Vegetable Crops
Extension Report
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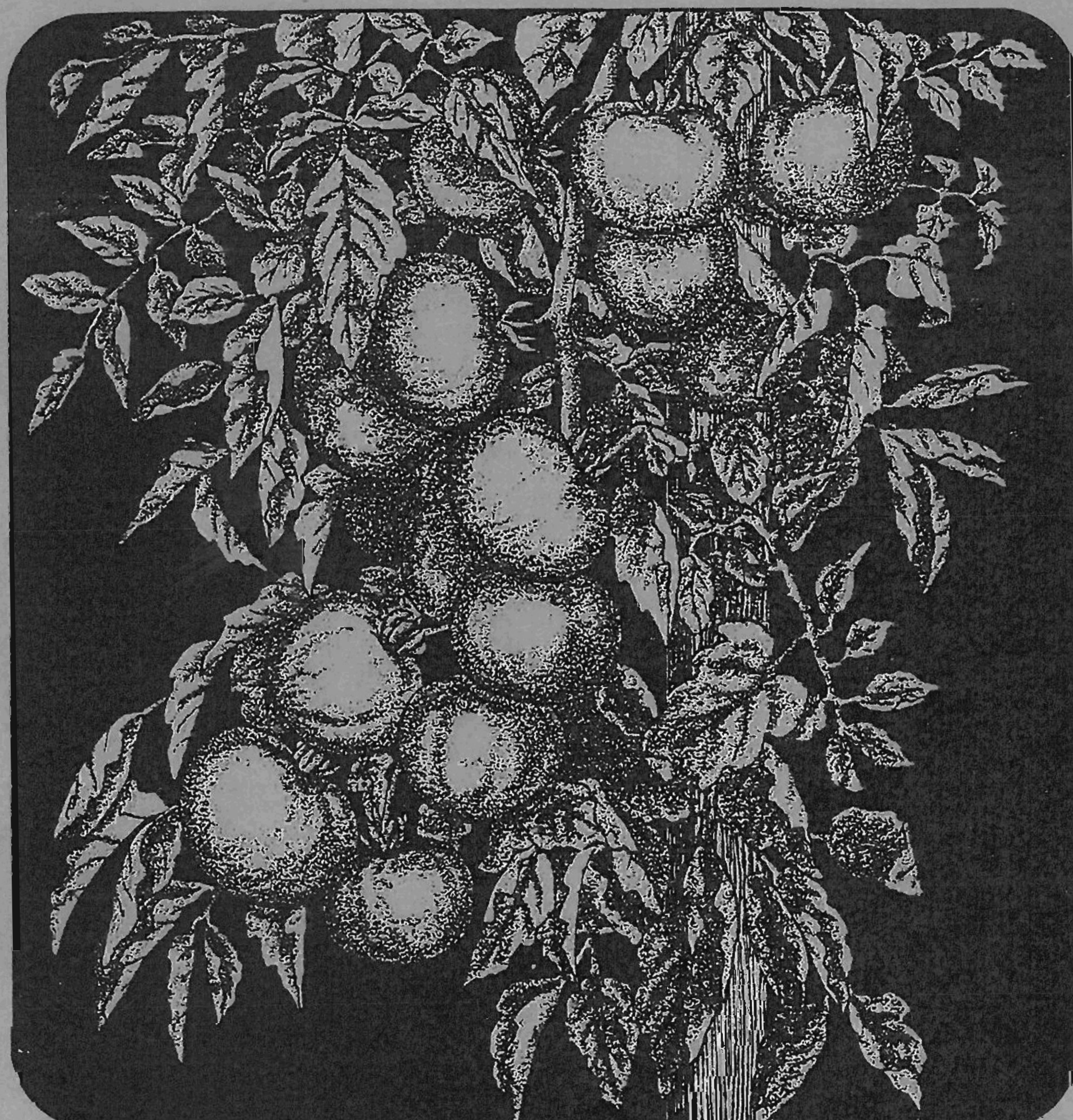
1986 Florida Tomato Institute



Vegetable Crops Department
Institute of Food and Agricultural Sciences
University of Florida, Gainesville, FL 32611

W. M. Stall
Editor

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Introductory Remarks

D. J. Cantliffe

Vegetable Crops Department
Gainesville, FL 32611

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

As Florida tomato growers start a new season, they should reflect for a moment on last year's crop. Success stories were more abundant for Florida growers during the 1985-86 season, as killing freezes stayed away. The threat of frost and freezes continue every year, as do so many of the other production problems facing tomato growers. Each year increased population and urbanization in Florida brings on yet the threat of new problems with the coexistence of agriculture and the urban population. These problems include loss of prime warm land areas, higher land costs, higher taxes, competition for water and other natural resources, and public concerns for the environment.

The theme of "agriculture was here first" does not bring on a lot of support from those who, in essence, run the state - the almost 12 million people mostly centered around Florida's growing cities and coastal areas. Now more than ever before, the Florida farmer is challenged with these new problems. They enhance the need for the modern tomato grower to maintain the sharpest of management skills.

Each year at the Tomato Institute we attempt to bring you the latest information on new varieties, fertilization recommendations, pest control measures, and solutions to the various problems in production and marketing of the tomato crop. Answers to problems are becoming increasingly harder to find. Many old techniques simply do not work because of regulations, restrictions in land availability, changes in water quality, and so on.

Many of the needed solutions will take a concentrated research effort over a long period of time. Cooperation of industry with the public sector will be essential. The modern Florida tomato grower will have to continue to sharpen his management skills. We in IFAS, as in the past, will continue to serve the Florida farmer with the needed information to accomplish more precise management.

The IFAS faculty and staff sincerely hope that the Tomato Institute is a tool to bring about a closer cooperation between the tomato industry and the public sector. We look forward to hearing your needs in an effort to better serve you.

TOMATO VARIETIES FOR FLORIDA

D. N. Maynard
University of Florida
Gulf Coast Research & Education Center
Bradenton, Florida 34203

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 1200 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 about two-thirds of the state's acreage. The proportion of acreage in which 'Sunny' is planted has gradually increased in each of the last three seasons. 'Sunny' accounts for almost all the commercial acreage in southwest Florida, and about 90 and 80% for the east coast and Palmetto-Ruskin, respectively. Most of the north Florida acreage is in 'Sunny'.

'Duke' is the most important variety in Dade county, accounting for about two-thirds of the acreage there. A few acres of 'Duke' are grown in the other production areas. Although the 'Duke' acreage in Dade County seems to be remaining constant, statewide acreage is declining. Overall, 'Duke' acreage is less than 20% of the statewide total.

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

'Flora-Dade acreage has accounted for 3 to 4% of the state total for the last three seasons making it the fourth most important variety grown in Florida. Almost all of the 'Flora-Dade' acreage is in Dade County.

'Hayslip' is the fifth most important variety statewide but accounts for less than 2% of the acreage, most of which is in the Palmetto-Ruskin area. Acreage planted in 'Hayslip' appears to be declining.

Perhaps 10 to 15 other varieties are grown on very small acreages. These varieties are mostly new varieties being evaluated for their commercial production potential. About 5% of the statewide acreage is devoted to these varieties.

1985-86 Variety Trial Results

Tomato variety trials were conducted at the Gulf Coast Research & Education Center, Bradenton; Southwest Florida Research & Education Center, Immokalee; Tropical Research & Education Center, Homestead; and Ft. Pierce Agricultural Research & Education Center in the fall of 1985 and spring of 1986. Spring 1986 trials were conducted at the North Florida Research & Education Center, Quincy. Many varieties were evaluated at all locations in both seasons, other varieties were evaluated only at certain locations.

Variety trials were conducted at four locations in fall 1985 (Table 1). The top five varieties for earliness, total yield, and fruit size are listed. Varieties or experimental lines, in addition to the standard varieties, that performed well in three catagories were: IFAS 7131, IFAS 7175, IFAS 7177, and XPH 5011 (Asgrow). At Immokalee, FTE 23, SR 445 (Sunrise Research) and ACX 5x5(abbott & Cobb) each performed well in two categories. IFAS 7155 performed well in two categories at Ft. Pierce.

Table 2. Spring 1986 Tomato Variety Trial Summary

Bradenton (4)			Immokalee		
Yield		Fruit size	Yield		Fruit size
Early	Total		Early	Total	
Freedom	IFAS 7183	IFAS 7178	ACX 5x5	IFAS 7182	XPH 5074
Horizon	IFAS 7181	Freedom	Horizon	Hybrid 26	Hybrid 26
IFAS 7183	Freedom	Piedmont	Hybrid 26	XPH 5074	XPH 5011
Hybrid 26	Horizon	IFAS 7183	FMX 79	FTE 23	Duke
IFAS 7131	IFAS 7177	Summit	Allstar	ACX 5x5	IFAS 7178

Ft. Pierce (7)		Homestead (1)			Quincy (6)	
Total Yield	Fruit size	Large fruit		Fruit size	Total yield	Fruit size
		Harv. 1	Harv. 2			
IFAS 7182	IFAS 7178	Duke	XPH 5031	IFAS 7131	FTE 12	IFAS 7178
FTE 12	Horizon	FTE 23	IFAS 7177	IFAS 7183	Flora-Tom II	XPH 5074
IFAS 7181	IFAS 7185	FTE 12	IFAS 7183	IFAS 7175	Sunny	IFAS 7175
Duke	IFAS 7183	HPX 2798	Sunny	IFAS 7178	Flora-Tom I	IFAS 7181
Sunny	IFAS 7182	IFAS 7181	IFAS 7183	Sunny	IFAS 7181	XPH 5011

XPH 5011 = Gator
XPH 5074 = Pacific

Advanced Tomato Lines for Possible Release

J. W. Scott

Gulf Coast Research & Education Center

5007 60th Street East

Bradenton, Florida 34203

This year four breeding lines are being considered for release. Two are ornamental dwarf types. The third is a heat and bacterial spot tolerant cherry type; and the fourth is also heat and bacterial spot tolerant with medium fruit size.

Ornamental Dwarf Tomatoes: Development of these lines has been in cooperation with a GCREC collegue, Dr. Brent K. Harbaugh, of the Ornamental Horticulture Department. Fla. 7190 is a yellow fruited dwarf suitable for hanging baskets. The cherry sized fruit have jointed stems, green shoulders and ripen well. The flesh is light yellow and the epidermis has an orange hue which results in a yellow-light orange color. Fruit have a slightly mild tomato flavor as do many yellow fruited varieties. It is resistant to grey leafspot (*Stemphyllium solani* Weber). The plants have a more prostrate growth habit than 'Florida Basket' and drape over the containers nicely. Three plants per 10 inch basket has given the best symmetrical appearence. Foliage holds its green color well after fruit ripen provided fertilization is adequate. Breakdown of foliar color in yellow fruited dwarfs had been a problem in earlier breeding lines which were tested.

Florida 7191 is the number we assigned to this miniature dwarf tomato. Not only does it have the short internodes and reduced growth rate characteristic of dwarf tomatoes, but leaf and fruit size have also been reduced. It is the smallest tomato plant developed to date. Fla. 7191 can be grown as a single plant in 3 or 4 inch pots for a window sill or as a hanging basket with 3 plants in a 5 inch container. It has a prostrate growing habit and drapes nicely over the container. Foliage color is dark green and it holds well after most fruit ripen. The red fruit are about 0.5 inch in diameter, have jointed stems, but is still segregating for green shoulders. Shoulder color for the release has yet to be decided. Fruit flavor is quite good. Fla. 7191 is resistant to gray leafspot.

Heat Tolerant Tomatoes: Florida 7166 is a heat tolerant cherry tomato with tolerance to bacterial spot and resistance to Fusarium wilt races 1 and 2, Verticllium wilt race 1, and gray leafspot. Fruit are jointless, have green shoulders, and hold well for shipping. Fruit size is uniform, averaging about 2/3 the size of 'Cherry Grande' the predominant variety in the state (Tables 1, 2, 3). Fruit do not oversize. Plants are determinate with a compact plant habit. Internodes are short with vigorous lateral branching. Vines reach stake height (4 ft.) but take longer to do so than varieties like 'Cherry Grande'. A looser tie would be more desirable to minimize vine injury during picking. The vines can also be grown without stakes. Fla. 7166 has yielded relatively well compared to 'Cherry Grande' and other tomato varieties in both Bradenton and Homestead in the summer (Table 1, 2) and Bradenton in the Fall (Table 3). Summer yields at Bradenton were low compared to the fall season largely because of the manual inoculation with bacterial spot, which was severe even for a bacterial spot tolerant variety. Florida 7165 is a sister line to 7166 which has not performed as consistantly as Florida 7166 and it does not have Fusanium wilt race 2 resistance. Thus, Florida 7166 was chosen as the release cnadidate. The combination of heat tolerance and bacterial spot tolerance make Fla. 7166 especially attractive for summer productin in Florida.

Florida 7156 is a heat tolerant, medium fruit sized tomato with tolerance to bacterial spot and resistance to Fusarium wilt race 1, Verticillium wilt race 1, and gray leafspot. It has yielded and graded well in both Bradenton and Homestead under high temperature conditions (Table 4, 5). Fruit size averages about 4 oz. (Table 4, 5). Fruit are jointed; have green, slightly rided shoulders; ripen well; and have good flavor. They are crack resistant but might split if left on the vine past the early table-ripe stage. Fla. 7156 is recommended for home garden or local market sales during the summer months in the southeast. The decision to release this tomato is contingent on results of Summer 1986 replicated trials in Bradenton and Homestead.

Table 1. Yield and bacterial spot infection for cherry tomato genotypes inocultaed with bacterial spot, Summer 1985, at Bradenton, Florida. Bacterial data in cooperation with Dr. J.B. Jones.

	Marketable fruit		Culls	Bacterial Spot infection	
Genotypes	Yield (15 lb. flat/A)[z]	Size (oz)	(%)[y,x]	Foliage[w]	Fruit (%)[x]
Fla. 7165	1201.2 a[v]	0.41 b	30.3 b	6 a	22.9 b
Fla. 7166	1180.6 a	0.40 b	19.8 c	6 a	12.9 c
Cherry Grande	638.4 b	0.58 a	66.1 a	7 b	59.0 a
Castlette	370.7 c	0.58 a	69.7 a	7 b	66.8 a

[z]Sum of 5 harvests, Sept. 9 through Oct. 7, 1985.

[y]Percentage of total harvest by weight.

[x]Data transformed to $\sqrt{\quad}$ arc sine for analysis.

[w]Rated on Horsfall-Barratt scale, higher numbers indicate greater disease incidence.

[v]Means not followed by the same letter are significantly different by Duncan's Multiple

Table 2. Yield of cherry tomato genotypes grown in an observation trial in Homestead, Florida, Summer, 1985. Data supplied by Dr. H. H. Bryan.

	Marketable fruit		Culls
Genotypes	Yield (lb./plant)[z]	Size (oz)	(%)[y]
Fla. 7165	4.35	0.42	4.2
Fla. 7166	4.33	0.54	3.5
Cherry Grande	2.18	0.82	11.5

[z]Sum of 2 harvests, Oct. 10 and Nov. 4, 1985.

[y]Percentage of total harvest by weight.

Table 3. Yield of cherry tomato genotypes at Bradenton, Florida, Fall 1985. Data supplied by Ms. T. K. Howe.

	First Harvest		Total Season ^{z}	
Genotypes	Yield (15 lb. flat/A)^{y}	Fruit Size (oz)	Yield (15 lb. flat/A)	Fruit Size (oz)
Fla. 7166	1297.9 a^{x}	0.64 c	3670.9 a	0.54 c
Fla. 7167	936.5 ab	0.57 c	3015.2 bc	0.51 c
Fla. 7165	884.4 ab	0.68 c	2899.9 cd	0.57 c
Cherry Grande	699.2 bc	1.01 a	3859.3 a	0.87 a
Fla. 7143	331.5 cd	0.90 b	3582.2 ab	0.78 b
Castlette	43.5 d	1.06 a	2304.2 d	0.83 ab
Red Cherry Large	35.3 d	0.92 b	1506.1 e	0.86 a

^{z}Total of 4 harvests on Oct. 28, Nov. 4, Nov 1, and Nov. 20, 1985.

^{y}An acre = 9860 linear feet.

^{x}Means not followed by the same letter are significantly different by Duncan's Multiple Range Test, 5% level.

Table 4. Early and total season yield parameters for fresh market tomato genotypes at Bradenton, Florida, Summer 1985.

	Early Season[z]			Total season[y]		
Genotypes	Mkt. Yield (25 lb. carton/A)	Culls (%)[x]	Fruit Size (oz)	Mkt. yield (25 lb. carton/A)	Culls (%)[x]	Fruit Size(oz)
C111d	871.0 a[w]	28.0 ab	1.27 b	1255.3 ab	30.1 bc	1.23 b
Fla. 7156	467.0 b	17.1 b	4.02 a	1399.8 a	16.7 c	3.95 a
Fla. 7169	153.6 c	16.5 b	4.80 a	1538.2 a	14.8 c	4.20 a
FM #9	252.0 bc	37.5 ab	4.48 a	896.6 bc	40.5 ab	3.67 a
Walter	171.7 c	47.1 a	4.73 a	642.9 c	55.8 a	4.34 a

[z]Sum of first two harvests, Sept. 10 and Sept. 17, 1985.

