of mechanical spread of the pathogen during thinning and other handling operations.

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Table 1. Preplanned single-degree-of-freedom orthogonal contrasts, contrast sum of squares (CSS), and F-test values (F) for percent tomato plants with bacterial spot in plots thinned at Homestead, FL in 1988

Preplanned contrasts	Statistics for arcsin square root-transformed percent diseased plants ^a			
	Entire plot (40-50 hills)		First 10 hills ^b	
	CSS	F	CSS	F
unthinned vs. thinned	0.514	4.56*	0.987	6.67*
no XCV vs. XCV (inc. bactericides)	0.20	0.175	0.359	2.43
thinned + XCV vs. thinned + XCV + bactericides	3.84	34.08**	5.48	37.09**
Betadine vs. 70% ethanol	<0.001	<0.001	0.0	0.037
unthinned wet vs. dry	0.45	0.40	0.152 *	1.03
thinned, no XCV wet vs. dry	0.143	1.27	0.312	2.11
thinned + XCV, wet vs. dry	1.12	9.95**	1.64	11.12**
Betadine, wet vs. dry	0.036	0.32	0.04	0.28
ethanol, wet vs. dry	0.249	2.21	0.44	2.99

^aBased on visual inspection of all plants for 2 or more discrete bacterial spot lesions. Plants rated 2 wks after thinning.

^bFirst 10 hills starting at end of row where thinning was initiated after handling infected plants and appropriate bactericide treatments.

* = significant difference(s) at P = 0.05 and ** = significant difference(s) at P = 0.01.

Table 2. Populations (colony forming units) of *Xanthomonas campestris* pv. *vesicatoria* (XCV) on hands of farm workers and the reduction of XCV by bactericide hand washes^a

Farm worker	XCV pop. on hands before Betadine wash	XCV pop. after Betadine wash	Reduction %	XCV pop. after ethanol wash	Reduction %	XCV pop. based on 612 cm ²
A	3.9×10^5	NDT ^b	≈ 100.0	NDT	≈ 100.0	4.5×10^5
B	8.0×10^5	1.8×10^4	97.8	NDT	≈ 100.0	8.5×10^5
C	5.4×10^6	5.5×10^5	90.0	2.0×10^4	99.6	5.1×10^6
D	7.9×10^6	1.4×10^6	82.3	NDT	≈ 100.0	7.2×10^6
E	4.8×10^6	NDT	≈ 100.0	9.9×10^4	98.0	4.6×10^6

^a Leaves of field-grown diseases tomato plants rubbed gently through the hands for 20 sec. Hands rinsed with 250 ml sterile buffer and appropriate dilutions of rinsate plated on Tween medium B (7). Two experiments conducted with similar results; data from first experiment shown.

^b NDT - none detected even when concentrated by passage through 0.45 μ m filter.

Figure Captions

1. Spatial distribution of diseased plants in hills 2 wks after thinning in morning (0730-0930) when plants were wet with dew. Xanthomonas campestris pv. vesicatoria (XCV) inoculum produced by gently rubbing naturally infected plants between hands for 10-20 sec. Betadine or 70% ethanol used to wash hands between inoculum exposure and thinning. Solid black ovals represent plants with bacterial spot symptoms. Clear ovals are asymptomatic plants.
2. Spatial distributions of diseased plants in hills 2 wks after thinning in afternoon (1400-1600) when plants were dry. See Fig. 1 for details.
3. Effects of specific management practices on percentage of 'Duke' tomato plants in first 3.0m of row with bacterial spot caused by Xanthomonas campestris pv. vesicatoria (XCV).
4. Effect of specific management practices on percentage of 'Duke' tomato plants in 15.2m of row (entire plot length) with bacterial spot caused by Xanthomonas campestris pv. vesicatoria (XCV).

Thinned in morning (plants wet)

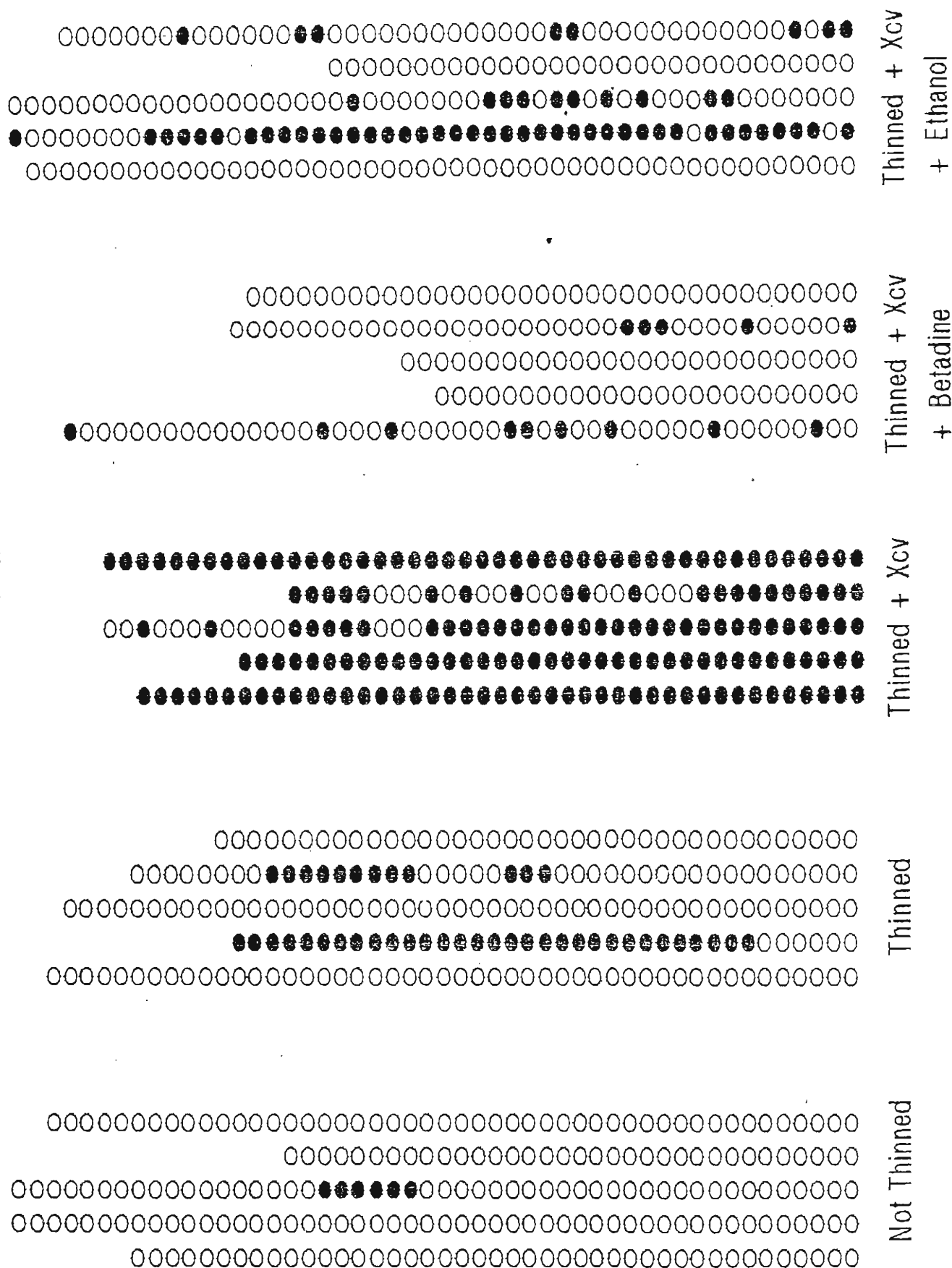


Fig. 2

Thinned in afternoon (plants dry)

