line 79B 888-3 yielded more than the other genotypes tested (Table 1). The commercial cultivars were intermediate in yield, whereas USDA breeding line 79B 823-3 yielded poorly. Although small differences in the percentage of rot were obtained between treatments and in yield between treatments, the gain in yield was significant and resulted from concentrated ripening. The primary use of Ethephon is to concentrate ripening as an aid to mechanical harvest, but the indirect control of fruit rot would be sufficient reason for the practice.

Literature Cited

1. Ashworth, L.J. and W.R. King. 1962. Etiology of tomato fruit in the Red River Valley of Texas. Phytopathology 52:723. (Abstr.)
2. Barksdale, T.H. 1974. Evaluation of tomato fruit for resistance to *Rhizoctonia* soil rot. Plant Dis. Rptr. 58:406–408.
3. Batson, W.E. 1973. Characterization and control of tomato fruit rots. Plant Dis. Rptr. 57:453–456.
4. Crossan, D.F. and P.J. Lloyd. 1956. The influence of overhead irrigation on the incidence and control of certain tomato diseases. Plant Dis. Rptr. 40:314–317.
5. Crossan, D.F., et al. 1963. The effect of fungicide and wax mulch treatments on tomato fruit disease control. Plant Dis. Rptr. 47:111–113.
6. Gonzalez, L.C. and J.H. Owen. 1963. Soil rot of tomato caused by *Rhizoctonia solani*. Phytopathology 53:82–85.
7. Goode, M.J. 1965. Controlling fungal diseases of tomato. Arkansas Farm Res. 14:7.
8. Goode, M.J., J.L. Bowers, and Joe McFerran. 1976. Tomato and cucumber diseases. Proc. Ark. State Hort. Soc. 97:127–128.
9. Johnson, C.E., E.L. Moore, and W.E. Batson. 1981. Inheritance of Rhizoctonia soil rot resistance in tomato. MAFES Res. Rpt. 5(15).
10. Jones, C.W. and S.M. Carter. 1974. Etiology of tomato fruit rots and evaluation of cultural and chemical treatments for their control. Phytopathology 64:1205–1208.
11. McCarter, S.M. and T.H. Barksdale. 1977. Effectiveness of selected chemicals in controlling *Rhizoctonia* fruit rot of tomato in greenhouse and field tests. Plant Dis. Rptr. 61:811–815.
12. Ramsey, G.B. and A.A. Bailey. 1929. The development of soil rot of tomatoes during transit and marketing. Phytopathology 19:383–390.

HORTSCIENCE 19(5): 677–679. 1984.

Developmental Stages of 'Flora-Dade' Tomatoes

J.E. Peña, V.H. Waddill, R.B. Volin, and L. Ramos-Ledon
University of Florida, IFAS, Tropical Research and Education Center, 18905 S.W. 280 St., Homestead, FL 33031

Additional index words. *Lycopersicon esculentum*, phenology, pest management

Abstract. **Phenological stages of 'Flora-Dade' tomatoes are described using a nomenclature system to be used for tomato pest management. Two vegetative stages (TV_1, TV_2) are listed as well as 3 reproductive plant stages (TR_1, TR_2, and TR_3). Vegetative stage TV_1 describes plants 1–15-days old with 2–3 primary leaves. TV_2 describes plants 6–39 days-old with 5–7 leaves. Reproductive stages (TR_1, TR_2, and TR_3) cover plants 40–135 days-old, characterized by presence of flowers clusters, and fruit formation and ripening. Characteristics of each stage are discussed. A senescent stage (TS_1) is present from 136–200 days after plant emergence.**

There is a continuing trend in modern horticulture to use a nomenclature system that describes plant phenology from a pest management point of view. Several important economic plants (e.g., soybean and cotton) (2, 8) have systems of names that facilitate an understanding of the plant substrate under field conditions. This information is useful in a sampling program or to describe the plant stage for pest management decisions against weeds, arthropods, and pathogens. This information is lacking for tomatoes, however, despite extensive studies on taxonomy, growth, and development (1, 3, 6, 7, 9).

The objectives of this research were to divide tomato plant development into recognizable growth periods and to develop a simple, standarized nomenclatural system for use by scouts and other field personnel.