[y]Sum of four harvests, Sept. 10, Sept. 17, Sept. 24, and Oct. 1, 1985.

[x]Percentage of total harvest by weight, data transformed to $\sqrt{\quad}$ arc sine for analysis.

[w]Means not followed by the same letter are significantly different by Duncan's Multiple Range Test, 5% level.

Table 5. Yield parameters for fresh market tomato genotypes from an observation trial at Homestead, Florida. Summer 1985. Data supplied by Dr. H. H. Bryan.

	First Harvest			Total Harvest[z]		
Genotypes	Mkt. Yield (lb./plant)	Culls[y] (%)	Fruit Size (oz)	Mkt. yield (lb./plant)	Culls[y] (%)[x]	Fruit Size (oz)
Fla. 7156	3.81	0	4.06	4.46	5.4	3.77
Fla. 7169	2.34	0	5.29	2.69	5.8	4.44
FloraDade	0.14	0	5.54	0.82	27.8	2.86
Suncoast	0.29	0	5.71	0.94	14.9	3.07
Horizon	0.00	0	-	0.70	38.9	2.82

[z]Two harvests Oct. 10 and Nov. 4, 1985.

[y]Percentage of total harvest by weight.

COLD HARDINESS - FUTURE POSSIBILITIES

C. Eduardo Vallejos
Department of Vegetable Crops, IFAS
Gainesville, FL 32611

Low temperatures have an overall adverse effect on tomatoes. Temperatures in the range of 32 to 55°F (the chilling injury range, 0-12°C) retard growth, affect fruit size, normal fruit development and ripening. Furthermore, temperatures below 32°F (0°C) cause irreversible damage to the crop. Florida tomato production is based on the winter and spring markets. It is precisely during this period that the entire industry is extremely susceptible to erratic weather behavior which can cause devastating losses such as those experienced in the '76-'77, '83-'84, and '84-'85 seasons (FTC 1977, 1984, 1985). Decreases in yield and the extra cost of replanting, in addition to unfair foreign competition, take a toll from the Florida tomato industry.

Cultural practices, such as plastic tunnels and sprinkle irrigation (Stall *et al*., 1985; Tyson, 1985), represent immediate but expensive solutions to the problem of low temperatures. A lasting solution to this problem can be obtained through genetic manipulation of the crop by utilizing the rich germ plasm resources of tomato. There are eight species of tomato living in the wild and adapted to extreme environments. Three of these species--*L. chilensis*, *L. peruvianum*, and *L. hirsutum*--have ecotypes adapted to elevations in excess of 10,000 feet in the

Andes of South America (Vallejos, 1979). When water is available throughout the year, these ecotypes behave as perennials and therefore are exposed to drastic diurnal and seasonal temperature fluctuations. All these species represent important sources of low temperature tolerance. L. hirsutum hybridizes more readily with the cultivated tomato; however, hybridizations with the other two species are possible if embryo rescue techniques are used.

Recent studies have demonstrated the ability of a high altitude ecotype of L. hirsutum to outgrow the cultivated tomato at low temperatures (Vallejos et al., 1983). Studies of photosynthesis have also shown that this species has a capacity to acclimate to low temperatures (Vallejos and Pearcy, 1986). Furthermore, some genetic components of low temperature tolerance from L. hirsutum have been identified using an interspecific backcross to L. esculentum (Vallejos and Tanksley, 1983; Zamir et al., 1982). Results from these experiments indicate that low temperature tolerance is a trait controlled by several genes. These genes will first have to be identified in order to effect their efficient transfer into commercial tomato cultivars.

Current techniques in molecular biology make it feasible to identify, at the molecular level, genes responsible for low temperature tolerance. The central dogma of molecular biology states that genetic information will flow from DNA to RNA and then to proteins (Enzymes). However, a number of mechanisms control this flow by setting the "on" and "off" signals for the expression of genes. Genes involved in acclimation to low temperatures are expected to be "turned on" at the onset of low temperatures and the gene products (proteins) would be detectable in the plant. In the absence of the signal (low temperatures), the genes would be "turned off" and the proteins will eventually disappear from the plant.

Experiments directed at the identification of genes controlled by low temperatures and with a possible role in low temperature tolerance are being conducted at the University of Florida, Dept. of Vegetable Crops. In preliminary experiments, plants of the high altitude ecotype of *L. hirsutum* were grown in a temperature regime of 25/18°C (77/65°F), and then exposed to low night temperatures by changing the temperature regime to 25/8°C (77/46°F). Analysis of tissue proteins by electrophoresis indicated that exposure to low night temperatures induced the accumulation of at least three proteins. It was mentioned earlier that exposure to low temperatures induced acclimation in the high altitude ecotype. Thus, it is expected that proteins that accumulate after exposure to low temperatures might have a role in low temperature tolerance. Similar experiments where proteins induced in the low temperature sensitive cultivated tomato are compared to those in *L. hirsutum* will help us to discern which proteins might have a role in low temperature tolerance. Experiments to label proteins *in vivo* and *in vitro* with radioisotopes are underway. This technique increases the sensitivity of detection and is likely to reveal the presence of more proteins induced by low temperatures. In addition, experiments which involve exposure to lower temperatures (day and night) are being planned.

Identification and characterization of these gene products will allow us to monitor their segregation in interspecific progenies obtained between the wild and the cultivated species. Selection based on the presence of these proteins, under conditions of temperature stress, will facilitate the transfer of low temperature tolerance into commercial cultivars.

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CONSUMER QUALITY - Where does it start,....and end?

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

Publicity - Press releases are not noted for extolling the many virtues of tomatoes. Such releases dwell on their demise or prediction of pending extinction. However, The Reader's Digest (January 1985) wrote of the tangy, tantalizing tomato, "...Whatever we consider it, our cuisine would suffer severely without its powerful personality: sandwiches and salads would lack zip, pasta would pale, pizza would have no pizazz, chili would be wiped out,...and hamburgers would have no ketchup." We might add that McD.L.T. would never have seen the light of day. This latest entry (McD.L.T.) has exacting requirements for quality and currently uses 10,000 25-lb. boxes per day and obtains essentially all of them from Florida and California.

Quality - This elusive attribute is "in the eyes of the beholder"; the producer sees yield, pack-out, size and uniformity, while the handler is more concerned with durability, efficiency of handling and shelf-life. The consumer, on the other hand, wants appearance, flavor, texture, shelf-life, and nutritional value. Nutrition is an added dimenson which was not even considered a few years ago. From the standpoint of "nutrional quality index" (essential vitamins, minerals, fiber, but low energy) tomatoes rank among the top foods.

Old vs. New - "They don't taste as good as they once did", "cannonballs", "plastic junk," all are phrases used in conjunction with fresh tomatoes. Let's consider the FACTS as they exist today.

Fact 1 - Old varieties were developed for local market and therefore could be picked at the ripe stage while new varieties are developed for world-wide markets and are shipped thousands of miles and may be in transit several days.

Fact 2 - New varieties have a much improved appearance and they taste just as well as the old varieties (Michigan State study - Price).

Fact 3 - Through genetic improvement, new varieties contain more ascorbic acid and have improved sugar/acid ratios as compared to old varieties. Studies on tomato quality and composition at the University of Florida during the past 20 years have shown that the new cultivars commercially grown here are superior to those previously grown.

Fact 4 - Tomatoes are now available 365 days a year throughout the U.S., in sufficient volume and at a price which the average customer can pay; there may be times when market manipulation, production, and adjustments due to environmental stress may cause a slight compromise in consumer quality in order to maintain the desired balance of supply and demand.

Consumer quality retention - Recently, postharvest studies were conducted at Gainesville to determine handling systems that could maximize retention of consumer quality of tomatoes. In the first study, cultivars of 'Duke' and 'Sunny' were evaluated. At the "breaker" stage, fruits were held in (1) controlled atmosphere [CA] at 20°C, (2) normal atmosphere at 20°C, and (3) normal atmosphere at 10°C. After treatment, fruits were ripened to the table-ripe stage in normal atmospheres and analyzed for firmness, color, pH, titratable acidity, soluble solids, total solids, ascorbic acid, cellulase activity and sensory evaluation.

Ripe fruits held at 20°C were more firm, developed more red color, contained more ascorbic acid and had a higher °Brix/acid ratio than fruits exposed to CA or reduced temperature. Cellulase activity was higher in fruits stored at reduced temperature as compared to CA or normally ripened fruits. Consumer acceptance of normally ripened (20°C) or short duration (2 weeks) CA stored fruits was better than fruits stored at 10°C or CA for periods greater than two weeks.

The significance of this study is that consumer quality is lost when the ripening process is restricted either by subjecting fruits to reduced temperatures or prolonged periods of controlled atmosphere storage. If shelf-life extension is mandatory, then fruit should be allowed to ripen normally before storing them at reduced temperature.

In the second study, tomato cultivars 'Duke', 'FTE-12', 'Flora-Dade', and 'Sunny' were harvested at four stages of maturity or ripeness (immature-green, mature-green, commercial vine-ripe, and pink) then ripened to the table ripe stage and evaluated for quality.

At the table-ripe stage, 'Flora-Dade' was more firm than the other three cultivars; otherwise, there was essentially no difference in quality between cultivars. A consumer-type panel could not detect any flavor difference in table-ripe tomatoes harvested mature-green as compared to fruits harvested vine-ripe or pink, however, fruits harvested immature-green were different. Panel preferred mature-green, vine-ripe, and pink over fruits harvested immature-green by 60%, 82%, and 85%, respectively. The different flavor of immature-green fruits was not related to acids and soluble solids content.

The significance of this study is that mature-green fruits are sufficiently developed and will ripen and have quality comparable to fruits harvested at a more advanced stage of development. However, immature fruit are less desirable and if harvested then mingled with more advanced tomatoes, there will be a diluting effect upon optimum consumer quality. The reduction in consumer quality is in direct proportion to the amount of immature-green fruit added. While it may seem economically advantageous to harvest and mingle immature-green fruit with those of a more advanced maturity, eventually this practice will impact upon the integrity of the packer and/or the Florida tomato industry.

Summary - Through genetic improvement, refinements in cultural practices and harvest technology, commercial tomato cultivars currently grown in Florida have superior quality to those grown several years ago. Utilization of technology for ripening initiation allows optimum development of flavor and texture. Transport and merchandising of tomatoes, without interfering with the ripening process, maintains that quality to the consumer. All segments of the process must operate properly to maximize consumer quality.

Most vulnerable segments of the process which have a degradative effect upon quality are harvesting immature-green fruit and restriction of the ripening process by exposure of ripening fruits to low temperatures or prolonged exposure to controlled atmospheres.

Table 1. Composition of 'table-ripe' tomatoes harvested at four different stages of maturity.

Maturity	Firmness	Total solids	Citric acid	Soluble solids	Sugar/ acid	Ascorbic acid	Beta carotene	Color a/b
	mm deform	%	%	%	%	mg/g	mg/g	ratio
IMG	2.41	5.34	0.34 a*	3.9	11.47	177 c	2.6 b	2.76
MG	2.28	5.36	0.38 b	4.2	10.99	202 b	2.9 a	2.74
VR	2.68	5.28	0.40 b	4.0	10.05	244 a	2.7 b	2.82
P	2.96	5.11	0.36 ab	4.1	11.32	197 b	2.9 a	2.97

IMG = Immatúre-green MG = Mature-green
VR = Commercial vine-ripe P = Pink

* Means within a column followed by the same letter are not significantly different at the P = 0.05 level, Duncan's Multiple/Range Test.

Table 2. Consumer evaluation of ripe tomatoes harvested at four different stages of maturity.

Comparison			Significance
MG	vs	VR	ns
MG	vs	P	ns
IMG	vs	MG	*
IMG	vs	VR	**
IMG	vs	P	**

Table 3. Effect of CA vs normal air storage on sensory evaluation of 'Sunny' tomatoes.

Treatment	Days in CA	Evaluation score
Air, 10°C	0 (14)	5.8 b
Air, 20°C	0 (7)	7.0 a
5% O_2/4% CO_2	7	6.8 a
5% O_2/4% CO_2	14	6.7 a
5% O_2/4% CO_2	21	5.7 b
5% O_2/4% CO_2	28	5.4 c

Table 4. Effect of CA vs normal air storage on the color of 'Sunny' tomatoes.

Treatment	Days in CA	a/b Color
Air, 10°C	0 (14)	2.3 c
Air, 20°C	0 (7)	2.8 a
5% O_2/4% CO_2	7	2.5 b
5% O_2/4% CO_2	14	2.5 b
5% O_2/4% CO_2	21	2.5 b
5% O_2/4% CO_2	28	2.5 b

Comparison of transplant and direct-seeding methods for fresh market tomatoes.

G. B. Odell and D. J. Cantliffe
Vegetable Crops Department, IFAS
Gainesville, Florida

H. H. Bryan
Tropical Research and Education Center
Homestead, Florida

P. J. Stoffella
Agricultural Research and Education Center
Fort Pierce, Florida

Introduction

At present approximately two thirds of Florida's tomato acreage is established using transplants, while the remaining acreage is direct seeded almost exclusively using a plug mix planting system. While the development of plug mix planting (Hayslip, 1973) greatly improved the reliability and uniformity of direct-seeded tomato stand establishment in the Rockdale soil of Dade County, growers continue to have problems with nonuniform stands leading to undesirable variations in harvest uniformity. Sand land growers, who have the option of direct seeding, are reluctant to do so because transplants have traditionally offered greater stand uniformity and predictable earliness when compared with direct seeding.

Research results from the previous two years indicated that priming of tomato seeds in a salt solution led to more rapid and uniform emergence under a variety of laboratory and field conditions, and especially at high temperatures (Odell and Cantliffe, 1986). These advantages of seed priming were further enhanced by the alteration of the seed microenvironment with such soil amendments as hydrophilic polymers and granular, calcined clay.

This past year's research has concentrated on assessing the stand establishment and yield effects of improved direct seeding techniques under different cultural regimes used in Florida.

Procedure

Two plantings were made in 1985 using 'FloraDade' as the test cultivar. A spring planting was made on April 1 at the IFAS Horticulture Unit in Gainesville and a fall planting was made at Gulf Coast Farms in Bonita Springs on September 7.

Cultural differences between plantings are presented in Table 1. The temperature regimes during the first two weeks after sowing are presented in Figure 1.

Seeds were sown through plastic mulch on raised beds in small aliquots of various soil amendments. Approximately 5 seeds were sown per drop in 60 ml of soil amendment. Seeds were sown pregerminated (48 hrs at 25°C), primed (in 1.5% K_3PO_4 + 1.0% KNO_3 for 6 days at 25°C and than dried), or nontreated. The soil amendments used were: 1) plug mix (Grace Co., Inc.); 2) gel mix, a

1:1 mixture by volume of plug mix and a 0.55% solution of Viterra II gel (Nesera, Inc.); Growsorb as LVM 24/48, a fine-textured, calcined montmorillonite clay (Mid Florida Mining, Inc.); and 4) sandy field soil used as a control. Transplants grown in Speedling 100 and 080A flats for four weeks were field set on the same dates as direct sowing for comparison of total yield and distribution of yield over multiple harvests.

Emergence counts were taken daily for direct-sown treatments, and seedling dry weights were determined from random samples of 10 seedlings approximately three weeks after sowing when plots were thinned to one plant per hole.

All treatments in both plantings were harvested twice with 10 days between harvests. Fruits were culled before being counted, weighed, and separated into standard marketable sizes.

Results

Total percentage emergence. On the basis of emergence counts at 14 days after sowing, Growsorb as LVM 24/48 applied as a seed cover was the most effective of the soil amendments in improving total percentage emergence when compared to sowing in plug mix at both locations (Table 2). At Bonita Springs, planting with primed seed significantly improved total percentage emergence over nontreated seed. Seed priming generally improved emergence over nontreated seed, while emergence of pregerminated seeds was not as good.

Seedling dry weight. Sowing in gel mix improved mean seedling dry weights when compared to the soil cover for all seed treatments at Gainesville, while the difference between gel mix and plug mix was significant only for pregerminated seed (Table 3).

At Bonita Springs, none of the soil amendments led to higher seedling dry weights for nontreated seed when compared to the soil cover (Table 3). For primed seed all soil amendments resulted in higher seedling dry weights compared to the soil cover, while sowing in gel mix led to significantly higher dry weights than either plug mix or LVM 24/48. Dry weights for primed or pregerminated seeds were greater than those of nontreated seeds with similar soil amendment treatments.

First harvest marketable yields (>7x7). At Gainesville all direct-seeded treatments were harvested 99 days after sowing. For nontreated seed, planting in gel mix led to higher first harvest marketable yields than planting in plug mix (Table 4). All soil amendments led to higher first harvest yields compared to the soil cover for primed seed. Growsorb as LVM 24/48 was the only soil amendment which improved first harvest yields over the soil cover for pregerminated seed at Gainesville.

At Bonita Springs there were no significant differences in first harvest yields at 94 days after sowing between any of the treatments, although primed seed tended to lead to numerically higher first harvest marketable yields than nontreated seed at this location and at Gainesville (Table 4).