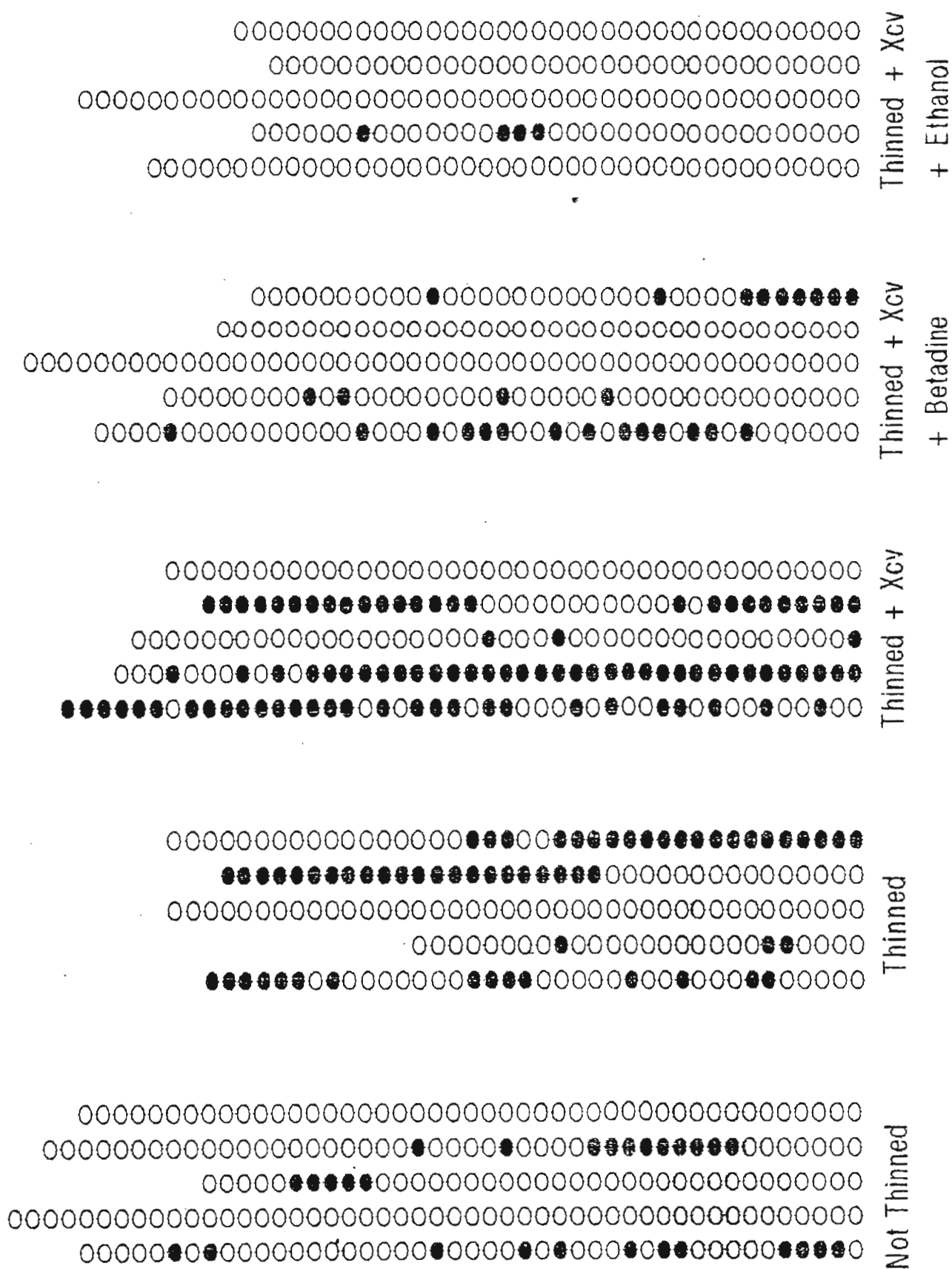


Fig. 3

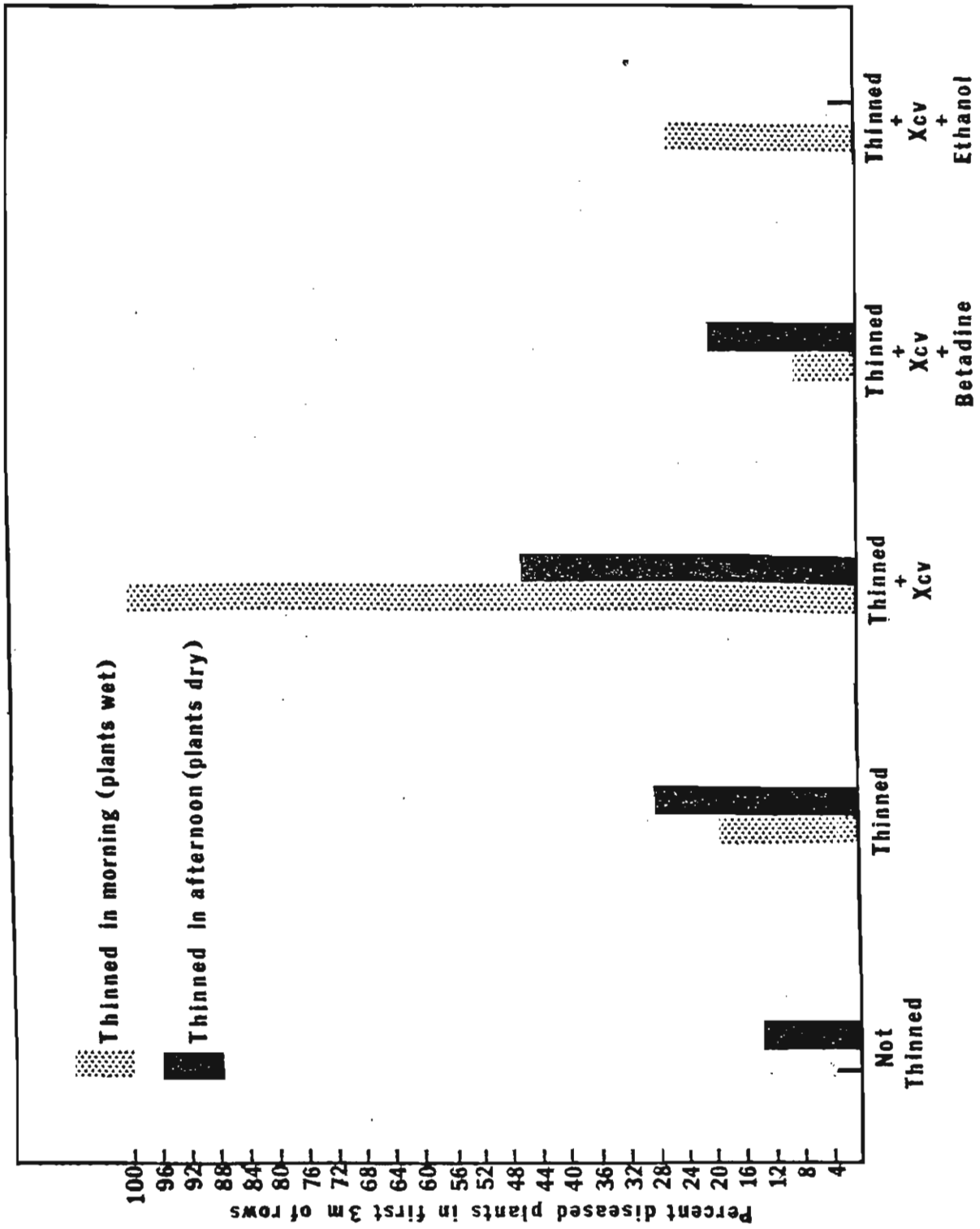
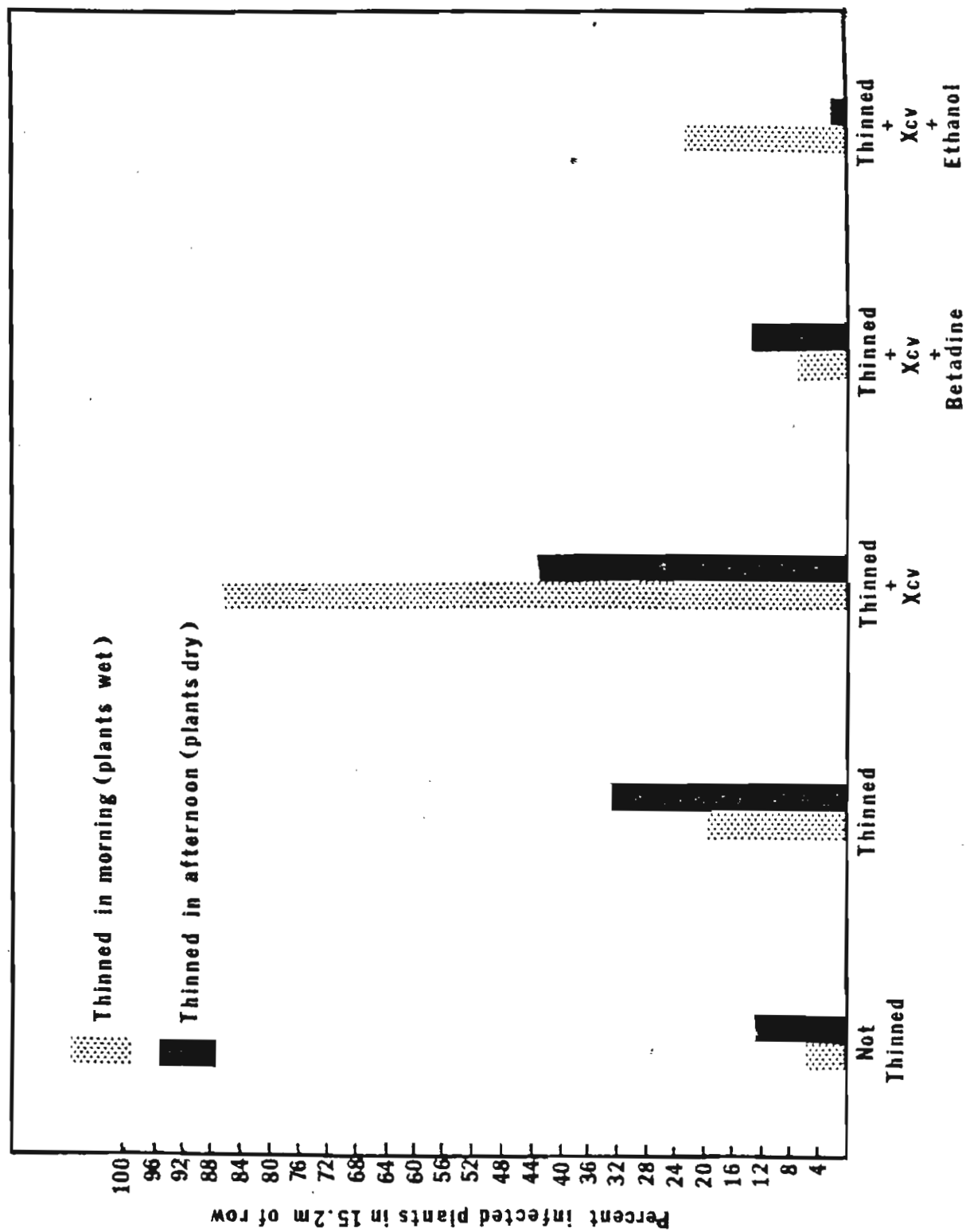


Fig. 4



Preemergence and Postemergence Control
of Nightshade 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, have begun to adversely affect tomato production in the state.

