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Luther Waters, Jr., Director
Auburn University, Auburn, Alabama

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AUTHORS

Mary Baltikauski
County Extension Coordinator
Geneva County

Tom Beckman
USDA–ARS
S.E. Fruit and Tree Nut Research Lab
Byron, GA

Bobby Boozer
Area Horticulturist
Chilton Area Horticulture Station

James E. Brown
Professor
Department of Horticulture

Jason Burkett
Superintendent–Horticulture Unit
E. V. Smith Research Center

Arnold Caylor
Superintendent
North Alabama Horticulture Station

Peggy Codreanu
Exchange Visitor
Ecole Nationale Superieure
Agronomique de Toulouse, France

Timothy D. Crawford
Graduate Research Assistant
Department of Horticulture

Fenny Dane
Assistant Professor
Department of Horticulture

Tony Dawkins
Superintendent
Sand Mountain Research and Extension Center

Bill Dozier
Professor and Department Chair
Department of Horticulture

Robert Ebel
Co-editor
Assistant Professor
Department of Horticulture

Wheeler Foshee
Extension Program Associate
Dept. of Entomology and Plant Pathology

Hernan Garcia-Ruiz
Graduate Research Assistant
Dept. of Entomology and Plant Pathology

Bill Goff
Professor and Extension Horticulturist
Department of Horticulture

Bob Goodman
Associate Professor and Ext. Economist
Dept. of Ag. Economics and Rural Sociology

Derenda Hagemore
Research Office Station Associate
North Alabama Horticulture Station

Christine Harris
Graduate Research Assistant
Department of Horticulture

Leigh Hawkins
Graduate Research Assistant
Department of Horticulture

David G. Himelrick
Professor and Extension Horticulturist
Department of Horticulture

Bob Jarret
USDA-ARS, Genetics Resource Unit
University of Georgia, Griffin, GA

Joseph Kemble
Co-editor
Assistant Professor and Extenion Horticulturist
Department of Horticulture

Tom Kubisiak
Affiliate Assistant Professor
Department of Horticulture
USDA Forest Service
Southern Institute of Forest Genetics
Saucier, MS

Ruhui Li
Research Associate
Dept. of Entomology and Plant Pathology

Ron McDaniel
Superintendent
Gulf Coast Research and Extension Center

John McVay
Associate Professor and Ext. Entomologist
Dept. of Entomology and Plant Pathology

Cecilia Mosjidis
Research Associate
Department of Horticulture

John F. Murphy
Associate Professor
Dept. of Entomology and Plant Pathology

Monte L. Nesbitt
Area Horticulturist
Gulf Coast Research and Extension Center

Andy Nyczepir
USDA–ARS
S.E. Fruit and Tree Nut Research Lab
Byron, GA

Malcomb Pegues
Assistant Superintendent
Gulf Coast Research and Extension Center

James A. Pitts
Superintendent
Chilton Area Horticulture Station

Daniel Porch
County Extension Agent
Blount County

Arlie Powell
Professor and Extension Horticulturist
Department of Horticulture

Bill Rhodes
Department of Horticulture
Clemson University

R. Rodriguez-Kabana
Professor
Dept. of Entomology and Plant Pathology

Jessie Scott
Grower
Slocomb, AL

Jeff L. Sibley
Assistant Professor
Department of Horticulture

Edward Sikora
Associate Professor and Extension Plant Pathologist
Department of Horticulture

Eric Simonne
Assistant Professor and Extension Horticulturist
Department of Horticulture

Bryan Wilkins
Graduate Research Assistant
Department of Horticulture

Floyd M. Woods
Associate Professor
Department of Horticulture

FRUIT PAPERS

Evaluation of Captan/Sulfur Tank-mixes for Peach Scab and Brown Rot Control on Peaches

Edward Sikora and Jim Pitts

Peach producers have a variety of fungicides available for use in a fungicide spray program. Factors such as effectiveness of disease control and cost per application should be considered when developing a spray schedule. Peach producers in Alabama commonly use sulfur as part of their disease management program. To improve its effectiveness, and to keep costs relatively low, some growers tank-mix sulfur with the fungicide Captan for spraying during the cover period. How effective this program is in controlling peach diseases and the relative ratio of sulfur to Captan needed for control are still not clear. This study compared two sulfur/Captan tank-mix programs with the standard, full season (cover period) programs of sulfur or Captan alone.