First harvest extra large fruit yields (>5x6). At Gainesville yields of extra large fruit in the first harvest were affected by soil amendments for both nontreated and primed seeds

(Table 5). Growsorb as LVM 24/48 led to higher extra large fruit yields compared with the soil cover for nontreated seed, while all soil amendments improved extra large fruit yields when compared to the soil cover for primed seed in the first harvest at Gainesville.

At Bonita Springs treatment effects on first harvest extra large fruit yields were not significant (Table 5).

Percentage of total marketable yield in the first harvest. Although there were no significant differences in total yield over two harvests between any direct-seeded or transplant treatments at either location, yield concentration did differ both among direct-seeded treatments and between direct-seeded and transplant treatments (Table 6). At both Gainesville and Bonita Springs, all direct-seeded treatments resulted in a greater concentration of total yield in the first harvest when compared with transplants. At both locations transplants were ready for harvesting before any direct-seeded treatments, but this difference was reduced to only ten days in the fall planting at Bonita Springs.

Results from both locations indicated that using primed seed significantly increased the percentage of total marketable yield in the first harvest when compared to nontreated seed (Table 6).

Conclusions

Total percentage emergence of direct-seeded 'FloraDade' was generally improved by using primed seed or by using Growsorb as LVM 24/48 for the seed cover regardless of seed treatment when compared with sowing in plug mix or gel mix.

Seedling dry weights from primed seed were consistently higher than nontreated seed, and gel mix was the most effective of the soil amendments in enhancing early seedling growth.

Yield differences between direct-seeded treatments were more difficult to substantiate, but the use of primed seed enhanced earliness at both locations compared to nontreated seed as measured by the percentage of total marketable yield in the first harvest. The use of pregerminated seed did not lead to any stand establishment or yield advantage compared to primed seed.

Differences in yield concentration between transplants and direct seeding indicated that direct seeding would be more economically appropriate for a once-over harvest system, and under warm conditions might offset the advantages of transplants in terms of earliness.

While reliable machinery for gel mix seeding is still in the developmental stages, the incorporation of primed seed into the normal plug mix planting procedure would be an immediate improvement requiring no equipment changes. If primed seeds were batch-mixed in plug mix before planting, they would not require any holding period before sowing to insure rapid, uniform emergence.

Another approach that can be easily mechanized is the precision sowing of pelletized seeds and covering them with Growsorb. Primed, pelletized tomato seed is commercially available from a number of seed companies. Although the primed seed is more costly, precision sowing may make it possible to plant to stand, thereby eliminating expensive thinning operations that are normally necessary after seeds are sown bulk-mixed in plug mix. Early results in this area are promising, but the system requires further research.

Economic pressure due to escalating production costs and scarcity of hand labor used for harvesting the Florida tomato crop has provided a great impetus for breeders to develop cultivars with concentrated, early fruit set allowing economically acceptable yields to be attained with fewer harvests. Although the adoption of these expensive hybrids has been rapid, continued research in the area of stand establishment is crucial in facilitating the full expression of their genetic potential for earliness. Earliness is of little value if rapid, uniform establishment is not achieved through improved planting technology.

References

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Table 1. Cultural practices used at Gainesville and Bonita Springs.

Location	Season	Irrigation	Mulch	Plant Arrangement: Spacing between: Beds	Plants	Rows/bed	Numbe Harve
				(ft.)	(in.)	(no.)	
Gainesville	Spring	Sprinkler	Black	4	24	1	2
Bonita Springs	Fall	Subseepage	White	6	20	1	2

Table 2. Effects of seed treatments and soil amendments on total percentage emergence at Gainesville and Bonita Springs.

Soil Amendment	Seed Treatment: Nontreated	Primed	Pregerm	Mean(SA)
Gainesville		%		
Soil	87.0	91.0	69.5	82.5
Plug mix	64.0	74.5	76.5	71.7
Gel mix	80.0	85.5	81.5	82.3
LVM 24/48	93.0	94.5	88.5	92.0
Mean (ST)	81.0	86.4	79.0	
LSD (0.05) for STxSA means = 15.1%				
Bonita Springs				
Soil	74.0	92.0	-[z]	83.0
Plug mix	72.0	75.5	-	73.8
Gel mix	70.5	77.5	-	74.0
LVM 24/48	89.5	90.0	-	89.8
Mean (ST)	76.5	83.9	-	
LSD (0.05) for ST means = 3.0, for SA means = 9.0%				

[z] Pregerminated seed not included as a treatment.

Table 3. Effects of seed treatments and soil amendments on seedling dry weight at Gainesville and Bonita Springs.

Soil Amendment	Seed Treatment: Nontreated	Primed	Pregerm	Mean(SA)
Gainesville (at 25 days)		- mg/plant -		
Soil	56	90	85	77
Plug mix	85	136	124	115
Gel mix	130	166	215	170
LVM 24/48	87	167	126	126
Mean (ST)	90	140	138	
LSD (0.05) for STxSA means = 55 mg				
Bonita Springs (at 21 days)				
Soil	308	393	-[z]	350
Plug mix	453	618	-	535
Gel mix	433	888	-	660
LVM 24/48	373	430	-	401
LVM 24/48				
Mean (ST)	392	582	-	
LSD (0.05) for ST x SA means = 157 mg				

[z] Pregerminated seed not included as a treatment.

Table 4. Effects of seed treatments and soil amendments on first harvest marketable ($\geq$7x7) yields at Gainesville (99 days) and Bonita Springs (94 days).

Soil Amendment	Seed Treatment Nontreated	Primed	Pregerm	Mean(SA)
Gainesville	-25 lb boxes/acre-			
Soil	1540	1620	1642	1598
Plug mix	1476	2344	1886	1865
Gel mix	1865	2027	1800	1897
LVM 24/48	1825	2243	2074	2048
Mean (ST)	1678	2059	1850	
LSD (0.05) for STxSA means = 376 boxes/acre				
Bonita Springs				
Soil	644	702	-[z]	673
Plug mix	731	781	-	760
Gel mix	752	752	-	752
LVM 24/48	461	749	-	695
Mean (ST)	691	745	-	

[z]Pregerminated seed not included as a treatment

Table 5. Effects of seed treatments and soil amendments on first harvest extra large fruit yield ($\geq$ 5x6) at Gainesville and Bonita Springs.

Soil Amendment	Seed Treatment Nontreated	Primed	Pregerm	Mean(SA)
Gainesville	- 25 lb boxes/acre -			
Soil	450	428	529	472
Plug mix	529	644	590	580
Gel mix	562	666	601	612
LVM 24/48	670	720	666	688
Mean (ST)	554	616	598	
LSD (0.05) for STxSA means = 148 boxes/acre				
Bonita Springs				
Soil	245	252	-[z]	248
Plug mix	245	281	-	263
Gel mix	256	234	-	245
LVM 24/48	252	266	-	260
Mean (ST)	248	259	-	

[z]Pregerminated seed not included as a treatment.

Table 6. Effects of seed treatments or transplant size on total marketable yield and percentage of total marketable yield in the first harvest at Gainesville and Bonita Springs.

Treatment	Tot. Mkt. Yield: Gainesville	Tot. Mkt. Yield: Bonita Springs	Percentage in 1st Harvest: Gainesville	Percentage in 1st Harvest: Bonita Springs
	- 25 lb boxes/acre -		- % -	
Nontreated	2520	1210	66.4b[y]	57.7b
Primed	2801	1224	74.2a	61.3a
Pregerminated	2621	-[z]	71.2a	-
Speedling 080A	2830	1138	44.2c	45.6c
Speedling 100	3067	1343	43.8c	48.1c

[z]Pregerminated seed not included as a treatment.
[y]Means separation by Duncan's MRT at the 0.05 level.

Row Covers - Possibilities for use on Tomatoes

W. M. Stall and S. R. Kostewicz
Vegetable Crops Department, Gainesville

Row covers are continuous rolls of synthetic materials, usually polyester, polypropylene or polyethylene, used to cover plants with the objective of increasing yields and earliness by increasing soil and air temperatures during cool or cold periods. Dual plastic row covers have been used in California since the late 1950's. These are opened for heat ventilation and closed for cold protection. Single piece clear or pigmented opaque plastic with a series of short, cross-wise slits or circular perforations that provide ventilation have been tried and used successfully in northern and midwestern states as tunnels. The tunnels are formed by installing the poly covers over wire support hoops. Woven and non-woven material, being developed by several companies, are also being evaluated as a row cover over plants. A few of these have been used in the textile industry as clothing interfacing.

The woven and non-woven row covers are porous and self ventilating. They are light weight and can be applied directly on the plants without the use of the supporting hoops required of tunnels. These are usually referred to as non supported or "floating" row covers.

Researchers have reported varied results with the use of tunnels and floating row covers throughout the U.S. In many cooler production areas of the U.S., the use of row covers is becoming an established practice.

Research on row covers has been carried out in Florida on many vegetables. The cucurbits seem to respond the best to their use. Watermelon, muskmelon and cucumbers have shown growth enhancement when grown under the covers and yields have been obtained 1 to 2 weeks earlier than unprotected plants.

Strawberries have also responded well to the use of row covers. Plant growth enhancement is seen when grown under the covers in cool conditions as well as earlier yields obtained. Flower buds have been protected with the use of row covers alone under frost conditions and protection is enhanced when overhead irrigation is used in combination with row covers under freeze conditions.

Preliminary work is also going on with the use of row covers with onions, broccoli, lettuce, Belgium endive, squash and others.

Row cover research has been going on in Florida for three years. There are many questions that remain to be answered, but general patterns are emerging from the work. Five separate tomato crops have been put in testing row covers in Gainesville. This data plus work that has been done in other areas of the state establish general guidelines for row cover use in tomatoes.

THERE IS NO ONE IDEAL ROW COVER. At least 10 different row covers have been tested on tomatoes. Each cover has qualities that would make it more or less favorable depending on the climatic conditions prevalent.

Mechanization

Several companies have developed machines to apply wire and the plastic for the supported tunnels. Mulch layers can be converted easier to lay the unsupported or floating row covers.

Removing the covers is more labor intensive although one Florida grower has developed a pick-up mechanism so that the covers can be moved and used again.

Growth Enhancement

When weather conditions (both day and night) are cool for a period of time, tomato plants will benefit with increased growth. The rise in daytime temperatures under the covers is more dramatic than night temperature increases. With warm days 70°F and cool nights, the growth enhancement affect is less evident.

Frost Protection

Row covers can protect tomatoes from short duration frosts. The more extended the cold period the less heat is retained under the covers until the temperatures are similar. Generally the thicker non-woven floating row covers retain the tempertures under the covers longer. For the short duration frosts, a 3 degree increase in temperatures under the covers has been recorded numerous times. All frosts are not the same. During one radiation frost in the spring of 1986, the tunnels protected better, in that the tomato leaves were burned where the floating row covers touched the plant. Other frost experiences were convective in nature.

Wind Protection

Row covers can help in periods of cool windy weather. Floating row covers have caused abrasion to young plants by rubbing accross the leaves. Damage and plant loss can be very severe in pepper. Supported covers are a better choice in periods of extended windy weather.

Pest Problems

Weed growth under row covers seems to be the major problem experienced. When mulch is used this problem is greatly reduced. In crops grown on ground beds, the same growth enhancement for the crop also applies for the weeds. Herbicides (so far) have not completely alleviated the weed problem.

Insects and diseases have not been seen as problems under covers. The covers may act as mechanical barrier to these pests.

Spray Through

Spraying pesticides through the slitted or perforated tunnel material may be very difficult. Spray penetration through the non-woven row covers, however, has not been seen as a problem. With two materials tried in Gainesville, as pressures as low as 15 psi, excellent coverage was obtained.

Yields

Early yield benefits from the use of row covers have not been seen wit tomatoes as it has with several other crops. In all trials the least amoun of time the row covers were left on the plants was 3 weeks.

When daylight temperatures reach into the 80°F range, the temperatur under the covers can reach 130°F or higher. Tomatoes are heat sensitive an at these temperatures fruit set can be delayed, even with very youn transplants. Leaving the row covers on the plants 5 weeks can reduc yields.

The lighter or more open weave materials do not delay yield as much a tighter or heavier fabrics and tunnels do under the warmer day temperatures Conversely they will not hold the night temperatures long as the heavie materials under cool nights.

If growers wish to test row covers, we would recommend that th conditions of day and night time temperatures as well as wind be taken int account before a choice is made on which material is selected.

During the winter of 1986-87 the extension service can help in puttin out small area demonstrations on several types of row covers on intereste growers field. If interested a grower should contact the local county agen and in turn G. Hochmuth, S. Olson, D. Maynard or W. Stall.

WATER QUALITY - POSSIBLE CONSEQUENCES

Art Hornsby

Soil Science Department, IFAS

Recent reported incidences of groundwater contamination by pesticides and nitrate nitrogen from agricultural practices in several states including Florida is cause to consider how use of these agri-chemicals can result in such contamination. The Florida Department of Environmental Regulation ,FDER, has filed suit against a producer for allegedly contaminating groundwater with nitrate nitrogen which moved off his property onto that of another. The FDER is seeking damages to clean up the groundwater to meet federal drinking water standards - 10 mg/l as nitrate nitrogen. In some counties, ordinances are being passed which will be very restrictive of agricultural chemicals use in wellfield and aquifer recharge areas. Land use restrictions may become more stringent as cities consider water sources for future growth and development. The question that agricultural producers must address is: "How can our management practices reduce water quality impacts ?"

Reduction of water quality impacts is often a matter of under-standing the pathways of loss of agricultural chemicals from their point of application and modifying management practices to reduce these losses. Loss pathways include plant uptake, biological transfor-mation, volatilization, and leaching. Both pesticides and nutrients move(leach) in soils in response to water movement. Generally, if you know how the water is moving you know how agricultural chemicals will move in that soil. Figure 1 shows the movement of a non- adsorbed

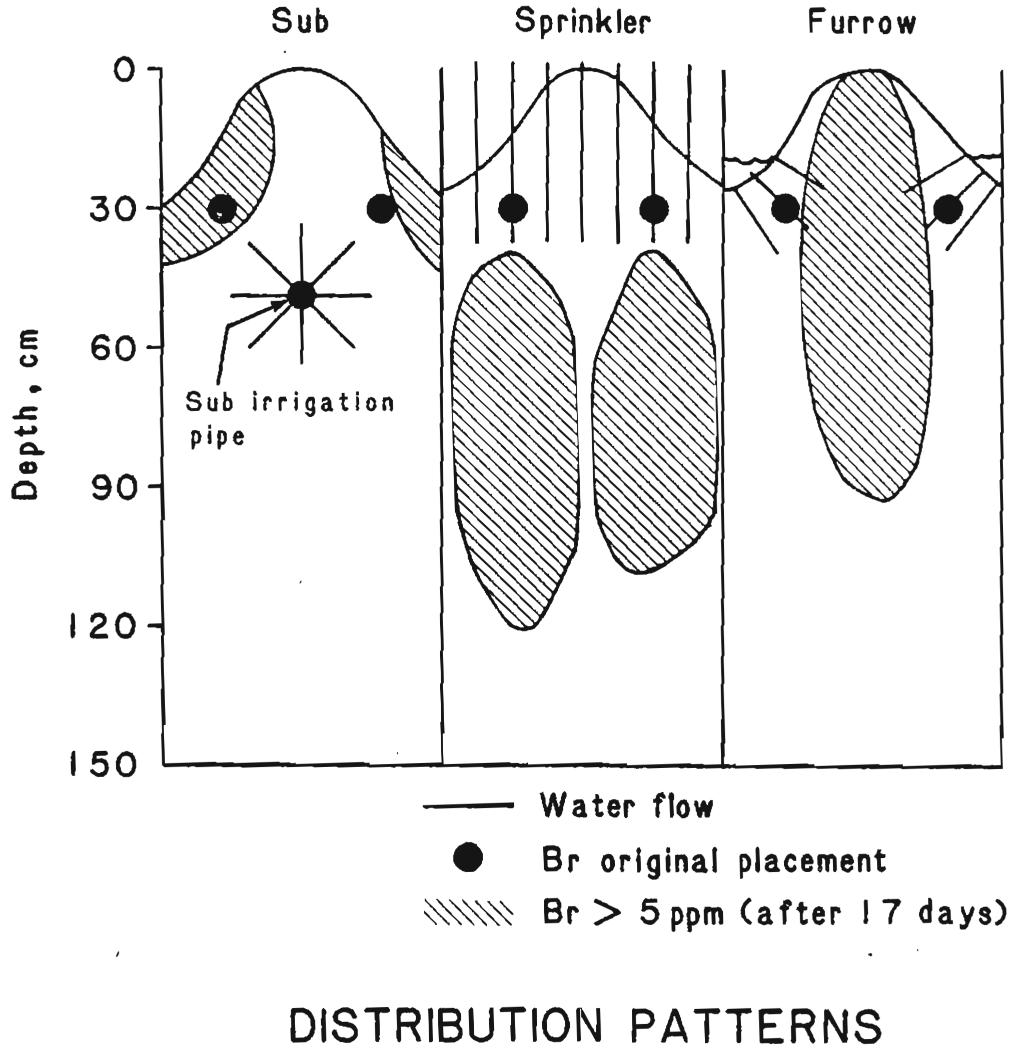

Figure 1. Movement of Chemical Tracer in Response to Water Application Method.

tracer in response to three methods of water application. It is evident that the chemical is moving in the same direction as the applied water. Chemicals that are adsorbed by the soil will also move in the same direction as the water but will be retarded or lag behind the non-adsorbed chemicals.