Currently, growers rely predominately on Lexone (Sencor), paraquat (Gramoxone), 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. The rapidity of results is also important; with paraquat, what you see is what you get, so to speak. However, over the past several years growers have reported increased difficulty controlling nightshade with paraquat. Results of a pest survey conducted by the University of Florida identified nightshade as the number one problem for 100% of the grower respondents in the Immokalee-Naples area and was cited as a major problem for many of the growers in the Palmetto-Ruskin production area. Populations of 100 nightshade seedlings per square foot are not uncommon on some farms.

Last year we reported that paraquat appeared to interact with copper residue on the foliage of nightshade, resulting in a substantial decrease in control. However, indications are that interaction with copper may not always be involved in the poor control of nightshade by paraquat.

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 Research 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 7 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 and 1987. 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. Last year we reported that Goal had consistently provided good control of nightshade, regardless of whether it was applied preemergence or early postemergence. No significant injury was ever observed on tomatoes in any of the tests conducted at Bradenton and Immokalee, including grower trials. Trials conducted by the manufacturer in several areas of the state under an experimental use permit in 1986 were also promising. The only injury ever observed was due to spray drift and was not particularly damaging to the tomato plants. All indications were that Goal would be registered for nightshade control in tomato middles by this year. Then something happened to change all of that. In the fall of 1987, several growers in the Naples-Immokalee area applied Goal and had injury appear over one month after application. Goal was immediately blamed; however, in most, if not all instances, Goal was applied as a tank mix with Basagran. Injury developed after a period of heavy rainfall in excess of 7 inches in many fields. Some individuals felt that either the Goal volatilized or moved into the bed with the soil moisture. Volatilization did not appear to be a likely cause since the material generally did not provide weed control for much longer than 60 days in tests and over 30 days passed before the damage occurred. Considering that Goal has a water solubility of 0.1 ppm, a feature for which it was originally chosen for inclusion in the original work at Bradenton, it also seemed unlikely that movement was the problem. Basagran, however, has a water solubility of 500 ppm. Concerned individuals felt that Basagran was not the source of the problem since it had been used in the past by some without damage, although perhaps not under similar environmental conditions. In any event, I regret to inform you that the manufacturer has withdrawn all support for this label and we can kiss that one goodbye. This leaves the industry right where we were 7 years ago. To address the industry's needs for effective pre- and postemergence control, two separate, accelerated herbicide screening programs have been initiated by the authors in commercial fields in the Palmetto-Ruskin and Naples-Immokalee areas. The remainder of this paper will report preliminary results of this work.

Working near Naples, Stall and Brown have conducted preliminary screening with Cobra, Tough, Enquick, Gramoxone (paraquat), Diquat, and tank mixes of Gramoxone, Enquick, and Diquat. Cobra is effective against many weeds when applied both preemergence and postemergence. Cobra is very similar to Goal in chemistry and activity, although research at Bradenton several years ago indicated it was not quite as effective as Goal. Application of 0.4 lb.a.i./acre of Cobra provided about 70% control of young (<4 inches tall) nightshade within 3 days of application and 80% control of regrowth when observed 17 days after application. Only about 50% control was obtained with an application to nightshade which was 5 to 12 inches in height. Tank mixing 0.2 lb.a.i./acre Cobra with 0.5 lb.a.i./acre Gramoxone or Diquat increased control of nightshade to 80% to 90%. By contrast, control with 0.5 lb.a.i./acre Gramoxone was only about 30% and 20% for young and old plants, respectively. Application of 0.5 lb.a.i./acre Diquat alone provided 50 to 70% control, but when tank mixed with the same rate of Gramoxone control ratings rose to 70 to 80%. Enquick alone provided little control. Tank mixing 5 gal./acre of Enquick with 0.5 lb.a.i./acre Gramoxone "burned down" 60% to 70% of the nightshade plants; however, 17 days after application considerable regrowth occurred and the rating dropped to 50% control. Tough was not observed to provide any control of nightshade in this experiment. Gilreath and Gilreath conducted 7 trials in double-cropped cucumbers on a commercial farm in the spring of 1988. Nightshade populations exceeded 100 seedlings per square foot in each trial with about 80% of the seedlings being less than 2 inches in height and remaining plants ranging from 6 to 14 inches tall. One trial involved studying the effectiveness of paraquat (Gramoxone) at rates of 0.5, 1.0, and 1.5 lb.a.i./acre and application volumes of 25, 50, and 100 gal./acre. Very poor control of nightshade seedlings was obtained with Gramoxone at rates as high as 1.5 lb.a.i./acre (1 gal./acre). Application volume had some effect on efficacy with 100 gal./acre providing better control than 50 or 25 gal./acre on a rate for rate basis, but control was still quite poor. Tough, BAS 514, Ignite, Goal, Goal + Fusilade, and Goal + Basagran were evaluated for nightshade control in a separate preliminary screening trial. Tough provided about 70% control of small plants, but less than 30% control of larger plants. Similar results were obtained in a second study with Tough. BAS 514 was slow providing control, but about 90% control was evident after 28 days and remained at this level through 58 days after application. BAS 514 provided about 80% nightshade control for 48 days after application in a second study. As expected, Goal provided 80 to 90+% control of small and large nightshade for 28 days after application with control decreasing to about 70% after 58 days. Tank mixing Goal with Basagran or Fusilade 2000 improved early control of larger nightshade plants, but had no effect on residual control. Additional tests comparing various rates of Goal alone and in combination with Fusilade 2000 or Basagran further substantiated the increase in early control of large nightshade with the tank mix of Goal + Fusilade 2000 and suggested that tank mixing 0.5 lb.a.i./acre Goal with Fusilade 2000 provided control comparable to 1.0 lb.a.i./acre Goal. Results with tank mixes of Goal and Basagran were less conclusive and demonstrated that Basagran did not enhance nightshade control by Goal. Applications of Ignite were extremely efficacious with control ranging from 92 to 100% within 8 days of application. No preemergence activity was observed with this herbicide. Ignite has been evaluated in several vegetable and ornamental crops at Bradenton since an initial trial as a

directed spray in nonmulched tomatoes in 1981. When applied as a directed spray with drift potential minimized, Ignite has not damaged any crops.

Because of the rapidity and completeness of control provided by Ignite, a separate rate and volume study was conducted comparing nightshade control efficacy of Ignite with Roundup. In general, Ignite provided much faster control of nightshade and in many cases was more efficacious on a rate for rate basis at 25 gal./acre of sprayer output. When the volume increased to 50 gal./acre, Ignite was more effective than Roundup.

Based on the results of these studies, research will continue with the more promising herbicides and several new ones in an attempt to find herbicides which would provide effective control of nightshade and would be acceptable to tomato growers.

Acknowledgement: Jim and Phyllis Gilreath wish to thank Allen Williford and Rick Mitchell of Williford Farms for their cooperation in providing several acres of primo nightshade for much of the research reported herein.

Note: Mention of a specific proprietary product does not constitute an endorsement by the authors or the University of Florida. Products mentioned in this manuscript, other than Gramoxone, are not labeled for use on tomatoes and growers are advised to not use them until the products are labeled.

MANAGEMENT OF THE SWEETPOTATO WHITEFLY ON TOMATO CROPS IN SOUTH FLORIDA

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Introduction

Sweetpotato whiteflies recently have made an important impact on tomato production in south Florida. They have caused producers to monitor their crops for a new pest and to modify insect management practices. Field-grown vegetables such as tomato, eggplant, melon, cucumber, pepper and snap bean on the lower east coast were first affected in the spring of 1987 (Schuster and Price 1987). In southwest Florida, whiteflies (probably the sweetpotato whitefly) were first noticed on tomatoes beginning in September 1987 but they did not increase dramatically until February 1988 (Reggie Brown, personal communication). Populations of the sweetpotato whitefly became extremely dense on some tomato farms in southwest Florida during the following weeks. Ornamental crops such as poinsettia, gerbera daisy and hibiscus were affected in 1986 (Price 1987).

Schuster and Price (1987) presented sweetpotato whitefly control and biological information available for Florida tomato crops through August 1987. Osborne and Price (1987) provided an additional summary of important aspects of sweetpotato whitefly identification, biology and behavior. This paper communicates information developed since the time of those publications.

Scouting

Effective management of the sweetpotato whitefly requires that specific action be taken when that insect first appears in a crop. Scouting a crop at least once per week is the best way to detect the initial appearance of the whitefly. Continued scouting provides information on the abundance of various life stages and indicates success of current control tactics and if additional tactics are required.

The sweetpotato whitefly may appear much like the whiteflies commonly seen on citrus or greenhouse crops; however adults of the sweetpotato whitefly hold their wings tightly against their bodies and thus may appear smaller. Sweetpotato whitefly adults have white, unmarked wings and appear as dandruff-like flecks on the undersides of leaves. Scouts, in their weekly inspections should look for adults resting on the undersides of upper leaves or flying from those leaves when disturbed. They can detect adults with yellow sticky traps placed among crop plants or weeds.

Whitefly adults are monitored at the IFAS GCREC in Bradenton using 3" X 12" X 1/8" lemon yellow Plexiglass strips covered with a very thin film of cooking oil (Butler et al. 1986). These yellow traps are placed horizontally in the transplant production house or on plant bed surfaces in the field for about 3 hours on bright mornings. Whitefly adults are attracted to the yellow strips and become stuck in the cooking oil. Whiteflies that are the size, shape or color of known sweetpotato whiteflies are considered "suspected sweetpotato whiteflies". Whiteflies can not be identified conclusively in the adult form. When suspected sweetpotato whiteflies are caught, the foliage of the crop and of known host plants nearby is carefully inspected for immature forms that can be identified conclusively (Hamon and Salguero 1987).

This system has been very effective to detect sweetpotato whitefly infestations early in their development and to indicate effectiveness of pesticides and other control measures. Population monitoring by this method is performed by scouts trained to recognize the suspected sweetpotato whitefly adults entrapped in oil and then to recognize immature forms on foliage for positive identifications. The method may not be reliable when used by less trained individuals.