Tomatoes 'Flora-Dade' were planted on 30 Oct., 25 Nov., and 30 Dec. 1980, and on 30 Jan. and 28 Feb. 1981, at the Univ. of Florida, Tropical Research and Education Center, Homestead. After metribuzin was incorporated into the soil at a rate of 0.84 kg a.i./ha, beds 45 m long were prepared and fertilized with 160N–320P–320K kg/ha. At the time of fumigation, drip tubing for irrigation was placed at a depth of 1.5 cm beneath the soil and 15 cm away from the bed center. Distance between beds was 70 cm. The beds were covered immediately with plastic mulch. Tomato seeds were planted 30 cm apart in the rows using the plug-mix seeding method (10). Two weeks after emergence, the seedings were thinned to one per hill. Plants were protected from pests by applications of fenvalerate 2.4 EC (0.045 kg a.i./ha) and of maneb and tribasic copper sulfate (0.97 + 5.71 a.i. kg/ha) at weekly intervals.

Table 1. Stage of development description for tomato 'Flora-Dade[z]' at Homestead, Fla.

Plant stage	Tomato plant description
Vegetative	
TV_1	Complete formation of 2–3 primary leaves; loss of cotyledons; plant height ca 5–7 cm. Plants 1–15 days old.
TV_2	Plant erect (12–16 cm); 5–7 leaves, development of laterals; plant with only 1 main stem. Plants 16–39 days old.
Reproductive	
TR_1	Development of laterals from nodes 1–5; at leaf 4–5 the stem bifurcates producing another stem as vigorous as the 1st main stem; production of floral clusters at node 5 and 2nd main stem; height 50 cm. Plants 40–50 days old.
TR_2	Fruit set; plant prostrated; yellowing of primary leaves. Plants 50–109 days old.
TR_3	90% fruit ripe; post-harvest maturity; at least 60% of the primary leaves necrosed, development of secondary laterals at nodes 3–5; plant totally postrate; height ca 32–57 cm. Plants 109–135 days old.
Senescence	
TS_1	Dead leaves on main stem and 2nd main stem; regrowth of plant from auxillary buds at nodes 1 and 2 and production of up to 3 floral clusters may occur; possible fruit development. Plants 135–200 days old.

[z]Description is based on observations from tomato plants grown during fall 1980 through winter 1981.

Received for publication 31 Jan. 1984. Florida Agricultural Experiment Stations Journal Series No. 5348. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

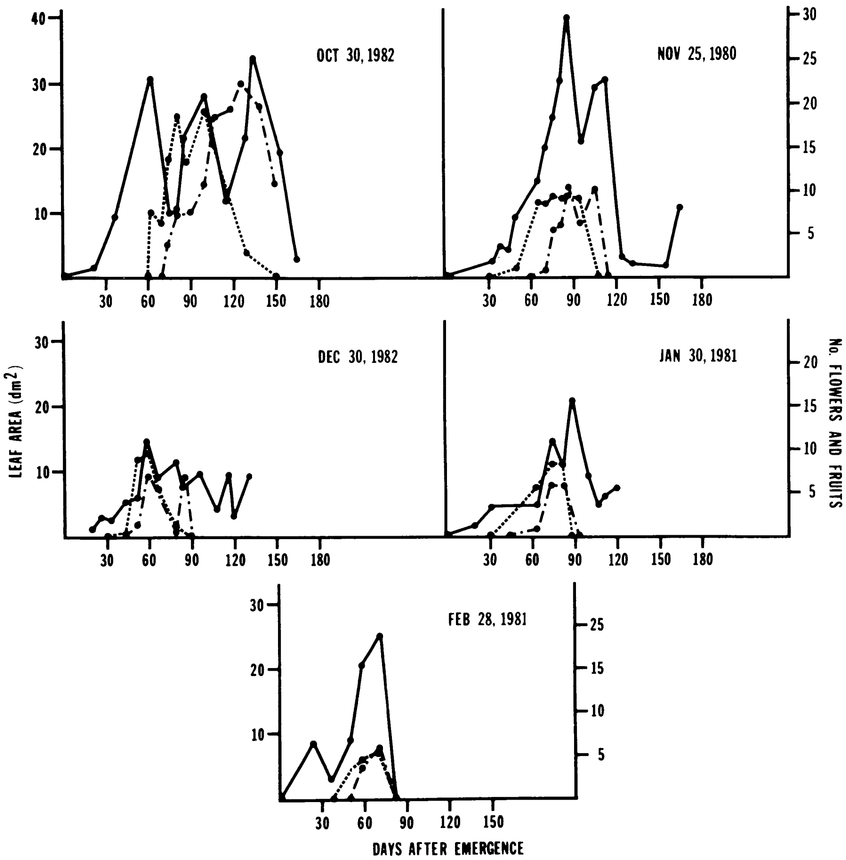

Fig. 1. Influence of time on tomato leaf area expansion, flowering, and tomato fruit numbers on 'Flora-Dade' grown in Rockdale soil under southern Florida conditions.