Loss of chemicals below the root zone represents both an economic loss and a potential for groundwater contamination. There are two principal means of minimizing this process. Since water leaches the chemical downward, attention should be paid to the water management system being used. If excess water is being applied over that needed for evapotranspiration one should expect leaching losses. Secondly, attention should be paid to the amount of nutrients applied relative to the expected yield goals. If excessive fertilizer is applied, there is a greater likelihood that significant leaching losses will occur. If you are applying the IFAS recommended rate of 240 # of n per acre and are harvesting 2000 boxes of tomatoes, then you are removing 90 pounds of N in the fruit and approximately 80 pounds in the vines(See Table 1). 160 of the 240 pounds applied are tied up in the crop. The remainder (80 pounds) is subject to loss by transformation or leaching. If you are applying more than the recommended rate or your yields are considerably less than 2000 boxes per acre, then all the excess is subject to loss and possible groundwater contamination.

Most Florida soils, particularly the surface horizons, have low retention capacities for water, nutrients, or pesticides due to the low water holding capacities, low ion exchange capacities, and low organic matter contents. Frequent irrigation is needed to avoid plant stress which reduces yield. Excessive irrigation or rainfall will tend to leach agrichemicals deeper into the ground. When possible, split applications of nutrients will reduce the amount available for leaching. To maximize returns from investment in fertilizers and pesticides and to minimize potential for groundwater contamination, careful management of the production inputs with efficient irrigation systems is necessary.

To avoid water quality degradation and possible additional regulatory restrictions on high value vegetable production, farm management practices (fertilization, irrigation ,and pest control) should be well integrated to provide the most efficient use of these resources as possible.

TABLE 1. NITROGEN CONTENT AND REMOVAL BY SELECTED CROPS AT THE INDICATED YIELD.

Selected Crop	Nitrogen Content %	Yield #/A	Nitrogen Removal #/A
Tomato,			
fruit	0.18	49,972	90
vines	---	---	71
Pepper,bell	0.19	21,416	41
Radishes,			
roots	0.18	19,989	44
tops	0.45	13,385	62

COMPARISON OF TECHNOLOGIES BETWEEN FLORIDA AND MEXICO TOMATO PRODUCTION - AN EXTENSION OVERVIEW

P.R. Gilreath
IFAS/Manatee County Extension Service
Palmetto, FL 33561

In late February of 1986, a group of seven IFAS Extension agents and specialists spent 6 days observing vegetable production and subsequent inspection procedures in W. Mexico. This educational opportunity 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 vegetable production practices of this area and to compare them with Florida in terms of technology and competitive advantage. Much of the trip was spent in and around the town of Culiacan in the state of Sinoloa, Mexico. Most production of winter fresh vegetables in Mexico occurs in 3 areas of Sinoloa - Los Mochis, Guasave and Culiacan valleys. The Sinoloan production region is generally dry during the winter and spring; however, they had experienced a hurricane and heavy rain in October of 1985 which did some damage and delayed planting. In general, the climate is as good if not better than that of Florida for tomatoes. The occurrence of severe frost in Sinoloa is highly improbable, but extreme temperature variations and rainfall can affect production.

Fresh vegetables available in the U.S. during the winter are supplied by Florida and Sinoloa. Florida traditionally is the dominant supplier in eastern U.S. markets, while Mexico dominates Western markets. Both compete in the Midwest. The ability of these areas to regularly provide the required quality and quantity of fresh vegetables has increased competition in both the U.S. and Canadian markets. Changes in supplies from one production area directly affect market price and returns in the other area. Competition in the winter fresh tomato market is heaviest between mature green ground tomatoes from Dade county and vine ripe, staked tomatoes from Sinoloa. Total export value of winter fresh vegetables from Mexico reached $278 million in the 1983/84 season (1). This was roughly half the $555 million received by Florida producers.

In general, agricultural producers in foreign countries are increasingly able to compete effectively with domestic producers, due to such factors as lower production costs, less rigid standards for production quality, export subsidies by foreign governments, and improved and readily accessible technology.

From our observations, although Sinoloan growers are picking up and implementing some U.S. technology in their production, a great deal of our technology is not the most cost effective alternative for their situations and thus is not used. In 1977, in a report from the UNPH Committee of Directors, a description was given of where they felt Mexican growers stood relative to their U.S. counterparts with respect to productivity improvement (3). In essence, the feeling was that they lack a technology of their own and the changes that take place are often a copy of the U.S. and are obsolete by the time they apply them, thus they are always behind. Since then, Mexican technology has increased to a point where, although perhaps not as advanced as Florida, it does not seem to be eroding their competitive position as they felt it once was.

When looking at production practices and technological changes in the field, there are several areas to address.

VARIETIES, TRANSPLANTS

The most popular tomato varieties grown in Sinoloa are 'Sunny' and 'Contessa' with hybrid seed imported from the U.S. Growers in Mexico, as in Florida, also test other varieties in the field. A popular one that many are looking at is a tall determinate variety from Asgrow called 'Humaya'. Yields differ markedly from Florida, due in part to cultural or technological differences, but also due to weather and market conditions.

Most growers now use transplants grown in polystyrene trays (both media and trays are often imported). Most larger growers have their own greenhouse transplant operations. Use of transplants has meant larger and better plants going into the field and thus higher and earlier yields. Plant spacing has decreased (i.e. denser plantings) in recent years making aerial spraying less efficient as the plants mature.

CULTURE

Sinoloan producers, like Florida growers, use both staked and ground culture for tomatoes; however, staked production is more common. Stakes are placed at intervals varying from 5 to 6 feet. In the past, stakes were placed far apart with 'wands' (shorter stakes) in between (1). They now place stakes closer together and use wire in place of twine or cord which has reduced costs as wire is cheaper and requires fewer workers. Stakes are cut and brought down from the mountains at a cost of about 5 cents each. They normally last about 4 years, the broken ones being used for staking peppers. Hand placement and removal of stakes and wire is obviously very labor intensive, but labor has been plentiful and relatively cheap.

In contrast to Florida, plant beds are not mulched or fumigated in Sinoloa, and the soil is much heavier with a higher clay content. Nematodes are not the problem they are in Florida and the only control is by rotation, with a four year maximum, followed by crops such as wheat, rice or soybeans. Herbicides are used to some extent, but are expensive, thus much cultivation is still done by hand and small tractors. Other hand operations include pruning and tying.

Approximately 90% of the tomatoes produced for export in Sinoloa are harvested vine ripe; thus, they are picked every 1 to 3 days. Production of mature green tomatoes in the Culiacan area has increased in recent years to approximately 10% of the total export production. This increase can be attributed to reduced labor requirements (fewer pickings), greater ease in handling and shipping, and increased potential for supplying markets farther from the production area. There seems to be a fairly recent increase in popularity of mature green ground or non-staked production. If this trend continues, it will inevitably heighten competition with Florida producers.

Fertilizer use has increased in recent years due both to higher plant populations and more intensive production. It is applied both by hand and by tractor before planting and while plants are small, and later is mixed with irrigation water. Although amounts used compare similarly to Florida growers, fertilizer costs are cheaper in Mexico because of domestic production. They purchase little from the U.S.(1).

Tomatoes are generally furrow-irrigated every 8 to 10 days, alternating in every other row middle. The water comes from the mountains and is transported through a main canal and delivery canals to the field. Water generally has not been a problem. Resources, including land and water, appear to be available for expansion should markets permit. In contrast, land rent in Florida is a major production cost and may have a significant effect on production due to urbanization and/or availability. Water is also a topic of increasing concern in Florida.

PEST MANAGEMENT

In the fields we visited, we were told the growers averaged 2 to 3 pesticide sprays per month. This had been a relatively dry season. Pesticides are still applied by hand in some cases. Aerial application is used more when plants are young, and may be the only way in rainy periods due to the heavy soil. Soil compaction is also a problem, although mechanizaton seems to be increasing with the use of 'high-wheel' tractors.

Pesticides are one of the most expensive production inputs for Mexican producers. Many Sinoloan producers have some sort of 'pest management technologist', similar to IPM scouts in Florida. Although, in general, most pesticides are sprayed on demand, in the fields we visited, growers seemed to accept higher threshold levels of some insects, for example leafminers. We noted an increasing interest in spray programs with a coinciding interest in maintaining the crop throughout the long harvest season. Growers seemed very conscious of the issue of pesticide residues, possibly because they realize it is one 'legal mechanism' U.S. producers can use to restrict imports.

LABOR

Over 200,000 workers are employed in the fields and packinghouses in Sinoloa. Many of these are Indians from the south. They are paid about 200 pesos per hour which is roughly equivalent to $4 per day (exchange rate of 470 peso/dollar). In one field where they were harvesting pinks, we were told that they were paid by the day, but they also kept track of the number of buckets.

Although cheaper in Mexico, labor is still the most expensive preharvest cost in Sinoloa as well as in Florida. Rural wage rates have increased significantly from 1965 to 1984. In 1979, W. Mexico daily wage rate was 1/5 that of Florida, but labor cost per unit of production was about 1/2 of Florida's. Although fluctuating heavily, Mexican wage rates in 1983 were only 11% of the Florida rate, which indicates that Mexican producers have maintained a labor cost advantage (1). Indeed, one source of W. Mexico's competition in the past has been very low labor costs.

PACKING AND MARKETING

Both picking and packing are done by hand and therefore are quite labor intensive. After picking, tomatoes are dumped into fiberglass gondolas for transport to the packinghouse. A few producers heat the water in the dump tanks. Tomatoes are then washed, waxed, sorted and packed. Hand packs are used for greens and count packs for ripes. Most Mexican growers have their own packing shed, and ship using their own individual grower-shipper labels.

In Mexico, production and marketing for export are coordinated through state and national cooperative federations. The area planted in vegetables on irrigated land is regulated by the government through recommendations from the state federation (CAADES - Confederation of Agricultural Associations of Sinoloa) and the UNPH - the national vegetable grower's association. UNPH also controls quality and quantity of vegetables exported. During periods of low prices, the UNPH usually will set stricter quality standards which limit supply and encourage higher prices. Minimum export standards for vine ripe tomatoes are often raised during periods of low prices to reduce supplies and strengthen prices (3). The greatest percentage of production is exported; whereas, the domestic market appears to be a refuge market for nonexportable sizes and qualities.

Although Sinoloan producers maintained a cost advantage over Florida producers in total preharvest, harvest, and packing costs, this advantage was lost due to the high marketing costs of exporting tomatoes to the U.S. In 1984/85, marketing costs were 38% of total costs for tomato production in Sinoloa, compared with 3% for producers in Palmetto/Ruskin and Southwest Florida (1). Just getting the tomatoes to the border is a 600 mile trip, across often poorly maintained roads, keeping in mind that 90% are vine ripe. Mexico needs a place pack to help reduce damage in transport. We saw considerable damage on some unloaded trucks in Nogales, such as broken pallets, crushed boxes, etc.

In Nogales, at the USDA inspection station, trucks are backed up to a CAADES truck dock where they are made accessible to inspection by partial unloading. Mexican tomatoes must be inspected for quality, condition and size to comply with the Agricultural Marketing Act. For loads of 400 boxes or more (8 pallets), 8 boxes are selected at random from the entire load. An inspector will then spend approximately 20 minutes inspecting samples from these 8 boxes, after which an inspection certificate is issued for grade and whether the load meets U.S. import standards. Two of the reasons why a load would fail inspection are decay (1% is allowed) and worms or worm damage (5% is allowed).

The truck is then reloaded and proceeds to the border for clearance by Mexican and U.S. customs. It is then subjected to FDA inspection. Loads are sampled at random; however, I was informed they do try to cover all growers and brands when pulling samples. FDA inspectors pull an average of 30 samples a day, 5 days a week during the bulk of the season from early January to June (2). These samples are then shipped to Los Angeles for residue analysis. Thirty samples per day is apparently the limit as far as what the lab can process. In the last few years, only 1 1/2 to 4% of loads have been over tolerance. Growers that have produce in excess of tolerance limits are put on surveillance which means every load they ship is checked.

After release by customs, the load then goes to a distributor's warehouse in Nogales, Arizona where it is unloaded. Once a sales agreement is reached with a buyer, the produce is repacked and loaded onto a U.S. trailer for shipment to markets within N. America. A few firms handle a very large proportion of the produce. Many distributors in Nogales also play an active role in vegetable production as well. Once a load clears customs, marketing channels are then quite similar as for U.S. produce.

TRENDS

Vegetable production in both Florida and Mexico has increased substantially over the last decade, with tomato production in Florida almost doubling. This can be attributed to both increased acreage and increased yields from new hybrid varieties and more efficient production practices. Sinoloan plantings have shown more variation from season to season (responding to climatic, economic and marketing factors), but overall acreage has shown a slightly increasing trend. Sinoloan growers have actually experienced a very marginal decrease in the trend value of staked tomato yields (1). This may be explained, at least in part, by the lack of significant technological innovations.

This apparent lack of technological innovation in comparison with Florida should not be overestimated. This fact may not be enough to allow Florida to maintain its competitive position. It is clear that W. Mexico tomato production is a fairy sophisticated, efficient and thriving industry. Most Sinoloan producers ship only if the export price they receive exceeds their fairly high export marketing costs. In periods of low prices, they may ship tomatoes to the domestic or national market. On the other hand, high prices may divert production from the domestic market. Over 60% of production has been exported in recent years (1). Relaxation of quality restrictions during periods of high prices may result in shipment of lower quality tomatoes to the export market.

High export marketing costs incurred by Mexican growers allow Florida to remain competitive. What we gain here, however, has at times been outweighed by the ability of W. Mexico to ship large volumes of tomatoes to the U.S. markets during periods of high prices. The market is also very quick to respond to production disruptions in Florida by shifting to Mexican produced tomatoes to satisfy U.S. needs. A very good example of this occurred in 1985 during the week that followed the January freeze. Mexican tomato shipments increased 16% over the previous week while Florida shipments dropped 54%. This allowed Mexico to obtain a 76% share of the U.S. vegetable market between January and March (1).

Although Florida shipments of tomatoes have far exceeded Mexican shipments between 1978/79 and 1984/85, according to recent USDA information, Florida lost its competitive advantage in 1984/85, probably due to these periods of freezing weather. Eggplant was the only winter fresh market vegetable where Florida producers retained both a cost and price advantage in 1984/85 (1). Mexican growers held the advantage in supplying U.S. markets with the other 5 major vegetables (tomatoes, peppers, squash, cucumbers and green beans). This edge has the potential to continue if U.S. prices remain high enough to offset Mexico's high marketing costs and if Florida continues to suffer damaging weather.

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In addition to the above references, information presented here was obtained through personal communications, observations and notes by the author and other members of the group which included:

Mr. Reggie Brown, Collier County Extension Director
Mr. Rick Mitchell, Hillsborough County Extension Agent
Mr. Walter Prevatt, Extension Economist, G.C.R.E.C.
Mr. Ken Shuler, Palm Beach County Extension Agent
Dr. Bill Stall, Extension Vegetable Specialist, Gainesville
Mr. Richard Tyson, Dade County Extension Agent

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NEW THREATENING PEST IN FLORIDA - WESTERN FLOWER THRIPS

S. M. Olson and J. E. Funderburk
North Florida Research and Education Center
Quincy, Florida 32351

Introduction: The western flower thrips (WFT), *Frankliniella occidentalis* (Perganda), has long been a pest of flowering plants and some crops in the southwestern and western U.S. The species was first recorded in the southeastern U.S. in 1980, with economic problems developing on cotton in Georgia, Alabama, South Carolina, and Florida. Additional problems developed in Florida on various ornamentals. The WFT now ranks as one of the most important greenhouse pests in the eastern U.S. and Canada.

During the last two years, a very serious problem has occurred to the spring tomato crop in northern Florida. Many fruit were found to contain small feeding scars. Circumstantial evidence implicated thrips, including WFT. The damage was economically important in 1985 and 1986, but the problem was particularly acute in 1985.

Life Cycle: The WFT has 6 lifestages, including egg, 2 larval stages, prepupa, pupa and adult. The females deposit eggs directly into plant tissue.

Creamy white, wingless larvae hatch in 2-7 days. The 2 larval stages are active feeders on plant tissue. The prepupal and pupal stages do not feed and are found commonly in the soil beneath the plant. The adults are also active feeders on plant tissue.

Adults are about 2 millimeters long with 2 pairs of fringed wings. The adult females exhibit 3 distinct color forms, including golden brown to almost black, light yellow and colorless. The adult males are light colored. The mouth parts are a modified sucking type and the WFT are able to puncture plant tissues and feed on sap that exudes. On tomato flowers the adult is the primary feeder. Total developmental time from egg to adult is about two weeks.

Description of Damage: The feeding damage probably occurs after the bloom has opened enough to allow entrance of the insect. In many cases, the damage can be seen by physical removal of the corolla before its sloughing. The damage by the WFT appears as a small dark spot or depression with a surrounding whitish discoloration. The discoloration sometimes disappears as the fruit matures, leaving only a small depression with a dark center.

The damage is confined to the lower half of the fruit, apparently because the calyx hides the upper half of the immature fruit in the bloom when the damage occurs. In most cases the crown set fruit are not affected. Rather the damage is most prevalent during later fruit set.