Leaves found with suspected sweetpotato whitefly colonies and the skins cast by newly emerged adults should be given to local Cooperative Extension Service personnel to obtain reliable identifications. The specimens should be sealed in plastic bags to prevent escape and spread of the whiteflies.

Biology

Most biological activities of the sweetpotato whitefly occur on the undersides of leaves. In GCREC Bradenton greenhouses, the sweetpotato whitefly advances from the newly laid egg (period 1), through the crawler and scale-like nymphal stages (period 2), through the pupal stage (period 3) to the newly emerged adult whitefly (period 4) in 21 days during warm July-September temperatures and in 28 days at cooler September and October temperatures. As temperatures decrease further, time required for each of the developmental stages increases. Time spent in each of the first three developmental periods is about equally divided. Under warm, field conditions in Florida, sweetpotato whiteflies probably lay an average of about 6-12 eggs per day.

Sweetpotato whitefly populations in tomato fields usually will contain all life stages simultaneously. Great variability in time required for development among individuals within a population and frequent arrivals of adult whiteflies into the crop from the neighboring environment ensures populations of mixed life stages. After eggs hatch, the resulting first stage nymphs (crawlers) move a fraction of an inch away from the egg and within a day cease to move; no further movement occurs until the adult whitefly has emerged.

Whitefly nymphal (period 2) and adult stages (period 4) obtain food by ingesting plant sap through sucking mouthparts. Saliva is injected into the plant during feeding. Insect saliva predigests the food and

protects the insect's mouth parts during plant growth. Egg (period 1) and pupal stages (period 3) do not take nourishment from host plants.

Cultural Management Considerations

The best sweetpotato whitefly management begins with sound sanitation and other cultural practices that may avoid, delay or lessen the severity of the problem. Following are some important points of cultural management that can have an important impact on the management of sweetpotato whiteflies in tomato crops:

1. Crop succession. New tomato crops should not be established in or near fields or greenhouses presently experiencing a sweetpotato whitefly problem. Cooperation for whitefly management should be established among neighboring vegetable and ornamental growers.
2. Whitefly movement into transplant production houses. Transplant production houses located in regions where the sweetpotato whitefly occurs should be enclosed where possible to exclude whiteflies. Do not wear yellow clothing or use anything yellow in production houses as sweetpotato whiteflies are attracted by that color and they may hitchhike on such materials or be attracted to tomato production houses.
3. Volunteer plants and weeds. Volunteer tomato and other crop plants and weeds serve as excellent hosts for sweetpotato whitefly between seasons and during production. These plants should be removed from the environs of the tomato land well in advance of the crop.
4. Tomato transplants. A field crop can be infested by whiteflies introduced on transplants. Therefore, transplants should be inspected to ensure they are free of the insects before setting. Plant production houses should be chosen for their reputation for providing top quality material.
5. Post harvest activities. Sweetpotato whiteflies continue to develop on tomato vines after harvest, even after irrigation to the crop has been terminated. These insects can infest other crops and weeds in the area and can serve as a reservoir for whiteflies in the following season. Insecticides should be used to kill adult whiteflies present on the plants when the harvest is complete. The crop then should be destroyed immediately with an approved herbicide.

Where sweetpotato whiteflies have become a problem in a tomato crop, crop management practices will differ from those previously used. Such changes, especially new insecticides chosen and new insecticide schedules, can have an important effect on other insects and mites. In view of these effects, tomatoes should be scouted very carefully for various other pests and plans should be developed to respond to additional pest problems.

Problems Associated with Insecticidal Control

Several insecticides are active against various life stages of the sweetpotato whitefly in Florida. However, to kill a whitefly, the proper insecticide must be delivered to the susceptible stage in the whitefly life cycle. Fortunately, there are some insecticides that can kill sweetpotato whiteflies at either of two life stages (Table 1). Following are some specific problems relating to chemical control of the sweetpotato whitefly:

1. Canopy penetration. Tomato plants form a dense canopy that is difficult to penetrate with insecticide sprays and reach whiteflies on the undersides of leaves. Penetration to the whitefly target on the lower leaf surface is complicated further following each tying operation.
2. Adherence to target insect. Adult whiteflies are covered with waxy secretions that may reduce adherence of insecticide droplets to the insect's living tissues.
3. Consumption of insecticide. Whiteflies are sucking insects so insecticide residues remaining on leaf surfaces are not eaten. Whiteflies consume only liquids from inside the plants. Thus only systemic insecticides in plant sap are ingested by whiteflies. Eggs and pupae do not consume any food from plants and thus are protected from toxicity via ingestion.
4. Walking or landing on insecticide. Sucking insects such as whiteflies may walk or land on insecticide residues and be killed. However, only adults throughout their lives and crawlers in the first hours in that stage are mobile. Eggs, scale-like nymphs and pupae do not move and can not walk or land on a toxic particle.
5. Residual activity of insecticide. Immature stages of whiteflies (except crawlers in their first few hours) are killed only when insecticides are deposited directly on them so advantages of an insecticides' residual activity on leaf surfaces are oftentimes lost.
6. Insecticide resistance. Populations of sweetpotato whitefly in various parts of the world have become resistant to some organophosphorous and some synthetic pyrethroid insecticides (Prabhaker et al. 1985). Uses of some important insecticides may be lost if genes for that resistance are present in whiteflies infesting Florida tomato crops.

Uses of Insecticides.

Insecticides should be applied that kill the stages of the sweetpotato whitefly known to be present in the field. An infested tomato field likely would have all life stages present so weekly applications of an insecticide effective against adults and one effective against nymphs should be made. Alternating among insecticidal groups is essential to reduce the chances of resistance. Following is a list of

insecticides registered on field-grown tomatoes in Florida. The insect stage on which the insecticide is effective is indicated. New uses of any pesticide or pesticide combination, for field-grown, fresh market tomatoes must be approached very cautiously until uncertainties about phytotoxicity have been cleared.

Table 1. Insecticides effective for control of the sweetpotato whitefly life stages indicated and registered for use on tomatoes in Florida.

INSECTICIDAL GROUP	INSECTICIDE	ACTIVITY AGAINST		
		ADULTS	NYMPHS	PUPAE
Carbamate	Vydate	X	X	
Synthetic pyrethroid(*)	Asana	X	X	
	Ambush, Pounce	X	X	
Natural pyrethrum	Pyrenone	X	X	
Chlorinated hydrocarbon	Thiodan	X		
	Lindane	X		
Potassium salts of fatty acids	Safer Insecticidal Soap(**)		X	X

(*) The piperonyl butoxide synergist, Butacide, slightly enhanced the effectiveness of these synthetic pyrethroids.

(**) Safer Insecticidal Soap has not been widely tested under Florida's tomato production conditions.

Pesticide labels inform users how to apply pesticides effectively, safely and legally. Always follow the label and apply pesticides only when permitted. Never use a pesticide or method of application not thoroughly tested for the intended production system as serious losses from plant damage could occur. Sound judgement requires that a small portion of each tomato variety and growth stage be treated and observed for a few days before treating the larger production area.

(The use of trade names in this report does not constitute endorsement by the University of Florida of one product to the exclusion of other properly labelled products.)

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THE 1987-88 TOMATO SEASON
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The Organizational Meeting of the Florida Tomato Committee was held on September 10, 1987, at the Ritz Carlton Hotel, Naples, Florida. The initial regulations were the same as those in effect for the 1986-87 season except 6x7 No. 3 grade tomatoes were eliminated and the regulatory period was extended to June 30th each year. These changes were not approved until February 9, 1988.

Marketing Agreement No. 125 and Order No. 966 for Fresh Florida Tomatoes were amended in 1986 to provide for paid advertising and promotion and production research projects. The production research projects and the education and promotion programs recommended to the Secretary of Agriculture by the Florida Tomato Committee for the 1987-88 season were approved as presented.

The Committee met again on December 15, 1987, at LaBelle, Florida, with the primary reason being to review the activities in the attempt to amend the U. S. Grade Standards for Tomatoes to adopt the Florida sizes. The Committee unanimously reaffirmed their position on amending the U. S. Grade Standards for Fresh Tomatoes.

The Endangered Species Act was also discussed so that Committee members and alternates would better understand some of the restrictions that may be placed on pesticide uses in the future. An update was also presented on a study to determine residues in dump tank water and proper disposal of same after each day's run. Shipment summaries and current activities of the Promotion and Education Program were also discussed.

The Committee's recommendations to eliminate 6x7 No. 3 grade tomatoes and extend the regulatory period until June 30th each season met practically no opposition. 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 February 8, 1988, and continued for the balance of the season. This regulation also applied to imports into the United States. Registered handlers were required to pack only tomatoes that met the Secretary's Order which effectively eliminated the sale of 7x7 and 6x7 No. 3 grade tomatoes inside as well as outside of the production area.

Total acres planted in Mexico were reportedly up; however, Mexico had very poor quality during most of their season. 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.

Total harvested acres in Florida were 53,939, compared to 50,908 the previous season and 45,530 in the 1985-86 season. Districts 2, 3 and 4 had increases of 503, 3,040 and 1,466 acres, respectively. District 1 was down 1,978 acres, giving a net increase of 3,031 acres. Since 1986-87 was 5,378 acres more than 1985-86, Florida had a total net increase of 8,409 acres in two years. There were 4,132 acres less of ground tomatoes and 7,163 acres more of staked tomatoes planted this season. The ratio this season was about 15.5% ground and the rest staked, compared to 25% ground the previous season. The major difference was the large acreage in Dade County that was grown on metal stakes this season. Total shipments were 64,746,068 25-lb. equivalents compared to 56,366,486 the previous season.