The experiment was conducted at the Chilton County Horticultural Station near Clanton, Alabama, on the cultivar 'Alred Alberta'. Treatments were replicated five times with four trees per replication in a randomized complete block design. Fungicides were applied using an air blast sprayer at 150 gpa. Treatments consisted of cover spray programs of (1) Unsprayed control, (2) Captan 50 WP 5 lb/acre, (3) Sulfur 80% 9 lb/acre, (4) Captan 50 WP 3 lb/acre plus Sulfur 80% 5.5 lb/acre, and (5) Captan 50 WP 2 lb/acre plus Sulfur 80% 3.5 lb/acre. Bravo Ultrex was applied at shuck split and petal fall, and two Orbit sprays were applied at seven and one day before harvest for all treatments except the control. A total of 40 fruit was picked from the center two trees of each treatment/replication. Percent of fruit with scab and percent marketable fruit was determined at harvest. Incidence of brown rot and Rhizopus rot was determined seven days after harvest.

All four fungicide programs produced 90% or more marketable fruit; however, the treatments with Captan alone at 5 lb/acre or Captan 3 lb/acre plus Sulfur at 5.5 lb/acre had fewer fruit with scab lesions compared to the sulfur alone treatment or the low rate of the Captan/sulfur tank-mix. There were no apparent differences among spray programs with regards to brown rot. The Captan alone treatment had significantly less Rhizopus rot than the other four treatments.

Evaluation of Captan/Sulfur Tank-mixes for Peach Scab and Brown Rot Control on Peaches

Fungicide cover spray program	% Marketable fruit	% Fruit with scab	% Brown rot	% Rhizopus rot
Unsprayed control	26.5	92.5	26.5	29.5
Captan 50 WP 5 lb/A	96.0	25.5	5.5	12.0
Sulfur 80% 9 lb/A	90.0	43.5	5.0	25.5
Captan 50 WP 3 lb/A + Sulfur 80% 5.5 lb/A	93.5	17.5	3.0	26.0
Captan 50 WP 2 lb/A + Sulfur 80% 3.5 lb/A	94.0	29.9	9.0	30.0

Evaluation of Abound for Brown Rot Control on Peaches

Edward Sikora and Jim Pitts

The fungicide Abound is a relatively new product for use on peaches for brown rot control. The product was just recently approved for use in the preharvest interval. This experiment was conducted to compare preharvest spray schedules that incorporate the use of Abound with other fungicide products.

The experiment was conducted at the Chilton County Horticultural Station near Clanton, Alabama. Treatments were replicated four times with three trees per replication in a randomized complete block design. Fungicides were applied using an air blast sprayer at 150 gpa. All treatments, with the excep-

Evaluation of Abound for Brown Rot Control on Peaches

Treatments (seven days then one day before harvest)	(Seven days after harvest) % Brown rot	% Rhizopus rot
Unsprayed control	13.1	10.6
Orbit 4 oz then Orbit 4 oz/A	0.6	15.6
Orbit 4 oz then Abound 12.3 oz/A	1.2	7.5
Abound 12.3 oz then Orbit 4 oz/A	4.3	6.2
Orbit 4 oz then Elite 45 DF 8 oz/A	1.2	17.5

tion of the untreated control, were sprayed with Bravo Ultrex at shuck split and petal fall and with Captan during the cover spray period. The four fungicide treatments consisted of two preharvest sprays applied seven and one day before harvest. The treatments were (1) two sprays of Orbit (4 oz/acre), (2) Orbit 4 oz/acre then Abound 12.3 oz/acre, (3) Abound 12.3 oz/acre then Orbit 4 oz/acre, and (4) Orbit 4 oz/acre then Elite 45 Df 8 oz/acre. The fifth treatment was an unsprayed control. Fruit were harvested one day after the final preharvest application. A sample of 40 fruit, picked randomly from the center tree of each three-tree treatment/replication, was stored at 77°F for seven days then examined for incidence of brown rot and Rhizopus rot.