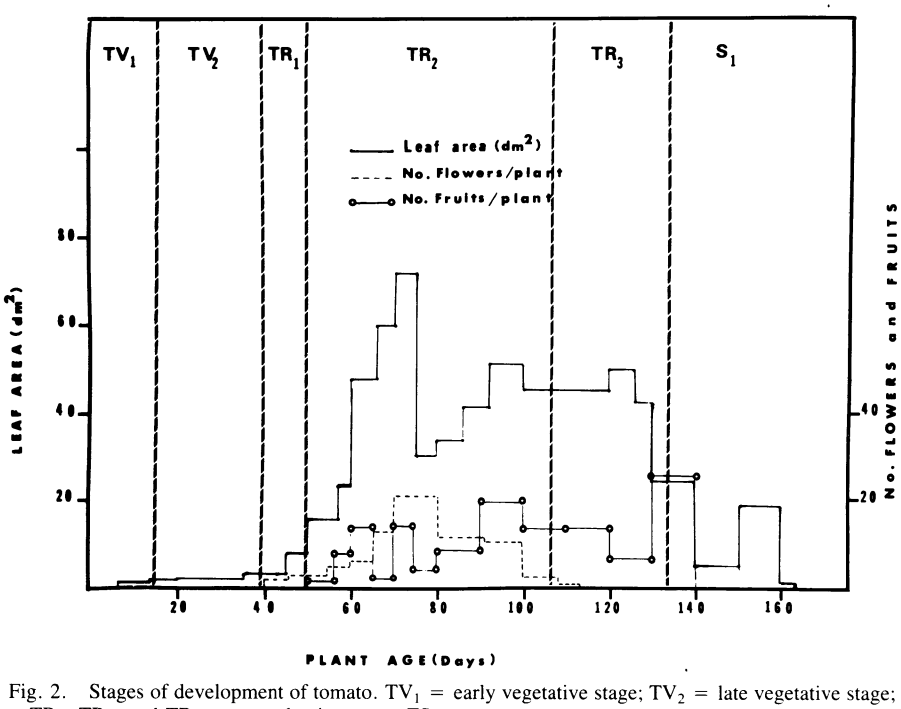

Fig. 2. Stages of development of tomato. TV_1 = early vegetative stage; TV_2 = late vegetative stage; TR_1, TR_2, and TR_3 = reproductive stage; TS_1 = senescent stages.

Two to 5 plants were selected at random from each of the 5 plantings, and height, leaf area, number of leaves, flowers, and fruit were determined and the average taken every 8–15 days.

The method used to describe tomato plant phenology was based on the technique used for soybeans, *Glycine max* L. (2). Three developmental stages of tomatoes were defined: vegetative, reproductive, and senescent. The descriptions of the vegetative and reproductive stages were based on the presence of characteristic plant structures as well as on the time at which flowers and fruit appeared.

The leaf area, flower number, and fruit number were averaged for the 5 plantings (Fig. 1). Tomatoes planted during October, 1980, began to flower 61 days after plant emergence, and fruit set occurred at 73 days. Maximum leaf area was reached at 134 days after planting. Tomatoes planted during November, 1980, started blooming at 54 days, and fruit set at 68 days. Maximum leaf area occurred 88–112 days after plant emergence. Tomatoes planted during December, 1980, and January-February, 1981, had a shorter vegetative period than full planted tomatoes, with flowering at 42–62 days and fruiting at 49–62 days. Leaf area reached a maximum at 62–89 days after planting. The total leaf area measured in the January-February plantings was lower than that produced from fall plantings.

'Flora-Dade' was developed for production of fresh market fruit (11) and is especially well adapted for fall production. Under southern Florida conditions, changes in the mean daily temperatures from autumn through winter to early spring are significant (5), and growth and development of tomatoes are affected by planting date. Consequently, planting before or after the months of October to December reduced leaf area and yield substantially.