Total shipments were up 8,379,582 25-lb. equivalents from the previous season. Weather conditions that prevailed throughout most of the winter season and irregular ripening problems in the spring prevented the shipments from being much higher. Fair crops were produced in the fall and winter seasons. Cold, windy weather caused bloom drop, scarring and a lot of misshapen fruit. Cold, wet conditions enhanced disease problems, making it nearly uncontrollable in some fields. Irregular ripening problems believed to be associated with heavy infestations of the sweet potato white fly caused severe problems in February, March and early April.

Harvesting of the fall crop began in Districts 1, 3 and 4 in mid-October with District 2 starting one week later. It is becoming increasingly more difficult to separate production areas and shipping areas since more and more crops are transported to other districts to be packed. Total shipments from all districts exceeded one million packages by the week ending November 14 and remained above one million per week until June 18th. There were 15 weeks with shipments exceeding two million 25-lb. equivalents, with two over three million, and one over four million.

District 2 started harvesting the last week of October and continued shipping good volume through the first week of May. Acreage planted for harvest was up 11 percent over the previous season but total shipments were up about 23.6 percent. Weekly shipments from this district exceeded 200,000 25-lb. equivalents for 22 weeks during the season with 11 of these weeks exceeding 300,000 25-lb. equivalents and three exceeding 400,000.

District 1 started shipping in mid-October, but most of the early tomatoes were trucked in from District 3. Shipments were less than 100,000 25-lb. equivalents until mid-December when normal production started in Dade County. Weekly volume increased steadily to mid-February and then remained constant through mid-April, and for all practical purposes, ended the first week of May. Total acres planted for harvest was down approximately 18 percent but shipments were up about 30 percent over the previous season. The contributing factors to this increase included a poor crop in 1986-87, more than 4,000 acres being planted on stakes this season, and much better size than normal on both ground and staked crops.

District 3 started shipping the last of October and by November 14 weekly shipments totalled more than 400,000 packages per week. The volume increased rapidly, and remained well above one half million packages per week for 25 of the remaining 30 weeks. Cold, windy, rainy weather caused grade outs to be high and reduced average yields on most farms, but the major problem was irregular ripening. Although it has not been definitely confirmed, it is believed the problem was associated with the sweet potato white fly. Losses on some farms exceeded 30 percent of the crop. Total shipments were up about 7.6 percent over the previous season, and acreage harvested was up nearly 20 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 the packinghouse in another district.

District 4 started harvesting in mid-October and reached shipments total-ling more than 500,000 25-lb. equivalents by the fourth week. Fall acreage was up about 12.5 percent and shipments were up nearly 20 percent. About 6.9 mil-lion 25-lb. equivalents were shipped from District 4 during the fall season compared to 5.7 million the previous season. 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 mid-April. About 575 more acres were harvested this spring, and shipments were up about ten per-cent. During the last 11 weeks of the season, District 4 shipped more than 15 million 25-lb. equivalents, but slightly more than 13.3 million of these were shipped in a seven-week period. Basic quality and size were good during most of this period. Prices were low for most of the spring season. Strong winds in late March and April caused severe scarring and misshapen fruit. Many fields were picked only twice due to price.

The total 64,746,068 25-lb. equivalents were shipped over a 37-week peri-od. Thirty-one of these weeks had shipments exceeding one million packages with 15 weeks showing more than two million, two weeks with more than three million, and one week with more than four million 25-lb. equivalents. The total shipments were up 8,379,582 25-lb. equivalents from the previous season.

The total value of the crop was about 465 million dollars, compared to 410.1 million the previous season. The average price was \$7.18 per 25-lb. equivalent for the entire season, compared to \$7.28 per 25-lb. equivalent for the 1986-87 season and \$7.78 for 1985-86. Evenly spaced supplies during the winter season and the lack of a freeze causing major replanting helped stabi-lize the season's average price. Tables Two, Three, Four and Five show the variations in average price between the districts.

During the 1987-88 season, there were about 15 different commercial vari-eties planted, which was about the same as last season. Sunny, Duke, F.T.E. No. 12, and BHN 26 accounted for nearly 94 percent of the total acreage. Some

of the other varieties planted were Freedom, Castle 1035, Floradade, Floratom, Pacific, Hayslip, Castleking, Summit and Mountain Pride. 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 additional 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.

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 almost 80% of the state's acreage. The proportion of acreage in which 'Sunny' is planted has gradually increased in each of the last five years. 'Sunny' accounts for almost all the commercial acreage in southwest Florida and the east coast, and about 85% 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 60% of the acreage there. A few acres of 'Duke' are grown in the

other production areas. The 'Duke' acreage in Dade County and statewide is declining. Overall, 'Duke' acreage is just over 10% of the statewide total.

'FTC-12' accounts for about 10% of the Dade County acreage and 2% of the statewide acreage, making it the fourth most important variety overall. There appears to be a decline in 'FTC-12' acreage in Dade County and statewide in the past few years. Only a few acres of 'FTC-12' are grown outside of Dade County.

'BHN 26' and 'Castleking' acreage increased in Palmetto-Ruskin and Dade County, respectively, in the 1987-88 season. 'BHN 26' is now the second most important variety in Palmetto-Ruskin and ranks third in acreage statewide. Small acreages of 'Flora-Dade', 'Floratom II', 'Castlehy 1035', 'Pacific', 'Hayslip', and 'Summit' were also grown in the 1987-88 season.

1987 Variety Trial Results

Tomato variety trial results are reported from the North Florida Research & Education Center, Quincy for Spring 1987 and from the Gulf Coast Research & Education Center, Bradenton for Fall 1987 and the Agricultural Research & Education Center, Ft. Pierce for the Fall 1987 and Spring 1988 seasons. At Quincy, NKH 1013 produced high yields and large fruit size. At Bradenton, 'Solar Set' and IFAS 7193 produced high early and total yields and large fruit size. At Ft. Pierce, 'Solar Set', IFAS 7168, Duke, Horizon, and IFAS 7193 produced high total yields and large fruit size.

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. Tomato Variety Trial Summary

Spring 1987: Quincy (2)

Total Yield	*Fruit Size
Floratom II	IFAS 7178
NVH 4459	NKH 1013
IFAS 7196	XPB 5074
NKH 1013	IFAS 7168
All Star	Horizon

Fall 1987: Bradenton (1)

Yield		Fruit Size
Early	Total	
Solar Set	Solar Set	IFAS 7193
IFAS 7193	Pacific	Solar Set
IFAS 7182	Duke	Pacific
Regency	Bonita	Duke
Castleking	IFAS 7193	Horizon

Fall 1987: Ft. Pierce (3)

Total Yield	Fruit Size
Solar Set	IFAS 7193
IFAS 7168	Solar Set
IFAS 7193	IFAS 7182
IFAS 7181	IFAS 7168
Duke	FTC 12

Spring 1988: Ft. Pierce (3)

Total Yield	Fruit Size
Solar Set	IFAS 7193
Horizon	Solar Set
Sunny	Horizon
IFAS 7211	Duke
Duke	

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.

FloraTom II (CF,NF) Petoseed. A jointless, determinate mid-season, large fruited hybrid available from Agrisales, Inc. and S&M Farm Supply. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot, Alternaria Stem Canker. FOR TRIAL.

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).

FTC 12 (SF, SWF, CF) Petoseed. An early to midseason, jointless, determinate hybrid developed for members of the Florida Tomato Committee. 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.

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.

Solar Set (F) IFAS. An early, large-fruited, jointed hybrid. Determinate. Fruit set under high temperatures (92°F day/72° night) is superior to other commercial varieties. Resistant: Fusarium Wilt (Race 1 and 2), Verticillium Wilt (Race 1) and Gray Leaf Spot. FOR TRIAL.

Summer Flavor Brand 6000 (SWF) Abbott & Cobb. A mid-season, jointless, determinate hybrid. Large, deep globe fruit. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2). 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) Sunseeds. 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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IX AA-1

Dr. Freddie Johnson, Extension Entomologist

INSECT CONTROL IN TOMATOES

Ants

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
carbaryl (Sevin)	5 B	20 - 40 lb	0

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Aphids

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
aliphatic petroleum (JMS Stylet Oil)	97.6% EC	see label	see label
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
demeton (Systox)	2 EC	1 - 1 1/2 pt per 100 gal	3
diazinon	4 EC	1/2 pt	1
dimethoate (Cygon, Defend)	4 EC	1/2 - 1 pt	7
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row space)	30
endosulfan (Thiodan) (green peach aphid)	3 EC	2/3 qt	1
esfenvalerate (Asana) (potato aphid)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin) (potato aphid)	2.4 EC	5 1/3 - 10 2/3 oz	1
lindane (Isotox-lindane)	25 WP	1 lb	Do not apply after fruits start to form.
malathion	5 EC	1 pt per 100 gal	1
methamidophos (Monitor)	4 EC	1 1/2 - 2 pt	7
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1
mevinphos (Phosdrin)	4 EC	1/4 - 1/2 pt	1
methyl parathion	4 EC	1 - 3 pt	15
parathion	4 EC	1 - 2 pt	10
phosphamidon	8 EC	1/2 pt	10
pyrethrins + piperonyl butoxide (Pyrenone) (green peach aphid)	66% liquid (EC)	2 - 6 oz per 100 gal	0

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IX AA-3

Armyworms

See also: Beet, Fall, Southern, and Yellow-Striped Armyworm

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
Bacillus thuringiensis (Javelin)	See label for rates and instructions		
carbaryl (Sevin)	5 B	20 - 40 lb	0
diazinon	4 EC	3/4 - 1 pt	6
esfenvalerate (Asana) (sugarbeet, Western yellow-striped)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin) (Southern, Sugarbeet, Western Yellow-Striped)	2.4 EC	5 1/3 - 10 2/3 oz	1
methomyl (Lannate, Nudrin)	1.8 L	1 - 2 pt	1
methyl parathion	4 EC	1 - 3 pt	15
parathion (up to 3rd instar)	4 EC	1 - 2 pt	10
trichlorfon (Dylox, Proxol)	5 B	20 lb	28

Fall Armyworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbaryl (Sevin)	80 WP	1 1/2 - 2 1/2 lb	0
diazinon	4 EC	3/4 - 1 pt	1
methomyl (Lannate, Nudrin)	1.8 L	2 pt	1
methoxychlor	2 EC	2 - 6 qt	1 for 3 1/2 qt 7 for 3 1/2+ qt

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IX AA-4

Southern Armyworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
diazinon	4 EC	3/4 - 1 pt	1
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of
(Pounce)	3.2 EC	2 - 8 oz	harvest

* 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 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.