Thrips Populations in Tomato Blooms: Three other species of *Frankliniella* are commonly found in tomato flowers in northern Florida. They are *F. tritici*, flower thrips; *F. fusca*, tobacco thrips; and *F. bispinosa* (no common name). Each of these species has been commonly collected from tomato blooms, and each may be economically damaging to tomato fruit. Inadequate scientific information currently exists about the biologies and damage potential to tomato of the *Frankliniella* species. Other thrips species from different genera are found in tomatoes (either foliage or blooms) but none have been reported to be economically important.

Thrips populations were sampled in a study conducted in northern Florida during 1986 (W. B. Tappan, unpublished data). Their populations peaked in the tomato flowers during mid-May with an average high at this time of 32 thrips per bloom. Nearly all of the thrips in the tomato blooms were adults. Similar results were observed in actual tomato growers' fields (K. Jackson, personal communication).

Host Range and Sources of Infestations: At present, very little is known of the host range of the WFT. The species inhabits and damages the flowers of pears, cotton, and alfalfa, the flowers and seeds of onion, the young plants of cotton and peanuts, and the pods of broad beans. In the greenhouse, WFT will feed on many flowering crops such as roses and mums, causing deformity or early senescense of the flowers.

Likely sources of infestation of all *Frankliniella* spp. in tomato fields include grasses, small grains, weeds, and other crops. The increase in thrips problems in tomatoes coincides with the tremendous increase in small grain production in the tomato growing areas of the Southeast (R. Griffin, personal communication and the authors). Plant senescense in the small grain fields coincides with the onset of flowering of the tomato crop, and the grain fields are undoubtedly a major source of thrips populations infesting the tomato fields.

Insecticidal Control: At present only the following insecticides are cleared for tomatoes and have thrips included under the tomato label.

Material	Rate (lb a.i./A)	Time Limit
Guthion	0.5 - 0.75	0
Parathion	1.0 - 2.0	10

Numerous other insecticides are cleared for tomatoes. None are labeled for thrips in tomatoes, but each is registered for the control of thrips on other crops. Consequently, these materials are legal to use for thrips control on tomatoes but there are no data to indicate the efficacies and rates needed against thrips populations inhabiting and damaging tomatoes. These materials include Thiodan, Diazinon, Phosdrin, Proxol, Cygon, Vydate, methomyl and Monitor.

Only one experiment has been conducted concerning insecticidal control of thrips populations in northern Florida tomatoes (W. B. Tappan, unpublished data). The study compared different rates of Monitor (0, 0.5, 0.75, and 1.0 lb ai/ac) against thrips population numbers in the blooms. The amount of damage also was quantified for each treatment. Thrip population numbers did not change significantly in any treatment, but, surprisingly, differences were noted in percent fruit damage. The percent fruit damage ranged from 22% for the control to about 9% for both the 0.75 and 1.0 rate. The 0.5 rate had about 12% damaged fruit. The damage on the fruit in all treatments did not contain a whitish area surrounding the punctures, but did have the small dimples on the lower half of the fruit.

Economic Importance: In the 1985 tomato season in Gadsden County, Florida, a substantial amount of damage was evident. In some fields as much as 45% of the fruit was showing damage which was thought to be caused by thrips and primarily the WFT.

In the packing houses, the inspectors were counting the fruit as defective or off grade if the whitish area persisted until grading or if there were frequent hits on the fruit. In 1986, the damage was much less, probably because of a lighter infestation and/or the spraying of insecticides for thrips control when the scout was informing them of thrips in the blooms.

Tomato spotted wilt virus (TSWV) was also recorded for the first time in northern Florida in tomatoes in 1986. Young, infected tomato plants do not grow properly and produce no marketable fruit. Plants infected at a later growth stage will produce multicolored, yellow and red fruit. Known vectors of TSWV include *F. occidentalis* and *F. fusca*, which presumably transmitted the disease to the tomatoes in Florida. We anticipate that thrips will be even more economically important pests to tomatoes in future years, because of the potential increase in TSWV.

Research Needs: Obviously, serious informational shortfalls exist concerning WFT and related thrips species in tomatoes. The biology of each damaging thrips species in the tomato growing region needs to be understood, including reproductive potential, developmental rate, and sources of infestation. The injury to tomato fruit by each damaging life stage of the thrips species suspected to be of economical importance needs to be carefully characterized, and economic injury levels established for scouting programs. South Carolina has established an arbitrary threshold of 1 thrips per bloom in their tomato recommendations (R. Griffin, personal communication).

Information also is needed on efficacy and most effective use of labeled, unlabeled, and experimental insecticides against thrips on tomatoes. We feel that many materials need to be developed for use on tomatoes, in our geographical region, because of the explosive potential of the thrips populations. Alternating materials when frequently spraying may prevent the buildup of resistant thrips populations, thereby preventing the possibility of extremely serious economic problems.

TOMATO SPOTTED WILT VIRUS FOUND IN FLORIDA IN 1986

BY TOM KUCHAREK

The Florida Plant Disease Clinic diagnosed Tomato Spotted Wilt Virus (TSWV) on a commercial tomato sample received from Gadsden County on May 29, 1986. Later, other tomato samples from Gadsden and Santa Rosa Counties were determined to be positive for TSWV. A peanut sample received by the FPDC on June 30, 1986 from a commercial field in Santa Rosa County has determined to have TSWV. Later TSWV was confirmed on peanuts from Jackson County. Informal reports indicate that TSWV has occurred in other areas of the Florida panhandle; this would not be surprising in view of more numerous occurrences of this virus disease in Alabama, Mississippi, Georgia, Kentucky, and Texas during 1986.

This virus is spread by many species of thrips. Unusually high populations of thrips and thrips that may not be sensitive to insecticides, normally considered to be efficacious, have been reported for both field and greenhouse situations in the Southeast United States in recent years. Thrips acquire the virus from infected plants after feeding for 15 minutes or more during their larval stages. Then, after 4 to 10 days and after thrips become adults, transmission by thrips to new sites is possible. Thrips have been reported to retain the virus for their entire life; however, they do not transmit the virus to their progeny. Thrips appear to be the primary vector for TSWV. However, this virus has been transmitted by grafting and mechanical means. Seed transmission is not normally associated with this virus except for a couple of vague reports.

The host range of TSWV is extensive including crop and non-crop plants in 34 families. To state specifically each host species would be somewhat presumtive because of the different strains of TSWV that exist, partially due to recombination of existing strains, and possible differences in susceptibility or degrees of resistance that might occur between and within crop species. Also, environmental factors such as light and temperature alter symptom expression. Cultivated plant species that are often associated with TSWV include tomato, peanut, tobacco, lettuce, peppers, eggplants, peas (English), gladious, calla lilly, chrysanthemum, nasturtium, dahlia, zinnia, false Jersualem cherry and many others. Also, numerous weed species are susceptible. The plant families leguminosae, solanaceae and compositae contain many susceptible species. Also note above that monocotyledons as well as dicotyledons are susceptible. It has been observed in other states that the severity of TSWV is often greater near urban areas where susceptible perennial ornamentals abound.

Symptoms are variable on many host plants depending on light, temperature, status of nutrition, and age of plants. Leaf etchings, often in ring-like patterns, and leaf mosaic or mottle may occur. Plant stunting and distortion may occur. On red tomato fruit of the sunny variety, yellow blotches and rings that were somewhat circular and sometimes overlapping occurred in Gadsden County in 1986. Green, mature green, and red fruit in the same planting had bronzed somewhat circular blotches up to an inch or more in diameter, often with stellate- or circular-like cracks. Larger yellow blotches have been associated with tomato fruit in other localities. It is conceivable that symptoms of TSWV could be confused with tobacco mosaic virus and advanced symptoms of stink bug injury. Laboratory diagnosis should be relied upon for diagnosis until you are familiar with the multivariate symptoms associated with TSWV.

Effective control measures for TSWV on tomatoes is currently lacking unless a means for depressing thrip populations is available. Some degrees of resistance in tomato pedigrees has been reported but commercial availability of such is not known. The highly sporadic occurrence of TSWV on both a temporal and spacial basis has been relied upon in the past. The occurrence of a few plants in one field has not been an automatic signal for further spread in some situations; yet in other situations, serious losses have occurred in other states.

COPPER-MANCOZEB/MANEB EFFECTS ON CONTROL OF TOMATO DISEASES

John Paul Jones and Jeffrey B. Jones
Gulf Coast Research & Education Center
Bradenton, FL 34203

Copper and maneb or copper and mancozeb originally were tank mixed in Florida by a number of researchers (including Stall (11), Thayer (12), Conover (3, 4), Averre (3), Vakili (13), Delp (unpublished), and Gerhold (4) in the effort to control bacterial and fungous diseases of tomato and other vegetable crops. Surprisingly, the combination consistently gave better control of bacterial spot (Xanthomonas campestris pv. vesicatoria) of tomato than either maneb, mancozeb, or copper alone. Currently the mancozeb + copper combinations remain our recommendations for chemical control of bacterial spot.

Despite the repeated demonstration of the efficacy of maneb or mancozeb + copper combinations for the control of bacterial spot (6), these combinations are not entirely satisfactory when weather conditions are favorable for the spread of the pathogen and development of the disease (4). Also, during certain nondelineated conditions some combinations are phytotoxic to tomato and repeated applications may result in decreased yields and/or fruit injury (7). Consequently, at times the treatment of choice for bacterial spot control in Florida seems to be more injurious than the disease.

In addition to the problems of phytotoxicity and less than satisfactory control of bacterial spot, there also in a problem of incompatibility in that the maneb or mancozeb + copper combinations do not always control certain fungus-incited diseases of tomato as well as maneb or mancozeb alone. Conover and Gerhold (4) reported that the same combinations that resulted in enhanced control of bacterial spot were less effective than the carbamate alone for control of gray leafspot, caused by Stemphylium solani. However, the results were inconsistent and in a report in the 1961 Fungicide and Nematicide Reports, Conover (2) demonstrated that maneb + copper gave as good control of gray leafspot as maneb alone. Conover and Gerhold (4) also presented evidence that control of late blight (Phytophthora infestans) was reduced by the maneb + copper combination compared to a schedule of maneb alternated with zineb. However, Jones (7), and later Dougherty (5), found in one field experiment that the combination of maneb + copper controlled late blight as well as maneb alone. Obviously, under certain conditions which remain unknown, application of maneb + copper may or may not be as effective as maneb alone for the control of gray leafspot or late blight of tomato.

Jones and Jones (8) found in a series of growth room experiments that although mancozeb + copper combinations reduced the severity of target spot (Corynespora cassiicola), mancozeb alone was more effective. They concluded that the mancozeb + copper formulations applied for bacterial spot control should be augmented with chlorothalonil if target spot became troublesome in commercial fields in Florida. Perhaps these sentiments should be expanded to include late blight.

Early blight, caused by Alternaria solani, is another fungus-incited disease of serious concern to the Florida tomato grower. Although the efficacy of maneb/mancozeb + copper combinations was questioned long ago in regard to early blight control, only recently have sufficient Florida data been secured to help alleviate this concern. Jones and Jones (unreported data) found that once weekly applications of mancozeb + copper resulted in better disease control than mancozeb or copper alone. Similarly, chlorothalonil + copper resulted in better disease control than chlorothalonil or copper alone. Sitterly (10), as early as 1962, Vakili in 1966 (13), and Potter and Bates (9), a year later reported that maneb + copper resulted in control of early blight equal to that of either chemical alone and far superior to non-sprayed plots. It would appear that maneb-mancozeb + copper combinations can be used effectively for the control of early blight.

Undoubtedly maneb/mancozeb + copper combinations consistently decrease the severity of bacterial spot of tomato and they are the best materials commercially available for bacterial spot control. Nonetheless, as Conover and Gerhold (4) demonstrated, if environmental conditions favor disease development long enough, the combinations eventually will be overwhelmed. The mancozeb/maneb + copper combinations apparently also afford excellent control of early blight. However, these combinations seem to be incompatible in that certain fungus-incited diseases are not controlled consistently as well by the combinations as by the maneb/mancozeb alone. Additionally, some maneb/mancozeb combinations may cause damage to the foliage and fruit, resulting in decreased marketable yields. Beckenbach, et al. (1) in 1949 wrote that the proper spray program for tomatoes in Florida makes use of the minimum number of pesticide applications and that the tendency toward excessive spraying might result in fewer bushels of fruit per acre, and perhaps even serious crop damage. These sentiments are as valid today as then.

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PRESCRIPTIVE APPROACHES TO SOIL PEST CONTROL WITH METHYL BROMIDE AND CHLOROPICRIN

J.W. NOLING

Integrated Pest Management (IPM) is a pest control concept which utilizes all suitable techniques and methods, in as compatable a manner as possible, to maintain pest populations at or below ecomically damaging levels. The economic threshold forms the foundation and framework for development for many IPM programs, integrating the economics of pest control and crop production with pest population density. The economic threshold is most simply defined as the pest population density where the value of the damage avoided is equal to a greater than the cost of the control measure applied against the pest.

For advisory purposes it is frequently not possible to employ the economic threshold concept and predict within acceptable levels, potential losses in crop yields based solely on field estimates of nematode population density alone and in isolation of other plant yield reducing factors. This occurs as a direct result of the interaction between nematodes and other pests, pathogens, environmental and agronomic factors. In many cases significantly increased levels of yield losses occur as a result of a combination of plant stressors. This phenomenon is particular well documented in tomatoes on old production land when Fusarium wilt and Root-knot nematode are both present. With both pests present plants may die prematurely resulting in total crop failure. This interaction between pests poses a serious limitation on the use of economic thresholds developed for individual pests and justification for specific pest control strategies. The severity and reoccuring nature of multiple-pest problems, as in tomato production or old land, underscores the need for control strategies which consider pest density and diversity and their combined impact on tomato yield.

Methyl bromide (MB) and chloropicrin are marketed as broad spectrum soil fumigants controlling such soil borne pests as insects, weeds, nematodes, fungi, and bacteria. They are currently registered within Florida under various different labels and formulations as preplant treatments for tomatoes, peppers, eggplant, broccoli, cauliflower, melons, strawberry, and seedbeds for transplants. MB is commonly mixed in various proportions with Chloropicrin. In low concentrations chloropicrin is used primarily as field marker for detection of escapin MB fumes.

Since the discover of chloropicrin in 1848 and methyl bromide in 193 a considerable amount of research has been done to evaluate their dispersion and dissipation characteristics and efficacy against a myria of urban, storage, and soil borne pests. Even with this extensive research base there is some grower uncertainty concerning the broad spectrum activity of MB, chloropicrin, and their mixtures.

Lethal levels required to control individual pests are determined fro an understanding of the biology of individual pest species and the development of dose-response relationships. Pest control practices are then generally based on pesticide levels required to kill the most tolerant or resistant economic pest species. In general, the degree of nematode or general soil pest control increases non-linearly as fumigation rate increases. In the case of MB-Chloropicrin mixtures an element of complexity can be introduced into grower selection or use decisions if one compound possesses greater toxicity to specific pests.

This differential toxicity of the two compounds of MB-Chloropicrin mixtures should allow a more prescriptive approach to pest control for fields with differing pest complexes.

WEEDS

In the case of different weeds, the relative susceptibility of different weeds to MB and chloropicrin formulations and dosage levels have not been adequately assessed. Methyl Bromide is the primary herbicidal agent for the MB-Chloropicrin mixture and the weed control properties decrease as the rate per acre of the MB decreases. This is especially pertinent to weed species with hard seed coats or large corms or tubers. Many weeds including mallow, filaree, morning glory, vetch, dodder and some species of clover are difficult to control at recommended rates and methods of application and marked growth stimulation, especially of grasses, can also occur in response to inadequate rates of fumigation. At a broadcast rate of 400 lbs/a, nutsedge control can be marginal with formulations of 67-33% and has therefore promoted the use of 98-2% methyl bromide-chloropicrin formulation for more effective nutsedge control.

Failure to control weeds such as nutgrass and pigweed with MB which are tolerant is most frequently related to inadequate soil preparation and dry soil conditions prior to fumigation. Pretreatment irrigation, 1-2 weeks prior to fumigation is recommended to encourage seed germination and susceptibility to diffusing gases. Weed control at the bed surface may also be incomplete midpoint between injection points and permit weeds to compete with transplants set off-center of the injection path.

NEMATODES

In general, nematodes are much more sensitive to the multipurpose fumigants than are fungi, bacteria, weeds, or soil dwelling insects. Although sensitive, many nematodes still survive the fumigant treatment even at application rates sufficient to affect other more tolerant pests. The survivability of nematodes to fumigation is influenced by many factors. The presence of large, undecayed roots prior to treatmen can shelter endoparasitic nematodes from lethal gases. It has been shown that undecayed roots can be 8-16 times more resistant to fumigant than the pests or pathogens living in them and this resistance increase markedly with root size. Inconsistant control of root-knot nematodes has occurred with chloropicrin when complete decay of infested roots wa not achieved prior to fumigation. Conversely, excellent control of Root-knot nematode infested roots has been obtained with MB which penetrates intact roots tissues more readily.