Incidence of brown rot fruit rot seven days after harvest was highest on the unsprayed control (13.1%). Brown rot incidence among the four fungicide programs was less than 5%, and there were no significant differences among these treatments. There were no significant differences in Rhizopus rot among the five treatments.

EVALUATION OF FUNGICIDE SPRAY PROGRAMS FOR PEACH SCAB AND BROWN ROT CONTROL ON PEACHES

Edward Sikora and Jim Pitts

Peach producers have a variety of fungicides available for use in a spray program. Factors such as effectiveness of disease control and cost per application should be considered when developing a fungicide spray program. Along with these factors the need to choose a program that addresses disease resistance management should be considered. Peach producers in Alabama commonly use sulfur as part of their fungicide spray program. Sulfur is a relatively cheap product and can control a number of common fungal diseases. However, it is not considered as effective as Captan for scab or brown rot control when used in cover sprays.

An effective resistant management program relies on reducing the number of applications of a fungicide class during the season, using tank-mixes of compounds when appropriate, and/or alternating different classes of fungicides within the spray program during the season. The failure of growers to follow these practices may result in the development of fungal strains that are resistant to the class of fungicides overused in the orchard.

In this study, we compared fungicide spray programs that consisted of sulfur or Captan through the cover period. All of these programs used the fungicide Bravo Ultrex applied at bloom (shuck split and petal fall). Preharvest fungicide sprays for each program consisted of two applications at seven and one day before harvest. Programs consisted of one of the following: Captan then Orbit, Rovral then Orbit, or two sprays of Orbit (the industry standard).

The experiment was conducted at the Chilton Area Horticultural Station near Clanton, Alabama, on the cultivar 'Monroe'. Treatments were replicated four times with four trees per replication in a randomized complete block design. Fungicides were applied using an air blast sprayer at 150 GPA. Bravo Ultrex was applied on April 13 and April 20. Cover sprays were applied on May 5, May 14, May 24, June 4, June 25, June 29, and July 9. Preharvest applications were made on July 20 and July 26. Fruit were harvested on July 27. A total of 40 fruit were picked from the center two trees of each treatment/replication. Percent of fruit with scab and percent marketable fruit was determined at harvest. Incidence of brown rot and Rhizopus rot was determined seven days after harvest.

Programs that used Captan during the cover period had less fruit damage from scab and a higher number of marketable fruit than programs that used sulfur. There were no apparent differences among spray programs with regard to brown rot or Rhizopus rot. Programs that alternated among classes of fungicides (Rovral/Orbit or Captan/Orbit) in the preharvest period controlled brown rot as well as the program that used two consecutive sprays of Orbit.

EFFECT OF DIFFERENT FUNGICIDE SPRAY PROGRAMS ON INCIDENCE OF PEACH SCAB AND BROWN ROT

Fungicide program[1] B	C	H1	H2	% Fruit w/scab	% Marketable fruit	% Brown rot	% Rhizopus rot
U[2]	U	U	U	92.5	37.5	30.0	6.2
B	C	O	O	31.2	95.6	11.2	15.0
B	S	O	O	52.5	75.0	9.3	16.8
B	C	C	O	31.2	88.7	5.6	15.6
B	S	C	O	40.6	86.2	16.8	6.8
B	C	R	O	30.0	86.8	3.1	10.6
B	S	R	O	56.2	66.2	11.2	14.3

[1] B = bloom sprays (petal fall, shuck split), C = cover sprays, H1 = first preharvest spray, H2 = second preharvest spray.
[2] U = Unsprayed control, C = Captan 50WP (5 lb/acre), O = Orbit (4 oz/acre), S = sulfur 80% (9 lb./acre), R = Rovral 50WP (2 lb/acre).

IPM STRATEGIES FOR PEACHES: PRELIMINARY RESULTS

Wheeler Foshee, Bobby Boozer, John McVay, Ed Sikora, and Jason Burkett

Integrated pest management (IPM) involves the management of pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. IPM studies have shown promise in better timing of pesticide applications and reduction of sprays. In 1997, a study was initiated at the E.V. Smith Research Center to develop IPM strategies for our area. The purposes of this study were to (1) develop trapping techniques, (2) determine thresholds for sprays, and (3) reduce unnecessary pesticide applications.