Beet Armyworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
fenvalerate (Pydrin) (Sugarbeet armyworm)	2.4 EC	5 1/3 - 10 2/3 oz	1
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of
(Pounce)	3.2 EC	2 - 8 oz	harvest

* 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 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.

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IX AA-5

Yellow-Striped Armyworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	3 - 6 pt	14
endosulfan (Thiodan)	3 EC	1 1/3 qt	1
fenvalerate (Pydrin) (Western Yellow Striped)	2.4 EC	5 1/3 - 10 2/3 oz	1

Banded Cucumber Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	1 1/2 - 2 pt	0
diazinon	4 EC	3/4 - 1 pt	1
lindane (Isotox-lindane) larvae	25 WP	1 - 2 lb	preplant (soil)

Beetles

See also: Banded Cucumber, Blister, Colorado Potato, Darkling Ground, Flea, and Potato Flea Beetle

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label

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IX AA-6

Blister Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
cryolite (Kryocide)	96 WP	15 - 30 lb	wash fruit
endosulfan (Thiodan)	3 EC	2/3 qt	1
methoxychlor	2 EC	2 - 6 qt	1 for 3 1/2 qt 7 for 3 1/2+ qt
parathion	4 EC	1 - 2 pt	10

Cabbage Loopers

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
Bacillus thuringiensis (Bactur, Bactospeine, Dipel, Sok, Stan-Guard, Thuricide)	See individual labels.		0
cryolite (Kryocide)	96 WP	15 - 30 lb	wash fruit
endosulfan (Thiodan)	3 EC	1 qt	1
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1
methyl parathion	4 EC	2 - 3 pt	15
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of harvest
(Pounce)	3.2 EC	2 - 8 oz	

* 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 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.

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IX AA-7

Colorado Potato Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	1 1/2 pt	0
carbaryl (Sevin)	80 WP	2/3 - 1 1/4 lb	0
disulfoton (Di-Syston)	8 EC	1.2 - 3.5 fl oz per 1000 ft row (any row spacing) or 1 - 3 pt per acre (38" row spacing)	30
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row spacing) or 6.7 - 20 lb per acre (38" row spacing)	30
endosulfan (Thiodan)	3 EC	2/3 qt	1
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methoxychlor	2 EC	2 - 6 qt	1 for 3 1/2 qt 7 for 3 1/2+ qt
parathion	4 EC	1 - 2 pt	10
PennCap-M	2 EC	4 pt	15
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of harvest
(Pounce)	3.2 EC	2 - 8 oz	
phosphamidon	8 EC	1/2 pt	10
pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2 - 6 oz per 100 gal	0
rotenone (Rotenox)	5% liquid	2/3 gal	0

* 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 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.

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IX AA-8

Corn Earworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	3 - 6 pt	14

Crickets

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbaryl (Sevin)	5 B	20 - 40 lb	0
trichlorfon (Dylox, Proxol)	5 B	20 lb	28

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IX AA-9

Cutworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
carbaryl (Sevin)	80 WP	2 1/2 lb	0
carbaryl (Sevin)	5 B	20 - 40 lb	0
diazinon	14 G	14 - 28 lb	preplant
diazinon	4 EC	2 - 4 qt	preplant
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
lindane (Isotox-lindane)	25 WP	1 - 2 lb	preplant (soil)
methomyl (Lannate) (varigated cutworm)	1.8 L	2 pt	1
permethrin* (Ambush) (Pounce) (granulate cutworm)	2 EC 3.2 EC	3.2 - 12.8 oz 2 - 8 oz	up to day of harvest
trichlorfon (Dylox, Proxol) (surface-feeding cutworms)	5 B	20 lb.	28

* 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 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.

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IX AA-10

Darkling Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbaryl (Sevin)	5 B	20 - 40 lb	0

Drosophilas (fruit flies)

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	1 1/2 - 2 pt	0
diazinon	4 EC	1/2 - 1 1/2 pt	1
malathion	5 EC	2 1/2 pt	1
naled (Dibrom)	8 EC	1 pt	1

European Corn Borers

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0

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IX AA-11

Flea Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
carbaryl (Sevin)	80 WP	2/3 - 1 1/4 lb	0
carbophenothion (Trithion) (potato flea beetle)	8 EC	1/2 - 1 pt	7
cryolite (Kryocide)	96 WP	15 - 30 lb	wash fruit
disulfoton (Di-Syston)	8 EC	1.2 - 3.5 fl. oz per 1000 ft row (any row spacing) or 1 - 3 pt per acre (38" row spacing)	30
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row spacing) or 6.7 - 20 lb per acre (38" row spacing)	30
endosulfan (Thiodan)	3 EC	2/3 qt	1
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methyl parathion	4 EC	1 - 3 pt	10 for 1 pt 15 for 1+ pt
methoxychlor	2 EC	2 - 6 qt	1 for 3 1/2 qt 7 for 3 1/2+ qt
naled (Dibrom)	8 EC	1 pt	1
parathion	4 EC	1 - 2 pt	10
PennCap-M	2 EC	2 - 4 pt	15
phosphamidon	8 EC	1/2 pt	10
pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2 - 6 oz per 100 gal	0

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IX AA-12

Garden Symphylans

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
fonofos (Dyfonate)	10 G	20 lb	preplant, broadcast

Grasshoppers

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
carbaryl (Sevin)	5 B	20 - 40 lb	0
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
mevinphos (Phosdrin)	4 EC	1/2 - 1 pt	1
parathion	4 EC	1 - 2 pt	10

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IX AA-13

Hornworms (tomato hornworm)

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	3 - 6 pt	14
Bacillus thuringiensis (Bactospeine, Bactur, Dipel, Sok, Stan-Guard, Thuricide)	See individual labels.		0
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0
cryolite (Kryocide)	96 WP	15 - 30 lb	wash fruit
endosulfan (Thiodan)	3 EC	2/3 - 1 1/3 qt	1
esfenvalerate (Asana) (tomato hornworm, tobacco hornworm)	1.9 EC	0.85-1.7 fl oz	1
fenvalerate (Pydrin)	2.4 EC	2 2/3 - 5 1/3 oz	1
methomyl (Lannate)	1.8 L	2 - 4 pt	1
naled (Dibrom)	8 EC	1 pt	1
PennCap-M	2 EC	4 pt	15
permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2 - 12.8 oz 2 - 8 oz	up to day of harvest
trichlorfon (Dylox, Proxol)	80 SP	20 oz	21

* 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 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.

Lace Bugs

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0

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IX AA-14

Leafhoppers

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
carbaryl (Sevin)	80 WP	2/3 - 1 1/4 lb	0
carbophenothion (Trithion) (potato leafhopper)	8 EC	1/2 - 1 pt	7
disulfoton (Di-Syston)	8 EC	1.2 - 3.5 fl oz per 1000 ft row (any row spacing) or 1 - 3 pt per acre (38" row spacing)	30
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row spacing) or 6.7 - 20 lb per acre (38" row spacing)	30
dimethoate (Cygon, Defend)	4 EC	1/2 - 1 pt	7
methoxychlor	2 EC	2 - 6 qt	1 for 3 1/2 qt 7 for 3 1/2+ qt
methyl parathion	4 EC	1 - 2 pt	15
mevinphos (Phosdrin)	4 EC	1/2 - 1 pt	1

Leafminers

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
azinphosmethyl (Guthion)	2 S (EC)	1 1/2 - 2 pt	0
carbophenothion (Trithion)	8 EC	1/2 - 1 pt	7
diazinon	4 EC	1/2 pt	1

(cont'd)

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Leafminers - cont'd

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
diazinon	50 WP	1/2 lb	1
dimethoate (Cygon, Defend)	4 EC	1 1/2 - 1 pt	7
disulfoton (Di-Syston)	8 EC	1.2 - 3.5 fl oz per 1000 ft row (any row spacing) or 1 - 3 pt per acre (38" row spacing)	30
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row spacing) or 6.7 - 20 lb per acre (38" row spacing)	30
ethion	4 EC	1 pt	2
fenvalerate (Pydrin)	2.4 EC	10 2/3 oz	1
lindane (Isotox-lindane)	25 WP	1 1/2 lb	Do not apply after fruit starts to form
methamidophos (Monitor) adults	4 EC	1 1/2 - 2 pt	7
naled (Dibrom)	8 EC	1 pt	1
oxamyl (Vydate L)	2 EC	2 - 4 pt per 100 gal	1
parathion	4 EC	1 - 2 pt	10
PennCap-M	2 EC	2 - 4 pt	15
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of harvest
(Pounce)	3.2 EC	2 - 8 oz	
phorate (Thimet)	20 G	11.3 oz per 1000 ft row (min 38" spacing)	at planting
phosphamidon	8 EC	1/2 pt	10
trichlorfon (Dylox, Proxol)	80 SP	20 oz	21

* 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 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.