The vertical migration of nematodes within the soil, especially prior to cool and or dry fallow periods is now being considered as another important factor which maintains populations below treated zone following fumigation. In very dry soils, many nematodes which can survive in a dehydrated state can tolerate 10 times the lethal dose of active forms in moist soils. The rapid escape of volitalizing gases near the soil surface only compounds the problem. Another commonly overlooked factor is dosage level, the quantity of chemical per unit area of soil required to achieve control. Dosage levels vary not only with soil type, soil moisture, and temperature but is also a function of nematode infestation level. Higher dosages are generally required to control nematodes as well as other pathogens to subeconomic levels in heavily infested rather than in lightly infested soils.

OTHER PLANT PATHOGENS

MB and Chloropicrin are also used to reduce the incidence of soil borne fungal pathogens such as Fusarium and Verticillium. In field and laboratory studies MB has generally failed to control Verticillium, even at rates in excess of 200 lbs/a. In other tests MB was ineffective for control of Fusarium and Corynebacterium. Microscerotia of Verticillium are difficult to kill and control of the microsclerotial forming fungi decrease rapidly with MB dosage, especially in soils with high organic content. In contrast to MB, chloropicrin in itself is an excellent fungicide having a much wider spectrum of activity against many plant pathogenic fungi of economic importance. Toxicological studies relating the level of control of soil borne plant pathogens to increasing levels of Chloropicrin in MB mixtures have not been performed or are not readily available. In some cases it has been shown that percent control of Verticillium, Fusarium, Rhizoctonia, Phythium, and Thieloviopsis increased when chloropicrin was added to MB. This increased level of control in relation to MB or Chloropicrin alone is apparently due to the additived toxicity of the two compounds together.

Based solely on the above toxicological information some general guidelines for MB-Chloropicrin formulation decisions can be inferred. In fields where the primary objective is weed control, formulations emphasizing MB should be used as in formulations with 98% MB and 2% Chloropicrin. Formulations with 67% BM and 33% Chloropicrin are generally regarded as a borderline formulation for nutgrass control. In fields where plant pathogenic fungi are the primary problem, formulations emphasizing Chloropicrin should be used. For nematode control, MB has certain advantages over Chloropicrin. MB is cheaper, easier to handle, less corrosive to equipment and permits field replanting sooner than Chloropicrin. If a grower wants to replant as soon as possible MB is more satisfactory, since it penetrates undecayec roots and escapes from the soil more rapidly than chloropicrin. If chloropicrin is used at high levels in the MB formulation, then treatment and consequently replanting should be sufficiently delayed (ι to 21 days) to allow for root decay and to prevent any undesirable phytotoxic effects to the following crop.

The higher price of chloropicrin ($1.50 / lb) relative to methyl bromide ($0.75 /lb) is, in addition to differential toxicity, an important economic factor influencing fumigant use, rate, and grower formulation decisions. The difference in price allows the use of greate field dosage rates of MB than other chloropicrin containing formulation when equivalent material costs are considered. For example, field dosag rates of 200 lbs/a of MBC(67/33) and 267 lbs/a of MB(98/2) could be applied when material costs are held constant at $200 per acre. The difference in price allows 33% more MB(98/2) to be applied in relation to MB(67/33).

The comparitive efficacy of different rates and formulations of methyl bromide-chloropicrin are important considerations, especially pertinent when equivalent costs are evaluated. Formulation decisions based entirely on material costs can result in production losses due to marginal or incomplete control of MB tolerant or resistant pests. In this case the philosophy that `more is always better' can have serious economic consequences and should be avoided. At the same time it underscores the need for further study and economic analysis comparing returns over costs for different rates and formulations of fumigant nematicides.

EFFECTS OF ALTERNATIVE FUMIGANTS TO METHYL BROMIDE IN TOMATO PRODUCTION

Robert McSorley
Dept. of Entomology and Nematology
IFAS, University of Florida
Gainesville, Florida

INTRODUCTION

Broad-spectrum soil fumigants have been used beneath polyethylene mulch in tomato production for over 20 years (6), providing useful control of nematodes, soilborn diseases, and weeds. Mixtures of methyl bromide and chloropicrin have been the fumigants used most frequently (7). Recently, several fumigants containing methyl isothiocyanate and/or chlorinated C_3 hydrocarbons have provided levels of control similar to methyl bromide/chloropicrin mixtures when tested on sandy soils in southwestern Florida (5) or on calcareous soils in southeastern Florida (4). The objecti of this paper is to summarize studies in which control of nematodes and weeds by vario alternative fumigants were compared with methyl bromide/chloropicrin mixtures in tomato production on Rockdale soils (1) in Dade County, Florida.

MATERIALS AND METHODS

Four field tests were performed from 1983-86 in various sites at the Tropical Research and Education Center in Homestead. The soil in all test sites was a Rockdale fine sandy loam (1) with pH = 7.3 to 7.8, naturally infested with root-knot (Meloidogyne incognita) and reniform (Rotylenchulus reniformis) nematodes. All field tests were performed on raised beds 42 in wide and 6 ft apart, into which 2000 lbs/A of fertilizer (8-16-16) had been incorporated prior to fumigation. For most treatments tested, beds were covered with a 1 1/2 mil opaque gray-on-black polyethylene mulch immediately after treatement.

Test 1. Treatments for this test were applied on Dec. 5, 1983, and included: Dowfume® MC-33 (67% methyl bromide, 33% chloropicrin) at a rate of 225 lbs/bedded Vorlex® 201 (34% chlorinated C_3 hydrocarbons, 17% methyl isothiocyanate, 15% chloropicrin, 34% inert ingredients) at 25 gal/bedded A; Vapam® (32.7% sodium N-methyldithiocarbamate, 67.3% inert ingredients), drenched over the surface of the bed at 100 gal in 3000 gal of water per acre; Mylone® 99G (99% dazomet 1% inert ingredients) at 530 lbs/treated acre, followed by application of polyethylene mulch; Mylone 99G at the same rate without mulch; and an untreated control. The fumigants Dowfume MC-33 and Vorlex 201 were injected into the beds at a 6-in depth from three chisels spaced 12 inches apart. Mylone 99G was applied with a Gandy® fertilizer spreader and incorporated by rototilling. Beds for both fumigant treatments and one Mylone treatment were covered with polyethylene mulch immediately after treatment application, but the other Mylone treatment, the Vapam treatment, and the control we left uncovered. All plots received two inches of overhead irrigation after all treatme were applied. The length of each plot was 50 ft, and the 6 treatments were replicated times. Four-week-old 'Flora-Dade' tomato plants were transplanted into the plots on Dec. 16 at a spacing of 12 in. A-10 ft section of row was harvested on March 26 by

[1]Mention of a trademark name or a proprietary product does not constitute a guarant or warranty of the product by IFAS, and does not imply its registration or its approval the exclusion of other products that may be suitable.

removing, grading, and weighing all fruit from 10 adjacent plants. The root systems of these 10 plants were also removed and rated for galling from root-knot nematodes using Taylor and Sasser's (8) 0 to 5 rating scale, where 0=0 galls per root system, 1=1-2 galls, 2=3-10 galls, 3=11-30 galls, 4=31-100 galls, and 5=more than 10 galls per root system. Soil samples for nematode analysis were collected on Jan. 4 and March 22, 1984, and processed using Jenkins' (3) method. Weed populations were assessed by counting a 6.5-ft section of row on Jan. 18.

Test 2. Treatments for Test 2 were applied on Nov. 1, 1984, and consisted of: Terr-O-Gas® 67 (67% methyl bromide, 33% chloropicrin) injected into beds at a 6-in depth from four chisels spaced 8 in apart, at a rate of 225 lbs/bedded A; Vorlex 201 injected at 25 gal/bedded A; Vorlex® (80% chlorinated C_3 hydrocarbons, 20% methyl isothiocyanate) at 25 gal/bedded A; Trapex® 40 (40% methyl isothiocyanate, 60% inert ingredients) at 25 gal/bedded A; Vapam, drenched onto beds at 50 gal/treated A in a 16-in band, equivalent to 19 gal/bedded A; and an untreated control. All beds were covered with polyethylene mulch immediately after treatment. Each bed was 25 ft long and the 6 treatments were replicated 4 times. 'Flora-Dade' tomato plants were transplanted into the beds on Nov. 9, and a 10-ft section of row was harvested on Feb. 13 and 22, 1985. After the last harvest, root systems of 6 plants per plot were removed and rated for galling from root-knot nematodes, and soil samples for nematode analysis were collected on three occasions during the growing season.

Test 3. Conditions for this test were similar to those of Test 2. Nine treatments were applied on Oct. 30-Nov. 1, 1984: Terr-O-Gas 67, Trapex 40, Vorlex, Vorlex 201, and Vapam at the same rates used in Test 2; Busan® 1020 (33% sodium N-methyldithiocarbamate, 67% inert ingredients), applied in the same manner and rate as Vapam; Soilex® C-17 (17% chloropicrin, 83% penetrating solvents), injected at 25 gal/bedded A; Vydate® L (24% oxamyl 76% inert ingredients), applied foliarly at 2.0 qt/A in 100 gal water/A on three occasions at two-week intervals beginning on Jan. 2, 1985; and an untreated control. The 9 treatments were each replicated 4 times. 'Flora-Dade' tomatoes were seeded directly into all beds on Nov. 13, but were severely damaged by cold temperatures on Jan. 21. Four harvests were made between Feb. 28 and Apr. 16. Nematode samples were collected as in the previous test, and counts of nutsedge (*Cyperus* spp.) plants per 3.3 ft of bed were made on Dec. 14.

Test 4. Treatments in this test, applied on Oct. 7, 1985, were: Terr-O-Gas® 75 (75% methyl bromide, 25% chloropicrin) at 225 lbs/bedded A; Vorlex and Vorlex 201 at 25 gal/bedded A; Trapex 40 at rates of 25 gal and 35 gal/bedded A; and an untreated control. Plots were 25 ft long, and the 6 treatments were replicated 4 times. 'Flora-Dade' tomato plants were transplanted on Oct. 15, and four harvests were made from a 12-ft section of row between Jan. 10-Jan. 27. Root systems of 6 plants were rated for root-knot galling, and soil samples for nematode analysis were collected on three occasions. The number of weeds penetrating the plastic mulch and the number of planting holes containing weeds were counted on Nov. 25 and Jan. 29. A 22-ft section (22 holes) was evaluated on Nov. 25, and a 12-ft section (12 holes) on Jan. 29.

RESULTS AND DISCUSSION

Test 1. Soil populations of root-knot and reniform nematodes were significantly reduced by all treatments, particularly Vorlex 201 or Dowfume MC-33 (Table 1). Galling from root-knot nematodes was significantly lower than in control plots when either of these two fumigants were used. Populations of Santa Maria (*Parthenium hysterophorus*) were reduced by all treatments, and nutsedge (*Cyperus esculentus* and *C. rotundus*) populations were significantly reduced from levels in control plots by all treatments except Mylone. Other weed species present in lower numbers included Virginia pepperweed (*Lepidium virginicum*), sowthistle (*Sonchus oleraceus*), black medic (*Medicago* spp.), and Carolina geranium (*Geranium carolinianum*). Fruit yields were not significantly affected by fumigation, despite the levels of weed and nematode control achieved.

Test 2. In this case, nematode populations in soil were reduced to low levels by four of the fumigants tested, while effects of Vapam were intermediate between the control plots and the other fumigants (Table 2). Root galling was nearly eliminated by fumigants except Vapam, which gave similar results to the unfumigated control plots. this test, weed densities were low and affected little by treatment. Total fruit yield (marketable plus culls) was significantly enhanced by four fumigants, while results witl Vapam were again intermediate.

Test 3. Terr-O-Gas 67 reduced soil populations of root-knot and reniform nematodes to near zero on all sampling dates, but Trapex 40, Vorlex, or Vorlex 201 gav comparable control in several instances (Table 3). All four of these materials reduced root-galling to near zero. Other materials tested were less effective or ineffective in reducing nematode populations. Use of Vapam or Busan 1020 actually resulted in significant increases (over control plots) in root galling and nutsedge populations, possi because the large volume of water used in their application may have enhanced nutsed germination and hatch of root-knot juveniles from eggs. Tomato yields were highly erratic due to severe cold damage during the test.

Test 4. In addition to root-knot and reniform nematodes, the spiral nematode (Helicotylenchus dihystera) was also present in this test, but soil populations of all species were significantly reduced by all treatments (Table 4). Spiral nematode populations on Jan. 27 were reduced from 31/100 cm^3 soil in control plots to near zero all treatments (data not shown). Root galling was low in all plots. Weed populations consisted primarily of nutsedge (both C. esculentus and C. rotundus), and were significantly reduced by fumigation in many cases. No significant yield differences we observed.

CONCLUSIONS

Few conclusions can be drawn from the tomato yield data presented in these studies, since cold winter temperatures during the seasons the tests were conducted resulted in some plant damage and erratic yields. Consistent trends in control of nematodes and weeds were apparent, however. Performance of the methyl isothiocyanate/chlorinated C_3 hydrocarbon fumigants (Vorlex, Vorlex 201, Trapex 40) excellent and comparable to that of fumigants containing methyl bromide and chloropicrin. Other materials evaluated (Vapam, Busan 1020, Mylone, Soilex C-17) did not provide comparable levels of control in many instances.

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Table 1. Nematode, weed, and harvest data by treatment from tomato plots, Test 1 (1983-84).

Treatment	Nematodes/100 cm^3 soil[x] Reniform Jan. 4	Reniform Mar. 22	Root-knot Mar. 22	Root gall index[y]	Weeds/6.5 ft of row Santa Maria	Nutsedge	Total weeds	Total fruit yields (lbs)[z]
Control	81a	2259a	311a	2.45a	94a	48a	216a	51.1a
Mylone + plastic seal	6b	89bc	6bc	0.90abc	11b	20ab	58b	56.0a
Mylone + water seal	4b	22bc	99ab	1.65abc	11b	25ab	72b	54.7a
Vorlex 201	1b	5c	0c	0c	8b	14b	70b	58.4a
Vapam	6b	119b	144a	1.70abc	4b	9bc	42bc	48.1a
Dowfume MC-33	1b	6c	1c	0.02bc	3b	3c	24c	57.5a

[x]All data are means of 4 repliations; means in columns followed by the same letter are not significantly (P=0.05) different, according to the Waller-Duncan test (2).

[y]Rating on a 0-5 scale, averaged over 10 plants/plot, Mar. 26.

[z]Yields per 10 ft. of row (10 plants), Mar. 26.

Table 2. Nematode and harvest data by treatment from tomato plots, Test 2 (1984-85).

Treatment	Nematodes per 100 cm^3 of soil[x]					Root gall index[y]	Total fruit weight (lbs)[z]
	Reniform			Root-knot			
	Nov. 16	Jan. 8	Feb. 22	Jan. 8	Feb. 22		
Control	62a	632a	271a	12a	9a	2.72a	43.0a
Vapam	21a	30b	71b	0b	6a	2.95a	52.2ab
Terr-O-Gas 67	28a	0c	1c	0b	0b	0.00b	60.8b
Vorlex	29a	20bc	1c	0b	0b	0.17b	58.9b
Vorlex 201	31a	0c	10c	0b	0b	0.21b	55.8b
Trapex 40	28a	0c	0c	0b	0b	0.33b	61.1b

[x] All data are means of four replications; means in columns followed by the same letter are not significantly ($P=0.05$) different according to Waller-Duncan test (2).
[y] 0 to 5 scale, evaluated Feb. 22.
[z] Per 10-ft. plot, total of two harvests (Feb. 13-22).

Table 3. Nematode, nutsedge, and yields by treatment from tomato plots, Test 3 (1984-85).

Treatment	Nematodes per 100 cm^3 of soil[w] Reniform Dec. 4	Jan. 16	Apr. 16	Root-knot Apr. 16	Root gall index[x] Jan. 21	Apr. 16	Nutsedge[y] Dec. 14	Total fruit weight (lbs)[z]
Terr-O-Gas 67	0a	0a	1a	0a	0.08a	0.12a	6.0a	29.5a
Trapex 40	2ab	0a	85bc	48bcd	0.30a	0.00a	11.5ab	22.1a
Vorlex	45cd	1a	46b	6ab	0.18a	0.90a	11.2ab	24.6a
Vorlex 201	8abc	12bc	146bc	25bc	0.82ab	1.25a	11.0ab	16.4a
Vapam	1a	14bc	246bc	600d	2.95d	4.82c	31.2c	25.1a
Busan 1020	22bcd	5ab	334bc	459d	2.85d	4.70c	38.5c	15.0a
Soilex C-17	99d	36c	591c	84bcd	2.68d	3.28b	15.2ab	4.6a
Vydate L	88cd	15bc	234bc	175cd	2.30cd	4.15bc	18.5b	10.6a
Control	59cd	25bc	521c	220cd	1.62bc	3.15b	7.0ab	21.0a

[w]All data are means of four replications; means in columns followed by the same letter are not significantly different ($P=0.05$), according to Waller-Duncan test (2).
[x]0 to 5 scale, evaluated Apr. 16.
[y]Population per 3.3 ft. of row.
[z]Per 10 ft plot, total of four harvests (Feb. 28-Apr. 16).

Table 4. Nematode, weed, and yield data by treatment for tomato plots, Test 4 (1985-86).