A block of 'Correll', 'Sunland', and 'Biscoe' peaches, representing early to late season varieties, was used to study IPM techniques versus standard calendar spray schedules. Data collected included pheromone trap catches for plum curculio, Oriental fruit moth, peachtree borer, and stinkbugs; and non-pheromone trapping for plum curculio and tarnished plant bugs. Damage ratings for all insect and diseases were taken at harvest. In addition, a seven-day post-harvest examination was conducted for diseases.

Preliminary results indicated that plum curculio can be adequately controlled in early season varieties with three to four early sprays. The late varieties, as indicated by 'Biscoe', will require better monitoring techniques for determination of threshold sprays in order to prevent damage from summer generation plum curculio. During 1999, which was very dry, the IPM treatment, which had no cover sprays from 14 days after shuck-split until two weeks pre-harvest, gave adequate control of all major diseases.

A USDA Regional IPM Grant was obtained to assist in research of this project. Future plans are to look more closely at potential separation of IPM practices based on ripening periods (early, mid, late season) and utilize new PC monitoring techniques. In addition, new protocols for the control of Bacterial Spot on peaches will be validated.

With the loss of Penncap M and the reduction of the use of Guthion, IPM techniques will become increasingly important for the continued success of fruit production in Alabama. The IPM system being evaluated will have to be altered to reflect the pesticide changes to the industry.

IPM STUDY TREATMENTS

Treatment	Timing of application	Pesticide
Standard		
	75% bloom	Orbit
	Petal fall	Captan 50WP + Wettable Sulfur 80% + Penncap M
	Shuck-split	Captan + Sulfur + Guthion 50WP
	Cover sprays (7-10 day intervals)	Same as shuck split, can alternate Guthion and Penncap M
	2 weeks pre-harvest	Orbit
	1 week pre-harvest	Orbit
	1 day pre-harvest	Orbit
IPM		
	Pink bud	Thiodan 50WP
	50% bloom	Ronilan DF + Thiodan
	Petal fall	Bravo 720 + Guthion
	Shuck-split/shuck off	Bravo 720 + Penncap M
	10-14 days later	Captan 50WP + Penncap M
	14 days pre-harvest	Orbit
	7 days pre-harvest	Rovral 50WP
	1 day pre-harvest	Elite 45 DF

COMPARISON OF 'GUARDIAN' ROOTSTOCKS SELECTIONS TO OTHER PEACH ROOTSTOCKS FOR USE ON PEACH SHORT LIFE SITES

Bryan Wilkins, Bob Ebel, Tom Beckman, Andy Nyczepir, David Himelrick, and Jim Pitts

Peach Tree Short Life (PTSL) is a problem in many of the peach orchards in Alabama. PTSL is associated with the ring nematode, *Criconemella xenoplax,* and is characterized by the sudden death of trees in the spring that were apparently healthy the previous year. The use of soil fumigants has been the principle method of reducing nematode populations before planting. However, with the impending loss of methyl bromide and possibly other fumigants in the future, rootstocks that resist or tolerate the nematode need to be developed. Research has continued with selections from open-pollinated seedlings from the original BY520-9 tree, which has provided seeds for the 'Guardian' rootstock. Survival of the 'Guardian' rootstocks on sites prone to PTSL has been well documented. The current study is being conducted to determine the long-term horticultural performance on a site that has not displayed symptoms of PTSL.

The trees were planted in 1994. In this report, we summarize tree and fruit performance for 1994 through 1999. Trunk growth rate was similar for the BY520-9 selections over the six year period. 'SL1923', 'SL4028', and 'Lovell' were the most vigorous rootstocks. Suckering varied across rootstocks but none were extremely excessive. Fruit weight was variable across treatments but all fruit were of adequate marketable size. Yield varied across rootstocks. 'SL1923' had the highest yield. Most other rootstocks yielded as well as 'Lovell' although 'SL2170' performed poorly. Fruit color at harvest did not vary across rootstocks. Tree mortality was not statistically different; however, the BY520-8 selections tended to have greater tree loss than Lovell and most of the BY520-9 selections. In general, the 'Guardian' rootstocks selections have performed as well or better than 'Lovell', 'Nemaguard', and 'Flordaguard' in terms of yield, fruit weight, and fruit color in this trial.