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Loopers

See also: Cabbage Looper

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
Bacillus thuringiensis (Javelin)	See label for rates and instructions		
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1

Mites

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
MITES (GENERAL):			
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
carbophenothion (Trithion) (russet, tropical and two-spotted mites)	4 EC	1 - 2 pt	7
demeton (Systox)	2 EC	1 - 1 1/2 pt per 100 gal	3
dicofol (Kelthane)	1.6 EC	1 - 2 qt	2
disulfoton (Di-Syston)	8 EC	1.2 - 3.5 fl oz per 1000 ft row (any row spacing) or 1.3 pt (38" row spacing)	30
disulfoton (Di-Syston)	15 G	8 - 23.4 oz per 1000 ft row (any row spacing) or 6.7 - 20 lb per acre (38" row spacing)	30
ethion (tropical, two-spotted and tomato russet mites)	4 EC	1 pt	2
methyl parathion	4 EC	1 - 2 pt	15
mevinphos (Phosdrin)	4 EC	1/2 - 1 pt	1
naled (Dibrom)	8 EC	1 pt	1

(cont'd)

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Mites - cont'd

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
TOMATO RUSSET MITE:			
endosulfan (Thiodan)	3 EC	1 1/3 qt	1
malathion	25 WP	2 - 4 lb	1
methyl parathion	4 EC	1 - 3 pt	15
parathion	4 EC	1 - 2 pt	10
sulfur (Kolospray)	81% WP	7 lb	0
sulfur (Magneticide)	6 F	1/2 - 1 gal	0
SPIDER MITE:			
malathion	5 EC	1 1/2 pt per 100 gal	1

Mole Crickets

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
diazinon	15 G	7 lb	preplant
diazinon	4 EC	1 qt	preplant, broadcast

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IX AA-18

Pinworms (tomato pinworm)

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
azinthosmethyl (Guthion)	2 S (EC)	3 - 6 pt	14
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0
cryolite (Kryocide)	96 WP	15 - 30 lb	wash fruit
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methamidophos (Monitor) (suppression of low populations)	4 EC	1 1/2 - 2 pt	7
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt (ground application only)	1
PennCap-M	2 EC	4 pt	15
permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2 - 12.8 oz 2 - 8 oz	up to day of harvest

* 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 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.

Plant Bugs

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0
methyl parathion	4 EC	2 pt	15
parathion	4 EC	1 - 2 pt	10

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Potato Flea Beetles

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbophenothion (Trithion)	8 EC	1/2 - 1 pt	7

Potato Psyllids

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbophenothion (Trithion)	4 EC	1 - 2 pt	7
endosulfan (Thiodan)	3 D	33 lb	1
methyl parathion	4 EC	1 - 3 pt	15
parathion	4 EC	1 - 2 pt	10

Saltmarsh Caterpillars

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
trichlorfon (Dylox, Proxol)	5 B	20 lb	28

Sowbugs

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
carbaryl (Sevin)	5 B	20 - 40 lb	0

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Stinkbugs

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion) (green stinkbugs)	2 S (EC)	1 1/2 - 2 pt	0
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0
endosulfan (Thiodan)	3 EC	1 - 1 1/3 qt	1
parathion	4 EC	1 - 2 pt	10
phosphamidon	8 EC	1/2 pt	10
pyrethrins + piperonyl butoxide (Pyrethone)	66% liquid (EC)	2 - 6 oz per 100 gal	0

Thrips

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	2 - 3 pt	0
lindane (Isotox-lindane)	25 WP	1 lb	Do not apply after fruit starts to form
parathion	4 EC	1 - 2 qt	10

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Tomato Fruitworms (corn earworm)

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinthosmethyl (Guthion)	2 S (EC)	3 - 6 pt	14
carbaryl (Sevin)	80 WP	1 1/4 - 2 1/2 lb	0
cryolite (Krocide)	96 WP	15 - 30 lb	wash fruit
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
methamidophos (Monitor)	4 EC	1 1/2 - 2 pt	7
methomyl (Lannate, Nudrin)	1.8 L	2 - 4 pt	1
naled (Dibrom)	8 EC	1 pt	1
PennCap-M	2 EC	4 pt	15
permethrin* (Ambush)	2 EC	3.2 - 12.8 oz	up to day of harvest
(Pounce)	3.2 EC	2 - 8 oz	

* 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 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.

Tuberworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinthosmethyl (Guthion)	2 S (EC)	2 1/4 - 3 pt	0

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Weevils

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
allethrin (Pyrellin SCS)	1% liquid (EC)	1 - 1 1/2 pt	see label

Whiteflies

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
azinphosmethyl (Guthion)	2 S (EC)	1 1/2 - 2 pt	0
endosulfan (Thiodan)	3 EC	2/3 qt per 100 gal	1
esfenvalerate (Asana)	1.9 EC	1.7-3.4 fl oz	1
fenvalerate (Pydrin)	2.4 EC	5 1/3 - 10 2/3 oz	1
parathion	4 EC	1 - 2 pt	10
phosphamidon	8 EC	1/2 pt	10

White Grubs

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
lindane (Isotox-lindane)	25 WP	1 - 2 lb	preplant (soil)

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IX AA-23

Wireworms

Insecticide	Formulation	Rate/Acre	Min. Days to Harvest
diazinon	14 G	21 - 28 lb	preplant
diazinon	2 B	50 lb	none listed
diazinon	14 G	70 lb	preplant, broadcast
diazinon	4 EC	10 qt	preplant, broadcast
fonofos (Dyfonate)	10 G	20 lb	preplant, broadcast
lindane (Isotox-lindane)	25 WP	1 - 2 lb	preplant (soil)
parathion	10 G	30 - 40 lb	preplant, broadcast & disc 3 wks preplanting
parathion	4 EC	5 qt	apply to soil surface preplanting & work 6-9" into soil

NEMATODE CONTROL IN TOMATOES,
PEPPERS, & EGGPLANTS

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January 1988

II E-1

NEMATODE CONTROL IN TOMATOES, PEPPERS, & EGGPLANTS

These crops share similar nematode problems and nematicide registrations, and are grown and handled similarly. Their most important nematode pests are root-knot (in sand, muck and Dade Co. rock-based soils), stubby-root (in sand and muck soils), and sting (in sands) nematodes. Fumigants (Table 1) are much more consistently effective against root-knot nematodes than the non-fumigants (Table 2); under some circumstances, non-fumigants are more effective against stubby-root nematodes than are fumigants; most nematicides can be effective against sting nematodes if applied properly.

Tomatoes, peppers and, to some extent eggplant are produced on plastic-mulched beds in many areas of Florida. These beds are routinely fumigated with a multi-purpose fumigant at the time they are covered for broad spectrum soil pest control. Several brands of the fumigants used most widely for tomatoes, including many different methyl bromide/chloropicrin mixtures, have also been registered for peppers and/or eggplant. There is evidence to suggest that some formulations may be better suited for control of specific pest complexes (i.e., combinations of nematodes, weeds, and/or fungi). However, the GROWER must check the label of the product he is actually using to be sure that it is registered for the crops to be grown in the soil being treated. Most multi-purpose fumigants which do not contain methyl bromide may be legally used to treat production fields for nearly any vegetable crop.

TABLE 1. FUMIGANT NEMATICIDES FOR TOMATOES, PEPPERS AND EGGPLANTS IN FLORIDA. (Rates are believed to be correct for products named, and similar products of other brand names, when applied to mineral soils. Higher rates are required for muck (organic) soils. However, the GROWER has the final responsibility to see that each product is used legally; READ THE LABEL of the product to be sure that you are using it properly.)

Nematicide	Broadcast (overall) application		Row Application (single chisel/row)	
	Gallons/ acre	Fl oz/1000 ft/chisel spaced 12"	Gal/acre 36" row*	Fl oz/1000 ft/chisel, any spacing
Telone II**	12-15	35-44	5.3-6.7	46-62

*Gal/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. If using more than one chisel/row, space chisels and apply the same flow rate of fumigant/chisel as for broadcast application.

**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 Flagler counties. A result of this action is that there is no fumigant nematicide, except multi-purpose fumigants, which are available for use on this crop in much of Florida. Information about use of Telone II is provided to guide final use of existing supplies.

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TABLE 2. NON-FUMIGANT NEMATOCIDES FOR TOMATOES AND PEPPERS IN FLORIDA.
(These products are not as consistently effective against root-knot nematodes as the fumigants, but are registered as indicated.)

Product	Broadcast or Overall Rates		Row Rates	
	Per Acre	Per 1000 sq ft	Per Acre, 36' Inch Row Spacing	Per 1000 ft of Row, Any Row Spacing
Dasanit 15G*	66.7-134 lb	1.5-3.0 lb	22-43 lb	1.5-3.0 lb
Furadan 15G**	---	---	13.3-20 lb	14-22 oz

Vydate L - Tomatoes and peppers: treat soil before or at planting with any other appropriate nematocide or a Vydate transplant water drench followed by Vydate 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.

*Tomatoes only: early season suppression of nematodes.

**Peppers only: one preplant application of Furadan granules in a 12 to 14 inch band per growing season, incorporated in top 3" of soil for sting nematodes only.

IMPORTANT WARNING! Carbofuran is a chemical which can travel (seep or leach) through soil and can contaminate ground water as a result of agricultural use. Carbofuran has been found in ground water as a result of agricultural use. Users are advised not to apply carbofuran where the water table (ground water) is close to the surface and where the soils are very permeable i.e., well-drained soils such as loamy sands. Your local agricultural agencies can provide further information on the type of soil in your area and the location of ground water. In addition, some product label statements include as a further qualification of risky soils, soils containing sinkholes over limestone bedrock, severely fractured surfaces, and substrates which would allow direct introduction into an aquifer. A more complete discussion of this risk of groundwater contamination appears at the beginning of this Guide, immediately following the Table of Contents.