Treatment	Rate per bedded A	Nematodes per 100 cm^3 soil[w] Reniform Oct. 27	Nematodes per 100 cm^3 soil[w] Reniform Jan. 27	Root Gall index[x]	Weeds per bed Nov. 25[y]	Weeds per bed Jan. 29[z]	Planting Holes with weeds Nov. 25[y]	Planting Holes with weeds Jan. 29[z]	Total fruit weight (lbs)[z]
Control	—	4a	1859a	0.71a	12.2a	4.8a	22.0a	7.5a	27.6a
Terr-O-Gas 75	225 lbs	1a	5b	0.46a	2.2b	1.2a	0.2c	3.5ab	27.1a
Trapex 40	35 gal	0a	4b	0.21a	3.2b	0.8a	0.2c	0.8b	35.0a
Trapex 40	25 gal	4a	30b	0.25a	8.0ab	2.8a	3.8b	1.2b	31.9a
Vorlex	25 gal	1a	12b	0.25a	3.2b	0.8a	1.0c	1.0b	32.9a
vorlex 201	25 gal	0a	38b	0.25a	14.0a	0.8a	4.5b	1.8b	34.4a

[w]All data are means of 4 replications; means in columns followed by the same letter are not significantly different at P=0.05, according to Waller-Duncan test (2).
[x]Rating on 0-5 scale for 6 plants/plot.
[y]22 plant holes=22 ft of bed.
[z]12 plant holes=12 ft of bed.

METHYL BROMIDE FUMIGATION OF TOMATOES FOR INSECT QUARANTINE . . . PLUSES AND MINUSES.

J. K. Brecht
Vegetable Crops Department, IFAS
University of Florida
Gainesville, FL 32611

Methyl bromide (MB) is widely used in agriculture as an insecticide and nematicide. The efficiency of MB as a fumigant for the eradication of insect pests has been known since the early 1930's (2). Because of its efficacy and versatility, MB is used to a greater extent than any other single fumigant: for sterilization of warehouses, containers, and ship's holds, and for disinfestation of numerous fruits, vegetables, cuttings, greenhouse-grown plants, cut flowers, and herbaceous and perennial plants. Methyl bromide is effective against all stages of insects and mites (few pests are tolerant to normal quarantine schedules), and its highly effective penetration makes possible the destruction of leaf miners and other internal feeders. It is the only fumigant currently recommended for disinfestation of fruits which serve as hosts to the various fruit fly species. Its use for this purpose with tomatoes dates back about 50 years (3).

Physical Properties of MB

Methyl bromide (CH_3Br) is a colorless organic compound which, at normal atmospheric pressure is a liquid at temperatures below 4.6°C (40°F). It is supplied commercially in pressurized gas cylinders as a liquid, but volatilizes readily to the gaseous state when released to the atmosphere at normal room temperatures. The gas is relatively nonflammable, except within a very narrow range, 13.5 to 14.5 per cent by volume in air. It is also odorless except at very high concentrations, then having a sweetish odor. The specific gravity of MB gas is 3.27 (air=1). Thus, it must be dispersed and mixed in fumigation chanbers by the use of fans.

Toxicity of MD

Methyl bromide is highly toxic to humans. An exposure level of 15 ppm is the lower threshold for exposure during an 8 hour day, 40 hour work week. A level of 3,000 ppm is believed to be lethal after 30-60 min. exposure and 20,000 ppm is rapidly fatal. Symptoms include nausea, dizziness, confusion, abdominal pains, and later, convulsions and coma. Emergency treatment is artificial respiration and administration of oxygen.

Several of the characteristics of MB make it a particularly insidious poison. Since MB is odorless at low concentrations, a person may be exposed to toxic concentrations of the gas and not be aware of it. Toxicity symptoms may take 4 to 12 hours or as long as 48 hours to develop. Due to its organic nature, MB is readily absorbed by the fatty deposits of the body, particularly the covering of the central nervous system and the fatty deposits of the kidneys. Chronic exposure to low levels of MB can cause central nervous system depression and kidney injury. Furthermore, there is no known antidote to MB poisoning.

Phytotoxicity from MB has been reported for many commodities. In tomatoes, pitting, blotchy skin areas, and inhibition of ripening have been reported (7). The inhibition of ripening may occur at the recommended treatment schedule, while the other symptoms are only noted at higher levels of MB or when too cold fruit, or fruit with condensed water on the surface are fumigated. Green fruit are more susceptible to the phytotoxic effects of MB than are turning or later stages (5). The inhibition of ripening is about 5 days and appears to be due to a temporary loss of sensitivity to ethylene (1).

Mode of Action

The mode of action of MB as a fumigant was once thought to involve release of toxic inorganic bromide, a view which has not been substantiated by evidence. It is currently thought that MB acts by the irreversible methylation of vital sulfhydryl groups on enzymes of glycolysis and respiration (6). This mechanism would obviously account for the diverse deleterious effects noted in insects exposed to MB. The effectiveness of MB as a fumigant apparently rests in the relative insensitivity of the host plants to MB's effects compared to the insect pests it is directed at. The quarantine schedule for MB fumigation of tomatoes is considered to be marginal as to host tolerance.

Fumigation Procedure

Fumigation with MB can take place in permanent fumigation chambers, under tarpaulins, in railway cars, truck vans and containers. Detailed description of the treatment and safety procedures and equipment requirements can be found in the APHIS Plant Quarantine Treatment Manual (8). Commercial fumigation with MB is most commonly performed under tarpaulins, although railway cars, truck vans and containers which are in good condition and gas tight can be fumigated without a tarpaulin cover. Commercial fumigators must perform each fumigation under the supervision of an APHIS Quarantine Officer.

The site selected for carrying out fumigations with MB should be well-ventilated and sheltered, with low pedestrian and vehicle traffic. For tarpaulin fumigation, both the floor and the tarp itself should be constructed of some impervious material (concrete or asphalt for floors, PVC or coated nylon for the cover). Fans are needed to disperse and mix the MB and to evacuate the gas following the fumigation treatment. The concentration of MB is monitored with an instrument equipped with a thermal conductivity detector ('Fumiscope'). Leaks are detected with a halide detector commonly used to detect halogen refrigerants. The butane flame changes in color from clear to light green in the presence of 25-50 ppm MB, becoming progressively darker green and finally blue as 1000 ppm is reached.

The quarantine schedule for tomatoes infested with the various fruit flies calls for treatment with 32g MB/M^3 (2 lb/1000 cu. ft.) for 3.5 hours at 21°C (70°F) or above. This schedule is permanently in place for a number of commodities shipped from Hawaii and can be called into effect wherever an outbreak occurs. Thus, this would in all likelihood be the required treatment in the event of a fruit fly infestation in a commercial growing area in Florida, or in the case of a quarantine imposed on produce imported from another country where the fruit flies are indigenous. A alternative treatment approved by APHIS involves using vapor heat (steam) t raise the fruit pulp temperature to 44.4°C (112°F) and holding for 8.7 hours, then immediately cooling the commodity.

For leaf miners, surface feeders, and thrips, the schedule fc greenhouse-grown plants, cut flowers and herbaceous plants is used. Thi calls for from 24-56g MB/M^3 (1.5 - 3.5 lb./1000 cu. ft.) depending c temperature, for 2 hours. This schedule has been used for shipments c tomatoes imported to Florida from certain regions of the Caribbean due t evidence of leaf miner infestation. Severe phytotoxic effects were reporte in tomatoes fumigated with the higher MB levels called for at lowe temperatures.

Areas for Future Research

The research 50 years ago establishing the current treatment schedule for MB fumigation of tomatoes may need to be reexamined. The margina nature of the schedule with regard to phytotoxic responses points out tl need to look for alternative procedures. The current debate over the use c probit 9 mortality (4), which requires a disinfestation procedure to effec a mortality of 99.9968 per cent of eggs and larvae in fruit, suggests tha less severe MB treatments might give realistically effective insect control Evaluation of the response of different cultivars and maturities of tomatoe to MB has never been adequately investigated. The effect of MB treatment c the ripening of lots of tomatoes containing immature and partially matur green fruit is unknown at this time. Information on desorbtion of MB and M residues in fruit and containers and cartons is unavailable. Finally alternative quarantine treatments should be developed for tomatoes, ar other commodities, in the event that use of MB is ever curtailed in tl future.

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THE 1985-86 TOMATO SEASON

WAYNE HAWKINS
MANAGER, FLORIDA TOMATO COMMITTEE
ORLANDO, FLORIDA

The Organizational Meeting of the Florida Tomato Committee was held September 6, 1985, at the Marriott's Marco Beach Resort, Marco Island, Flor da. The initial regulations recommended to the Secretary of Agriculture we the same as those in effect for the 1984-85 season except all tomatoes leavi the production area had to be washed. They required all tomatoes to be r over sizing equipment and all containers had to be packed at the register handler's facility. Containers, net weights and size dimensions all remain the same.

The Committee met again on October 8, 1985, at LaBelle, Florida, with t primary reason being to draft proposed amendments to the Florida Tomato Marke ing Order. After considerable discussion, it was agreed that the Secretary Agriculture should be petitioned to hold a public hearing as soon as possib to consider amending the marketing order as follows: (1) to provide authori for production research and promotion, including paid advertising; (2) all the committee to accept voluntary contributions for research and promotion pr jects; (3) provide authority to accept assessments in advance or to borr money on a short term basis; (4) allow for interchange of alternates with districts at meetings; (5) limit the tenure of committee members and alte nates; and (6) provide for periodic referenda. Proposals 5 and 6 were mandat by the U. S. Department of Agriculture; and although a large majority of t Committee were not in favor of them, they were recommended since it was fear we would not get a public hearing on the other issues unless they were inclu ed.

The Tomato Division of the United Fresh Fruit & Vegetable Associati continued to concentrate their efforts on the handling of tomatoes in referen to temperature, particularly at the wholesale and retail levels. The Committ actively supported this campaign with press releases, articles in trade paper and conversations with buyers last season. The Division also voted unanimous to ask the Board of Directors of the United Fresh Fruit & Vegetable Associati to petition the U. S. Department of Agriculture and request that the U. Standards for Grades of Fresh Tomatoes be amended to adopt the size design tions presently being used in Florida. This petition was filed and Flori supported it strongly; however, it was killed by lack of support from Califo nia and opposition from New York repackers.

The United Fresh Fruit & Vegetable Association's Ad Hoc Committee changing the grade standards for tomatoes floundered through several meetin before finally reaching any agreement on anything. It was finally decided recommend only four sizes, that they be called small, medium, large and ext large, that 2/32 of an inch be allowed between sizes and that no commingling sizes be allowed in a carton. This proposal is being discussed in Florida, California and Mexico, and hopefully, will be considered again for final approval next season.

The Committee's recommendation to eliminate Extra Small tomatoes which the Secretary approved met no opposition from the industry this season. This regulation also applied to imports; however, it is customary for Mexican producers to impose regulations on themselves during most of the season that are more restrictive than those required by the Marketing Order. This was also the case at times this season.

Total acres planted in Mexico were reportedly up; however, Mexico had a very wet, cold winter and it took its toll on quality. Prices at Nogales, Arizona, were constantly cheaper than Florida prices which tended to depress the market, particularly in the west. In early January, 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 45,530 compared to 44,729 the previous season and 45,400 harvested in 1983-84. Districts 1, 2 and 3 had increases of 422, 115, and 1,354 acres, respectively. District 4 was down 1,090 acres, giving a net increase of 801 acres. There were 781 acres more of ground tomatoes and 20 acres more of staked tomatoes planted this season. The ratio remains about 1/3 ground and 2/3 staked. Total shipments were 52,421,792 25-lb. equivalents compared to 52,471,073 the previous season.

Total shipments were down 49,281 25-lb. equivalents from the previous season even though there were 801 more acres planted. This is directly attributable to the weather conditions that prevailed throughout most of the winter season. Good crops were produced in the fall and spring, but January, February and March saw very erratic situations. Cold, windy weather caused bloom drop and a lot of misshapen fruit. Cold, wet conditions enhanced disease problems, making it nearly uncontrollable in some fields.

Harvesting of the fall crop began in Districts 2, 3 and 4 in mid-October with District 1 starting the middle of December. Total shipments from all districts exceeded one million packages by the week ending November 2 and continued at this level for the next eight weeks, dropping to 816,000 on the week ending December 28. They again exceeded one million per week for five weeks ending on February 1. The next four weeks were 912,000, 1.5 million, 627,000 and 912,000. The last 15 weeks exceeded one million per week with five of them over two million and one over three million. The season ended with shipments of over 968,000 packages the last week.

District 2 started harvesting the third week of October and continued shipping good volume through the second week of May. Acreage planted for harvest was up three percent over the previous season but total shipments were up 26 percent. Weekly shipments from this district exceeded 100,000 25-lb. equivalents for 24 weeks during the season and 15 of these weeks had shipments that exceeded 200,000 25-lb. equivalents.

District 1 started picking the middle of December and for all practical purposes finished on April 19. Weekly volume remained steady throughout this period but in no way approached a normal season. Total acreage planted for harvest was up approximately 3.7 percent and shipments were down 16.5 percent. Again this points out how much damage was done by the cold, wet conditions that encouraged severe disease problems. This district in general packed the worst quality fruit it has ever shipped.

District 3 started shipping the middle of October and by November 16 weekly shipments totalled about one-half milion 25-lb. equivalents per week. The volume increased slightly each week until the week ending December 21 when shipments totalled more than one million 25-lb. equivalents. For the next eight weeks, they ranged from 313,000 to 742,000. They dropped below 200,000 for two weeks and then ranged from 230,000 to 1.2 million for the balance of the season with the exception of the last week which was 118,000. Cold, windy, rainy weather in December, January and February played havoc with the crop. Scarring, misshapen and cat facing caused grade outs to be high and reduced average yields on some farms. Total shipments were up 4.3 percent over the previous season, but acreage harvested was up 12 percent.

District 4 started harvesting in mid-October and reached shipments totalling more than 500,000 25-lb. equivalents by the third week. Fall acreage was down 15 percent but shipments were down about 24 percent. About 5.5 million 25-lb. equivalents were shipped from District 4 during the fall season compared to 7.2 million the previous season. This points out how bad the growing conditions were and it also explains why prices were above normal. Some of the tomatoes packed and shipped in District 4 are actually grown in District 3 and vice versa so it is very difficult to document exact figures from one season to the next.

Harvest of the spring crop in District 4 started in early April. Only 72 more acres were harvested this spring, but shipments were up 9.7 percent. During the last 11 weeks of the season, District 4 shipped more than 14 million 25-lb. equivalents, but slightly more than 12 million of these were shipped in a six-week period. Quality and size were good during most of this period. Prices were good until the end of May when the bottom fell out. Low prices and heavy rains in early June cut down some on the total yield since some fields were abandoned before they were totally picked.

The total 52,421,792 25-lb. equivalents were shipped over a 36-week period. Twenty-eight of these weeks had shipments exceeding one million packages with five weeks showing more than two million and one of these showing more than three million 25-lb. equivalents. The total shipments were down 49,281 25-lb. equivalents from the previous season.

The total value of the crop was about 408.1 million dollars, compared to 314.4 million the previous season. The average price was $7.78 per 25-lb. equivalent for the entire season, compared to $5.99 per 25-lb. equivalent for the 1984-85 season and $6.83 for 1983-84. Evenly spaced supplies during the winter season and the lack of a freeze causing major replanting helped raise the season's average price.

During the 1985-86 season, there were more than 15 different commercial varieties planted. Sunny, Duke, F.T.E. No. 12, FloraDade and Hayslip accounted for 94 percent of the total acreage. Some of the other varieties planted were Freedom, Mountain Pride, Castle 1035, Count, F.T.E. 20, BHN 26 and 8412. 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 PLANT DISEASE CHEMICAL CONTROL GUIDE

T. A. Kucharek
Plant Pathology Department
University of Florida
Gainesville, FL 32611

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomato	Benlate	1/2 - 1 lb.	NTL	Gray mold Leaf mold White mold (Sclerotinia) Phoma leaf spot	Target spot Rhizoctonia fruit rot	Field & Greenhouse.
	Botran 75 W	1 lb/100 gal water	NTL	Botrytis stem canker		Seedlings or newly set transplants may be injured by drenching. Greenhouse use only.
	Bravo 500	2 1/4 - 4 1/4 pts.	NTL	Early blight Late blight Gray leaf spot Leaf mold Septoria leaf spot Gray mold Black mold Rhizoctonia fruit rot Bacterial spot (when combined with Kocide 101, Tri-basic Copper Sulfate, or CP-Basic Copper TS-53-WP)	Phoma leaf spot Target spot Rhizoctonia fruit rot Bacterial speck (when used as indicated for bacterial spot)	Do not use with Copper Count-N in concentrated spray mixtures.
	Manzate 200 Flowable	1.3 - 2.5 qts.	5	Same as Dithane M-45		

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (Cont'd)	Dithane FZ	Field 0.8-2.4 qts greenhouse 4.5-6.1 fl oz/5000 sq ft	5	Leaf mold Early blight Late blight Gray leaf spot Septoria leaf spot Bacterial spot (use 1.2 qts combined with copper fungicides as in Dithane M-45)	See Dithane M-45	Do not use on young plants in greenhouse to avoid injury.
	Dithane M-45	1 1/2 - 3 lbs.	5	Late blight Early blight Gray leaf spot Leaf mold Bacterial spot	Leaf mold Phoma leaf spot Target spot Bacterial spot & Bacterial speck (When combined with Kocide 101, Tri-basic Copper Sulfate, or CP-Basic Copper TS-53-WP)	
	Dithane M-22	1-3 lbs.	5	Early blight Late blight Septoria leaf spot Gray leaf spot Leaf mold	See Dithane M-45	Field or greenhouse. Do not use on young tender plants under glass.
	Dithane M-22 Special	1-3 lbs.	5	Early blight Late blight Gray leaf spot Septoria leaf spot Bacterial spot	See Dithane M-45	To avoid injury do not use on young plants in greenhouse.