The vegetative stages were determined from the production of the 1st true leaf (node 1) to the development of an axis at nodes 6 or 7. This process has already been explained by Purseglove (6), who described that, on the main stem, a terminal bud produces an inflorescence and the axis is continued by development of an axillary bud. The 2nd main stem had the same development as the main stem. Therefore, vegetative growth of the tomato plant passed through 3 distinct phases. In the 1st phase, there was a steady increase in leaf area, and, in the 2nd phase, leaf area was relatively constant. The 3rd phase was characterized by a reduction in rate of leaf expansion, which occurred 130 days after plant emergence. The reproductive stages were characterized by production of floral clusters and fruit formation. Fruit ripening (fruit color) was used to describe the 2nd reproductive stage. Flowering and fruit (5–10 mm diameter) formation were observed at about 40 and 50 days postemergence, respectively. The number of inflorescences increased rapidly to a peak number at about 70 days and then steadily decreased. Subsequent fruit number reached a peak at about 90 days postemergence and then steadily decreased. Each of the major stages could be divided into substages. Description of the plants at these suggested substages is given in Table 1.

The relationship between leaf area and crop age is illustrated in Fig. 2. Leaf area increased until half way through the 2nd reproductive substage (TR_2). Leaf area was reduced during the 3rd reproductive stage (TR_3) and senescent stage (TS_1). Further subdivision of the TR_2 substage might enhance plant description for pest management practitioners.

The principal application of the proposed system of phenology is to aid in the assessment of pest populations as they relate to specific crop stages. For instance, using data from Keulart's (4) study of tomato defoliation, 20% defoliation of lower plant leaves at stages equivalent to TV_1 through TV_2 did not alter mean yield per plant. Twenty percent defoliation of upper plant leaves at a stage equivalent to TR_2 caused yield reduction. This nomenclature can apply to single 'Flora Dade' plants or to entire crops. Further testing is needed to determine if it can be applied readily to other cultivars and in other geographical regions.

Literature Cited

1. Cooper, A.J. 1964. Relations between growth of leaves, fruit and shoot of glasshouse tomato plants. J. Hort. Soc. 39:173–181.
2. Fehr, W.R., C.E. Caviness, D.T. Burmond, and J.S. Pennington. 1971. Stage of development for soybeans, *Glycine max* (L.) Merrill. Crop Sci. 11:929–931.
3. Hurd R.G., A.P. Gay, and A.C. Mountefield. 1979. The effect of partial flower removal on the relation between root, shoot and fruit growth in the indeterminate tomato. Ann. Appl. Biol. 93:77–89.
4. Keularts, J.L.W. 1980. Effect of the vegetable leafminer *Liromyza sativae* Blanchard, and the associated plant pathogens on yield and quality of the tomato, *Lycopersicon esculentum* Mill. cv. Walter. PhD Diss. Univ. of Fla., Gainesville.
5. Mitchell, A.J. and M.R. Ensign. 1928. The climate of Florida. Univ. of Fla. Agr. Expt. Sta. Bul. No. 200.
6. Purseglove, J.W. 1968. Tropical crops: Dicotyledons. Wiley, N.Y. 2:530–538.
7. Romshe, F.A. 1942. Correlation between fresh weight and area of tomato leaves. Proc. Amer. Soc. Hort. Sci. 40:482.
8. Smith, R.F. and L.A. Falcon. 1973. Insect control for cotton in California. Cotton Grow. Rev. 50:15–27.
9. Thompson, H.C. and W.C. Kelly. 1957. Vegetable crops, 5th ed. McGraw-Hill, N.Y.
10. Hayslip, N.C. 1973. Plug-mix seeding developments in Florida. Proc. Fla. State Hort. Soc. 86:179–185.
11. Volin, R. and H.H. Bryan. 1976. Flora-Dade: A fresh market tomato with resistance to verticillium wilt. Univ. of Fla. Agr. Expt. Sta. Circ. S-246.

HortScience 19(5): 679–681. 1984.