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NON-FUMIGANT NEMATICIDE VEGETABLE CROP REGISTRATION

-----Non-Fumigant Nematicide-----							
Crop	Temik	Furadan*	Mocap	Counter	Dasanit	Nemacur	Vydate
Beans			X				
Peas			X				
Corn, sweet		X	X	X	X		
Cabbage			X			X	
Brussel sprouts						X	
Cucumber		X	X				X
Melons		X					X
Squash		X					X
Okra						X	
Potatoes	X	X	X				
Potatoes, sweet	X		X		X		
Tomato					X		X
Pepper		X					X

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This information was compiled as a quick reference for the commercial Florida fruit and vegetable grower. The mention of a chemical or proprietary product in this publication does not constitute a written recommendation or an endorsement 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 or practices that may be suitable. Products mentioned in this publication are subject to changing State and Federal rules, regulations and restrictions. Additional products may become available or approved for use. Growers have the final responsibility to guarantee that each product is used in a manner consistent with its label.

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Methyl Bromide/Chloropicrin Formulations Used on Various Crops

Crop/Use	Formulations: % Methyl Bromide / % Chloropicrin										
	98 2	88.2 1.8	80 20	75 25	70 30	68.6 1.4	67 33	57 43	50 50	45 55	0 100
Asparagus			*				*				
Broccoli	*	*	*	*			*				
Cauliflower	*	*	*	*			*				
Cucumber											*
Eggplant	*		*	*			*				*
Melons	*			*			*				*
Muskmelon	*	*	*				*				
Onions (bulb)			*				*				
Onions			*				*				*
Peppers	*	*	*	*			*				
Strawberry	*	*	*	*	*	*	*	*	*	*	*
Sweet Potato											*
Tomato	*	*	*	*	*	*	*	*	*		*
Vegetable	*	*				*	*				
Plant Bed				*	*			*	*		*
Seed Bed	*		*	*			*	*		*	
Greenhouse	*		*				*				
Soil Fumigation			*				*				
Potting Soil	*		*				*				
Topsoil	*										

Other fumigants for vegetable crops: VAPAM, BUSAN 1020, VORLEX, VORLEX 201, TELONE II, Telone C-17

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WEED CONTROL IN TOMATOES

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XVII-1

WEED CONTROL IN TOMATOES

Herbicide	Labelled Crops	Time of Application to Crop	Rate (lbs. ai./acre)
Chloramben (Amiben)	Tomatoes (established)	Postemergence or posttransplant	3.0

REMARKS: 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.

Chloramben (Amiben)	Tomatoes (established)	Post planting or post trans- planting	3.0
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REMARKS: 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 Florida beggarweed.

DCPA (Dacthal)	Established tomatoes	Posttrans- planting after crop establishment (non-mulched)	6.0 - 8.0
		Mulched row middles after crop establishment	6.0 - 8.0

REMARKS: Controls germinating annuals. Apply to weed-free soil 6-8 weeks after crop 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 Postemergence Posttransplant incorporated	3.0 - 4.0
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REMARKS: Controls germinating annuals. Apply to moist soil 1 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 amaranth, bermudagrass, goosegrass, seedling johnsongrass, lambsquarter, pigweed, purslane, Fla. pusley and others.

(cont'd)

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XVII-2

Tomatoes - cont'd

Herbicide	Labelled Crops	Time of Application to Crop	Rate (lbs. ai./acre)
Metribuzin (Sencor)	Tomatoes	Postemergence, Posttransplanting after establishment	0.25 - 0.5

REMARKS: Controls small emerged weeds after transplants are established 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 (Sencor, Lexone)	Tomatoes	Directed spray in row middles	0.25 - 1.0
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REMARKS: 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, amaranthus sp., Florida pusley, common ragweed, sicklepod, and spotted spurge.

Napropamid (Devrinol)	Tomatoes	Preplant incorporated	1.0 - 2.0
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REMARKS: 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.

Napropamid (Devrinol)	Tomatoes	Surface treatment	2.0
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REMARKS: Controls germinating annuals. Apply to bed tops after bedding but before plastic application. Rainfall or overhead irrigate sufficient to wet soil 1 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, Florida pusley, and signalgrass.

Paraquat (Gramoxone)	Tomatoes	Premergence Pretransplant	0.5 - 1.0
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REMARKS: Controls emerged weeds. Use a non-ionic spreader and thoroughly wet weed foliage.

(cont'd)

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XVII-3

Tomatoes - cont'd

Herbicide	Labelled Crops	Time of Application to Crop	Rate (lbs. ai./acre)
Paraquat (Gramoxone)	Tomatoes	Post directed spray in row middle	0.5

REMARKS: 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.

Sethoxydim (Poast)	Tomatoes	Postemergence	0.188 - 0.28
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REMARKS: Controls actively growing grass weeds. A total of 4 1/2 pt product per acre may be applied in one season. Do not apply within 20 days of harvest. Apply in 5 to 20 gallons of water adding 2 pt of oil concentrate per acre. Unsatisfactory results may occur if applied to grasses under stress. Use 0.188 lb a.i. (1 pt) to seedling grasses and up to 0.28 lb a.i. (1 1/2 pt) to perennial grasses emerging from rhizomes etc. Consult label for grass species and growth stage for best control.

Trifluralin (Treflan)	Tomatoes (except Dade County)	Pretransplant incorporated	0.75 - 1.0
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REMARKS: 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.

Trifluralin (Treflan)	Seeded tomatoes (except Dade County)	Post directed	0.75 - 1.0
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REMARKS: 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		Special Remarks
				on label	not on label but controlled	
Tomato	Bentlate WP or DG	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	1 lb/100 gal water	NTL	Botrytis stem canker		Seedlings or newly set transplants may be injured by drenching. Greenhouse use only.
	Bravo 720	1 1/2 - 3 pts.	1	Early blight Late blight Gray leaf spot Leaf mold Septoria leaf spot Gray mold Black mold Rhizoctonia fruit rot	Phoma leaf 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.
	Bravo DG or Bravo W-75	1 3/4 - 2 1/4 lbs. 1 1/2 - 3 lbs.	1 1			
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		Special Remarks
				on label	not on label but controlled	
Tomatoes (cont'd)	Stoller Maneb	3 pts.	5	Leaf mold Early blight Late blight Gray leaf spot Septoria leaf spot Bacterial spot (use in combination with Tri-Basic copper sulfate.	See Dithane M-45	Field & Greenhouse
	Dithane M-45	1 1/2 - 3 lbs.	5	Late blight Early blight Gray leaf spot Leaf mold Bacterial spot	Septoria leaf spot Leaf mold Phoma leaf spot Bacterial spot & Bacterial speck (See under Bravo 720)	
Penncozeb		1 1/2 - 3 lbs.	5	Early blight Late blight Gray leaf mold Leaf mold	See Dithane M-45	Field or greenhouse. Do not use on young tender plants under glass.
	Dithane M-22 Special	Field 1-3 lbs. Greenhouse 1/4-1/3 lb/ 5000 sq. ft.	5	Leaf mold Early blight Late blight Grey Leaf spot Septoria leaf spot Bacterial spot	See Dithane M-45	

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases		Special Remarks
				on label	not on label but controlled	
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.
	Fidomil-Bravo 81W	1 1/2 - 2 lbs.	NTL	Early blight Late blight Gray leaf spot		
	Manzate 200	1 1/2 - 3 lbs.	NTL	Early blight Late blight Gray leaf spot Gray leaf mold Bacterial spot	See Dithane M-45	
	Manex	1.2 - 1.6 qts.	5	Leaf mold Early blight Late blight Gray leaf spot Septoria leaf spot	Target spot Phoma leaf spot	Field or greenhouse.
	Bravo C/M	2-3 lbs.	5	Bacterial spot Late blight Early blight	Target spot	

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases		Special Remarks
				on label	not on label but controlled	
Tomatoes (cont'd)	Dyrene (not for use in greenhouse)	2-5 lbs.	NTL	Botrytis Early blight Late blight Septoria leaf spot		If temperatures exceed 85°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.	NTL	Early blight Bacterial speck Bacterial 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.	NTL	Early blight Bacterial speck Bacterial spot	See Dithane M-45	Same as Kocide 101.
	Tri-basic Copper Sulfate	2-4 lbs.	NTL	Bacterial spot Bacterial canker Early blight Late blight Leaf mold Septoria Stemphylium 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.	NTL	Potato virus Y Tobacco etch virus	Tomato yellows	Must be applied with ground rig at 400 psi using Tee Jet TX5 SS nozzles. <u>READ LABEL.</u>

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases		Special Remarks
				on label	not on label but controlled	
Tomatoes (cont'd)	Ridomil 2E ¹ (Soil application)	2-4 pts. (Broadcast only)	PP1 treatment for plant beds.	Pythium damping off in plant beds Late blight Phytophthora stem canker		<u>May not be a necessary treatment for Pythium</u> If 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	
	Copper-Count-N	1/3 - 3/4 gal.	NTL	Bacterial spot		
	Ridomil 2E ¹ (Soil application)	4 pts. ³		Phytophthora or Pythium fruit rots.	Late blight	Same as entry above.

¹ Do not apply more than 12 pints Ridomil 2E/season.

² PP1 (via mechanical device) or POP1 (via irrigation) broadcast or banded.

³ Soil surface 4-8 weeks before harvest followed by irrigation. If plastic used on beds, apply as a band next to bed in middle if roots have developed beyond plastic. Ridomil translocates upward in plant from roots. If plastic is not used, band on soil below drip line.

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases		Special Remarks
				on label	not on label but controlled	
Tomatoes (cont'd)	Ridomil MZ-58 ¹ (Foliar spray)	1 1/2 - 2 lbs.	5	Late blight	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 or Dithane fungicides with Ridomil MZ-58.