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (Cont'd)	Manzate	1 1/2 - 2 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.
	Manzate D	1 1/2 - 2 lbs.	5	Early blight Late blight Septoria leaf spot Gray leaf spot	See Dithane M-45	Do not use on young plants in greehhouse as injury may occur.
	Manzate 200	1 1/2 - 3 lbs.	5	Early blight Late blight Gray leaf spot Gray leaf mold Bacterial spot	See Dithane M-45	
	Manzate Flowable	Field 1.2-2.4 qts. Greenhouse 4.5-6.1 fl oz/5000 sq ft	5	Early blight Late blight Septoria leaf spot Gray leaf spot	See Dithane M-45	Field and greenhouse. Do not use on young seedlings in greenhouse as injury may occur.
	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.

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (Cont'd)	Difolatin 80 Sprills (Mechanically harvested tomatoes only)	1 1/2 - 3 lbs.	NTL	Early blight Late blight Gray leaf spot Septoria leaf spot Fruit rot	Target spot Phoma leaf spot Leaf mold	Fruit spotting may occur when applied during high temperatures or drought stress.
	Dyrene (not for use in greenhouse)	2-5 lbs.	NTL	Botrytis Early blight Late blight Septoria leaf spot		If temperatures exceed 85^0 F do not use more than 1 lb if tank mixed with a copper fungicide.
	Kocide 101	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	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 Stemphyllium leaf spot	See Dithane M-45	Same as Kocide 101

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (Cont'd)	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 Pepper mottle virus	Tomato yellows	Must be applied with gound rig at 400 psi using Tee Jet TX5 SS nozzles. READ LABEL
	Ridomil 2E[1] (Soil application)	2-4 pts. (Broadcast only)	PPI treat-ment for plant beds	Pythium damping off in plant beds Late blight Phytophthora stem canker		Not a necessary treatment for Pythium 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	Same as entry above.

1 Do not apply more than 12 pints Ridomil 2E/season.
2 PPI (via mechanical device) or POPI (via irrigation) broadcast or banded.

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (Cont'd)	Ridomil 2E[1] (Soil application)	4 pts.[2] (Broadcast rate)		Phytophthora or Pythium fruit rots	Late blight	Same as entry above.
	Ridomil MZ-58[3] (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.

LEGAL INSECTICIDES
FOR CONTROL OF INSECTS
ON
TOMATOES

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

Prepared by: Freddie A. Johnson
Professor
Extension Entomologist

TOMATOES (Revised 8-1-86)

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
ants	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbaryl (Sevin)	5 B	20-40 lbs.	0
aphids	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	aliphatic petroleum (JMS-Stylet Oil)	97.6% EC	see label.	see label
	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	demeton (Systox)	2 EC	1-1 1/2 pts./ 100 gal.	3
	diazinon	4 EC	1/2 pt.	1
	dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row space)	30
	endosulfan (Thiodan) (green peach aphid)	3 EC	2/3 qt.	1
	lindane (Isotox-lindane)	25 WP	1 lb.	do not apply after fruits start to form
	malathion	5 EC	1 pt./100 gal.	1
	methamidophos (Monitor)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1

TOMATOES

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

TOMATOES

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

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
(yellow striped armyworms)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
	endosulfan (Thiodan)	3 EC	1 1/3 qts.	1
	fenvalerate (Pydrin) (Western Yellow Striped)	2.4 EC	5 1/3-10 2/3 ozs.	1
banded cucumber beetle	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	diazinon	4 EC	3/4-1 pt.	1
	lindane (Isotox-lindane) larvae	25 WP	1-2 lbs.	Preplant (soil)
beetles	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	See label.
blister beetle	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thiodan)	3 EC	2/3 qt.	1
	methoxychlor	2 EC	2-6 qts.	1-3 1/2 qts. 7-3 1/2+ qts.
	parathion	4 EC	1-2 pts.	10

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
cabbage looper	Bacillus thuringiensis Bactospeine, Bactur, Dipel, Sok, Stan-Guard, Thuricide)	See individual labels.		0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thiodan)	3 EC	1 qt.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	methyl parathion	4 EC	2-3 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
Colorado potato beetle	azinphosmethyl (Guthion)	2 S (EC)	1 1/2 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lb.	0
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts./A (38" row spacing)	30

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
Colorado potato beetle (cont.)	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	endosulfan (Thiodan)	3 EC	2/3 qt.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methoxychlor	2 EC	2-6 qts.	1-3 1/2 qts. 7-3 1/2+ qts.
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
	phosphamidon	8 EC	1/2 pt.	10
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
	rotenone (Rotenox)	5% liquid	2/3 gal.	0
corn earworm (See also tomato fruitworms)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
crickets	carbaryl (Sevin) trichlorfon (Dylox, Proxol)	5 B 5 B	20-40 lbs. 20 lbs.	0 28

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
cutworms	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbaryl (Sevin)	80 WP	2 1/2 lbs.	0
	carbaryl (Sevin)	5 B	20-40 lbs.	0
	diazinon	14 G	14-28 lbs.	preplant
	diazinon	4 EC	2-4 qts.	preplant
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)
	methomyl (Lannate) (varigated cutworm)	1.8 L	2 pts.	1
	permethrin* (Ambush) (Pounce) (granulate cutworm)	2 EC 3.2 EC	3.2-12.8 ozs. 2.8 ozs.	up to day of harvest
	trichlorfon (Dylox, Proxol) (surface feeding cutworms)	5 B	20 lbs.	28
darkling ground beetles	carbaryl (Sevin)	5 B	20-40 lbs.	0
Drosophila (fruit flies)	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	diazinon	4 EC	1/2-1 1/2 pts.	1
	malathion	5 EC	2 1/2 pts.	1
	naled (Dibrom)	8 EC	1 pt.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
European corn borer	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
flea beetles	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lbs.	0
	carbophenothion (Trithion) (potato flea beetle)	8 EC	1/2-1 pt.	7
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pt./A (38" row spacing)	30
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lb./A (38" row spacing)	30
	endosulfan (Thiodan)	3 EC	2/3 qt.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methyl parathion	4 EC	1-3 pts.	10 - 1 pt. 15 - 1+ pt.
	methoxychlor	2 EC	2-6 qts.	1 - 3 1/2 qts. 7 - 3 1/2+ qts.

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
flea beetles (cont.)	naled (Dibrom)	8 EC	1 pt.	1
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	2-4 pts.	15
	phosphamidon	8 EC	1/2 pts.	10
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
garden symphylans	fonofos (Dyfonate)	10 G	20 lbs.	preplant, broadcast
grasshoppers	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	5 B	20-40 lbs.	0
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	mevinphos (Phosdrin)	4 EC	1/2-1 pt.	1
	parathion	4 EC	1-2 pts.	10

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
hornworms (tomato hornworms)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
	<u>Bacillus thuringiensis</u> Bactospeine, Bactur, Dipel, Stan-Guard, Sok, Thuricide)	See individual labels.		0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thiodan)	3 EC	2/3-1 1/3 qts.	1
	fenvalerate (Pydrin)	2.4 EC	2 2/3-5 1/3 ozs.	1
	methomyl (Lannate)	1.8 L	2-4 pts.	1
	naled (Dibrom)	8 EC	1 pt.	1
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush)	2 EC	3.2-12.8 ozs.	up to day of harvest
	(Pounce)	3.2 EC	2-8 ozs.	
	trichlorfon (Dylox, Proxol)	80 SP	20 oz.	21

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
lacebugs	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
leafhoppers	allethrin (Pyrellin SCS)	1% liquid EC	1-1 1/2 pts.	see label
	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lbs.	0
	carbophenothion (Trithion) (potato leafhopper)	8 EC	1/2-1 pt.	7
	disulfoton (DiSyston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts./A (38" row spacing)	30
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
	methoxychlor	2 EC	2-6 qts.	1 - 3 1/2 qts. 7 - 3 1/2+ qts.

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
leafhoppers (cont.)	methyl parathion	4 EC	1-2 pts.	15
	mevinphos (Phosdrin)	4 EC	1/2-1 pt.	1
leafminers	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	carbophenothion (Trithion)	8 EC	1/2-1 pt.	7
	diazinon	4 EC	1/2 pt.	1
	diazinon	50 WP	1/2 lb.	1
	dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts/A (38" row spacing)	30
	disulfoton (DiSyston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	ethion	4 EC	1 pt.	2
	fenvalerate (Pydrin)	2.4 EC	10 2/3 ozs.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
leafminers (cont.)	lindane (Isotox-lindane)	25 WP	1 1/2 lbs.	Do not apply after fruit starts to form.
	methamidophos (Monitor) (adults)	4 EC	1 1/2-2 pts.	7
	naled (Dibrom)	8 EC	1 pt.	1
	oxamyl (Vydate L)	2 EC	2-4 pts./100 gal.	1
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	2-4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
	phorate (Thimet)	20 G	11.3 oz./1000 ft. row (min. 38" spacing)	at planting
	phosphamidon	8 EC	1/2 pt.	10
	trichlorfon (Dylox, Proxol)	80 SP	20 oz.	21
loopers	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
leafminers (cont.)	lindane (Isotox-lindane)	25 WP	1 1/2 lbs.	Do not apply after fruit starts to form.
	methamidophos (Monitor) (adults)	4 EC	1 1/2-2 pts.	7
	naled (Dibrom)	8 EC	1 pt.	1
	oxamyl (Vydate L)	2 EC	2-4 pts./100 gal.	1
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	2-4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
	phorate (Thimet)	20 G	11.3 oz./1000 ft. row (min. 38" spacing)	at planting
	phosphamidon	8 EC	1/2 pt.	10
	trichlorfon (Dylox, Proxol)	80 SP	20 oz.	21
loopers	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
loopers (cont.)	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
mites	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbophenothion (Trithion) (russet, tropical & two-spotted mites)	4 EC	1-2 pts.	7
	demeton (Systox)	2 EC	1-1 1/2 pts./100 gal.	3
	dicofol (Kelthane)	1.6 EC	1-2 qts.	2
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1.3 pts. (38" row spacing)	30
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	ethion (tropical, two-spotted, and tomato russet mites)	4 EC	1 pt.	2
	methyl parathion	4 EC	1-2 pts.	15
	mevinphos (Phosdrin)	4 EC	1/2 - 1 pt.	1
	naled (Dibrom)	8 EC	1 pt.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
(tomato russet mite)	endosulfan (Thiodan)	3 EC	1 1/3 qts.	1
	malathion	25 WP	2-4 lbs.	1
	methyl parathion	4 EC	1-3 pts.	15
	parathion	4 EC	1-2 pts.	10
	sulfur (Kolospray)	81% WP	7 lbs.	0
	sulfur (Magneticide)	6 F	1/2-1 gal.	0
(spider mite)	malathion	5 EC	1 1/2 pts./100 gal.	1
mole crickets	diazinon	15 G	7 lbs.	preplant
	diazinon	4 EC	1 qt.	preplant, broadcast
pinworm (tomato pinworm)	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
pinworm (tomato pinworm) cont.	methamidophos (Monitor) (suppression of low populations)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts. (ground application only)	1
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
plant bugs	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	methyl parathion	4 EC	2 pts.	15
	parathion	4 EC	1-2 pts.	10
potato flea beetle	carbophenothion (Trithion)	8 EC	1/2-1 pt.	7
potato psyllid	carbophenothion (Trithion)	4 EC	1-2 pts.	7
	endosulfan (Thiodan)	3 D	33 lbs.	1
	methyl parathion	4 EC	1-3 pts.	15
	parathion	4 EC	1-2 pts.	10
salt marsh caterpillar	trichlorfon (Dylox, Proxol)	5 B	20 lbs.	28

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
sowbug	carbaryl (Sevin)	5 B	20-40 lbs.	0
stinkbugs	azinphosmethyl (Guthion) (green stinkbugs)	2 S (EC)	1 1/2-2 pts.	0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	endosulfan (Thiodan)	3 EC	1-1 1/3 qts.	1
	parathion	4 EC	1-2 pts.	10
	phosphamidon	8 EC	1/2 pt.	10
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
thrips	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	lindane (Isotox-lindane)	25 WP	1 lb.	Do not apply after fruit starts to form.
	parathion	4 EC	1-2 qts.	10

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
tomato fruitworm (same specifics as corn earworm and fruitworm)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methamidophos (Monitor)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	naled (Dibrom)	8 EC	1 pt.	1
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
tuberworm	azinphosmethyl (Guthion)	2 S (EC)	2 1/4-3 pts.	0
weevils	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label.
whitefly	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	endosulfan (Thiodan)	3 EC	2/3 qt./100 gal.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
whitefly (cont.)	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	parathion	4 EC	1-2 pts.	10
	phosphamidon	8 EC	1/2 pt.	10
white grubs	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)
wireworms	diazinon	14 G	21-28 lbs.	preplant
	diazinon	2 B	50 lbs.	none listed
	diazinon	14 G	70 lbs.	preplant, broadcast
	diazinon	4 EC	10 qts.	preplant, broadcast
	fonofos (Dyfonate)	10 G	20 lbs.	preplant, broadcast
	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)

TOMATOES

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

*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.

NEMATICIDES REGISTERED FOR USE ON FLORIDA TOMATO

PRODUCT	BROADCAST (RATE)	RECOMMENDED CHISEL SPACING	Row Application (6' row spacing - 36" bed) [5] CHISELS PER ROW	RATE/ACRE	RATE/1000 FT/CHISEL
FUMIGANT NEMATICIDES					
Methyl Bromide					
98-2	240-400 lb	12"	2	120-200 lbs	8.2-13.7 lb
80-20	225-350 lb	12"	2	112-175 lbs	7.7-12.0 lb
75-25	240-375 lb	12"	2	120-187 lbs	8.2-12.9 lb
70-30	300-350 lb	12"	2	150-175 lbs	10.3-12.0 lb
67-33	225-375 lb	12"	2	112-187 lbs	7.7-12.9 lb
57-43	350-375 lb	12"	2	175-187 lbs	10.3-12.9 lb
50-50	340-400 lb	12"	2	175-250 lbs	10.3-17.2 lb
Chloropicrin [1]	300-500 lb	12"	2	150-250 lbs	10.3-17.2 lb
Telone II [2]	12-15 gal	12"	2	6-7.5 gal	39.7-66.1 fl oz
Vapam	50-100 gal	5"	3	25-50 gal	1.1-2.2 gal
Vorlex Vorlex 201 [3]	30-50 gal	8"	2	6.7-11.1 gal	58.8-97.9 fl oz
NON-FUMIGANT NEMATICIDES					
Dasanit [4]	66.7-134 lb			11.1-22.3 lb	1.5-3 lb

Vydate L - treat soil before or at planting with any other appropriate nematicide 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.

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

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

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

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

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

Rates are believed to be correct for products listed when applied to mineral soils. Higher rates may be required for muck (organic) soils. Growers have the final responsibility to guarantee that each product is used in a manner consistent with the label. The information was compiled by the author as of August 1, 1986 as a reference for the commercial Florida tomato grower. The mentioning of a chemical or propietary product in this publication does not constitute a written recommendation or an 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 that may be suitable. Products mentioned in this publication are subject to changing Environmental Protection Agency (EPA) rules, regulations, and restrictions. Additional products may become available or approved for use.

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

Florida Cooperative Extension Service

WEED CONTROL IN FLORIDA VEGETABLES

TOMATO

Institute of Food and Agricultural Sciences ● University of Florida

VEC-TO1.86

W. M. Stall, Vegetable Crops Department

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

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

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

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

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

TOMATOES

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

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

	Tomatoes	post planting or post transplanting	3.0

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	Posttransplanting after crop establishment (non-mulched)	6.0 to 8.0
		Mulched row middles after crop establishment	6.0 to 8.0

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

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

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 ameranth, bermudagrass, goosegrass, seedling johnsongrass, lambsquarter, pigweed, purslane, Fla. pusley and others.

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

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

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

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

Napropamid (Devrinol)	Tomatoes	Preplant incorporated	1.0 to 2.0

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

	Tomatoes	Surface treatment	2.0

Controls germinating annuals. Apply to bed tops after bedding but before plastic application. Rainfall or overhead irrigate sufficient to wet soil 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.

Herbicide	Labelled crops	Time of application	Rate (lbs.ai./acre)
Paraquate (Ortho paraquat Gramoxone)	Tomatoes	Premergence Pretransplant	0.5 to 1.0

Controls emerged weeds. Use a non-ionic spreader and thoroughly wet weed foliage.

	Tomatoes	Post directed spray in row middle	0.5

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

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

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

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

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