COMPARISON OF GUARDIAN ROOTSTOCK SELECTIONS TO OTHER PEACH ROOTSTOCKS

	Trunk growth rate 1994-1999 *(in²/year)*	Suckers per tree 1997-1999	Fruit weight 1997-1999 *(lbs/fruit)*	Yield 1997-1999 *(lbs/tree)*	Fruit color 1997-1999 *(% blush)*	Tree survival 1994-1999 *(%)*
Standard Rootstocks						
Lovell	4.6b	2.4abc	0.370c	103.6bc	51	99.5
Nemaguard	4.9b	2.9ab	0.392bc	88.2bcd	57	100
Flordaguard	5.0b	1.1bc	0.423ab	83.8cd	54	100
Guardian Rootstock Selections						
BY520-9 selections						
SL1089	5.0b	4.2a	0.397abc	114.6b	58	100
SL1090	5.3ab	2.1bc	0.370c	94.8bcd	55	94.8
SL2165	4.7b	1.1bc	0.430ab	92.6bcd	61	93.5
SL2170	5.0b	2.6abc	0.434a	75d	59	98.6
SL3576	4.9b	1.1bc	0.373c	101.4bc	58	97.1
Other Rootstock Selections						
14DR51	4.7b	0.5c	0.370c	103.6bc	56	97.1
BY520-8 selections						
SL1923	6.0a	0.8bc	0.410abc	141.1a	54	89.1
SL2243	4.7b	2.7ab	0.414ab	97bcd	48	94.6
SL4028	5.9a	1.5bc	0.399abc	105.8bc	57	90

'FLORDACREST': BEST PERFORMING PEACH IN FAIRHOPE, 1998 AND 1999

Monte L. Nesbitt, Bob Ebel, Ron McDaniel, and Malcomb Pegues

The 1998 and 1999 growing seasons were difficult for peach growers everywhere, including the Gulf Coast area of Alabama. The 1997-98 winter provided adequate chilling for the Fairhope area, with 645 chill hours accumulated on February 15 and 787 accumulated by March 15. Unfortunately, a freeze occurred on March 11 and 12 with lows of 29° F and 28° F, respectively. Low chill peach and nectarine cultivars in the trial at the Gulf Coast Research and Extension Center in Fairhope had begun blooming in mid February, and some had small fruit set during the freeze. Substantial fruit and flower damage occurred on many varieties, including 'Flordadawn', 'Flordablaze', 'Flordaking', 'Flordagold', 'Flordacrest', 'Sungem' nectarine, and 'Sunsplash' nectarine.

The 1998-99 winter was unusually warm, and chill hour accumulation was low in Alabama. By February 15, Fairhope had accumulated only 357 chill hours, and by March 15 the total was 431 chill hours. Consequently, many cultivars in the trial at Fairhope had poor bloom crop and delayed foliation.

The cultivar trial at GCREC was planted in 1995, so trees were in their fourth growing season in 1998. The trial contained four trees each of 27 cultivars at planting. In late September 1998, Hurricane Georges destroyed 28 trees, including all four trees of 'Sunland' and three out of four trees of 'Juneprince', 'Bicentennial', and 'La Gold'. Trees were monitored regularly to determine date of full bloom, harvest date, and total yield. Fruit samples were also taken to determine important quality factors. 'Flordacrest' was the top yielding cultivar in both 1998 and 1999. 'Flordacrest' had set fruit at the time of the March freeze in 1998, and a portion of the crop was destroyed. The low chill requirement allowed it to set a good crop in 1999, averaging 70 pounds per tree. Flordacrest is an attractive peach with red/yellow skin and yellow flesh. Flavor was good in both years, and size ranged from 2.0 to 2.5 inches in diameter. It is a semi-freestone cultivar, with a very small point on the base of the fruit. A negative feature of 'Flordacrest' was a rating of "4" for Bacterial Leaf Spot in 1998, indicating moderate leaf damage. Other top yielding cultivars in the two-year period were 'Texstar' and 'Flordaking', which have performed well in previous, long-term trials. The challenge for peach growers in extreme Southwestern Alabama is to find cultivars for their orchard that give consistent results despite wide swings in chilling and unpredictable spring freezes. While 'Flordacrest' appears to have done well in 1998 and 1999, it may have other limitations that have not yet been expressed in this trial.