Semi-mechanically Harvested Fresh-market Tomato Yields as Influenced by Harvest Date and Cultivar

Peter J. Stoffella[1]
Agricultural Research and Education Center, IFAS, University of Florida, P.O. Box 248, Fort Pierce, FL 33454

Mark Sherman[2]
Vegetable Crops Department, IFAS, University of Florida, Gainesville, FL 32611

Additional index words. *Lycopersicon esculentum*, machine harvesting

Abstract. **Three jointless tomato (*Lycopersicon esculentum* Mill.) cultivars, 'MH-1', 'Hayslip', and 'Burgis', were evaluated for fruit yields using a semi-mechanical fresh-market tomato harvester. Harvest dates were 85 or 99 days after transplanting in Fall 1980, and 88 or 95 days after transplanting in Fall 1982. Total fruit yields of the late harvest were significantly higher than the early harvest in 1982, but not in 1980. An increased percentage yield (weight basis) of colored fruit occurred during the late harvest in both trials. 'Burgis' and 'Hayslip' had significantly higher green fruit yields and lower ripe fruit yields than 'MH-1' in both years. Yields of semi-mechanically harvested fruit were reduced by an average of 25% and 47% when compared with manually harvested fruit yields during 1980 and 1982, respectively.**

Nearly all of Florida's fresh-market tomatoes are harvested by hand. Seasonal labor for manual harvesting will undoubtedly increase the cost of fresh-market tomato production. In past years, growers have directed their interest primarily toward mechanical harvesting of mature-green tomatoes. Mechanical harvesting was reported to reduce energy requirements by 45% per acre and 58% per pound of tomato when compared to manual harvesting (5). Florida's projected share of U.S. winter fresh-market tomato production will increase from 49% in 1979 to 51% in 1985 (10). The likelihood of an increasingly competitive market may force growers to consider mechanical harvesting to reduce production costs.

In an attempt to improve the yield and quality of machine-harvested tomatoes, a modified semi-mechanical harvester was designed and tested (8). The purpose of this investigation was to evaluate semi-mechanically harvested fruit yields of 3 tomato cultivars at 2 harvesting dates. Yields obtained from semi-mechanically harvested plots were compared to those obtained from manually harvested plots of unstaked tomatoes grown with standard, full-bed, plastic mulch (6).

Three jointless tomato cultivars, 'MH-1' (4), 'Burgis' (2), and 'Hayslip' (1) were grown during the fall seasons of 1980 and 1982 at the Agricultural Research and Education Center, Fort Pierce, Fla. Dolomitic limestone (2.24 MT/ha) was preplant incorporated into an Oldsmar fine sand. Raised beds, 109 cm wide, were spaced at 2.1 m on center. A 4N–7P–3.3K fertilizer at 1570 kg/ha was preplant incorporated into the beds. An additional application of 8N–5.2P–16.6K fertilizer at 2350 kg/ha was banded under a 25-cm, black plastic strip offset from the center of each bed. The strip-mulch technique (7) was used to decrease fertilizer leaching, since heavy rainfalls occur frequently during the growing seasons.

Tomato seedlings were transplanted 61 cm apart in the center of each bed on 8 Oct. 1980 and 13 Sept. 1982. Each plot was 15.2 m in length. Pest control and cultural practices conformed with production recommendations for the Fort Pierce area. The Institute of Food and Agricultural Sciences (IFAS) semi-mechanical harvester was used 85 or 99 days after transplanting during 1980 and 88 or 95 days after transplanting during 1982. Prior to harvesting, plants were undercut using a rotating square bar attached to a tool bar. Conveyer belts of the harvester elevated the plants to a platform where 2 persons manually shook fruit from the plants into a chlorinated water tank. Fruits from the tank were conveyed to a 6-person sorting crew. The sorting crew removed culls and separated green fruit from those showing red color (breakers and above). Culls included fruit less than 54 mm in diameter, severely misshapen, or otherwise damaged fruits.

Fruits from the green group were weighed after removal from the harvester, and fruits with color were separated further into "turning" and "ripe" fruits, counted, and weighed. The "turning" classification includes USDA color classifications 2, 3, and 4 (9). The "ripe" classification includes USDA color stages 5 and 6. Mean fruit weight (g/fruit) was determined by dividing the total weight of the fruit with color by the number of fruits with color for each plot. Both experiments were arranged in a randomized complete block with 3 replications. Analysis of variance was performed on all collected data by the Sta-

Received for publication 19 Mar 1984. Fla. Agr. Expt. Sta. Journal Series No. 5439. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.
[1]Assistant Professor, Vegetable Crops.
[2]Assistant Professor, Extension Vegetable Specialist.