Peach and Nectarine Cultivar Performance, Gulf Coast Research and Extension Center, Fairhope, Alabama

Peach and nectarine cultivars	Chill requirement	Date of full bloom 1998	Date of full bloom 1999	Harvest date 1998	Harvest date 1999	Yield lbs/tree 1998	Yield lbs/tree 1999	Fruit diam. (in)	Taste 1998	Taste 1999	Bacterial leaf spot rating[1]
Peaches											
Flordadawn	300	2-16	2-10	5-13	4-30	0	28	2.1	nr[2]	excellent	4
Flordagold	325	2-25	2-12	6-1	6-1	0	27	2.2	nr	good	5
Flordablaze	375	2-25	2-17	5-13	5-7	0	51	2.0	nr	medium	3
Flordaking	400	2-25	2-25	—[3]	5-20	0	48	2.4	nr	bland	3
Flordacrest	425	2-25	2-14	5-20	5-20	28	70	2.2	medium	good	4
Flordaglobe	450	3-9	*[4]	5-13	5-24	3	0	2.1	bland	good	2
Sungrande	450	3-9r	3-10	6-26	6-17	10	18	2.5	bland	nr	3
Texstar	500	3-9	3-15	5-27	6-7	11	57	2.2	medium	good	3
Delta	550	3-19	*	6-5	6-10	7	1	2.5	bland	nr	2
Texroyal	600	3-9	3-20	6-16	6-10	19	15	2.2	excellent	nr	2
Empress	650	*	*	5-26	6-7	3	4	2.2	good	nr	2
Goldprince	650	*	*	—	6-10	0	0	—	nr	nr	1
Junegold	650	3-19	*	6-3	6-7	16	3	2.5	good	nr	2
Juneprince	650	3-25	*	6-13	—	9	—	2.2	good	nr	2
Springcrest	650	*	*	5-26	6-7	6	3	2.0	excellent	good	2
Gala	700	*	*	6-26	—	2	0	2.5	good	nr	2
LaGold	700	3-19	*	6-26	—	8	0	2.4	good	nr	2
Bicentennial	750	3-25	*	6-1	6-10	18	1	2.1	medium	nr	1
Sunland	750	3-25	*	6-26	—	12	—	2.4	good	nr	2
CVN-13W	?	3-19	*	6-26	—	5	0	2.7	bland	nr	1
Nectarines											
Sungem	425	3-9	3-7	5-28	5-24	8	47	2.2	very good	medium	3
Sunfre	525	3-19	*	6-5	—	8	0	—	good	nr	2
Fantasia	600	3-25	*	.	—	0	0	—	nr	nr	1
Sunsplash	450	3-9	3-1	5-26	5-17	1	31	1.8	nr	medium	1

[1] Bacterial leaf spot ratings: 1= none, 2 = light damage, 3 = light to moderate, 4 = moderate, 5 = severe.
[2] nr = not rated. [3] — = no data. [4] *= insufficient chilling and poor bloom crop.

Relating Effects of Fall Ethephon (Ethrel) to Peaches Based on Chill Hour Accumulation

Bobby Boozer, Arlie Powell, and Jim Pitts

Inconsistent cropping for peaches has been one of the major concerns for growers in Alabama and throughout the Southeast. Ethephon has been shown to benefit peach varieties by increasing winter hardiness as well as delaying bloom. While the benefits to fall application of ethephon are apparent, the best application time is not clear. Calendar dates as well as phenological stages such as leaf fall have been used for timing applications. Intensity of bloom delay has been shown to vary from year to year using a calendar day approach and certainly the percent of leaf drop varies from year to year. A better approach might be to correlate fall applications of ethephon to chill hour accumulation.

This study was set up to evaluate the effect of fall-applied ethephon based on pre-application chill hour accumulation. A block of 'Fireprince', an 850 chill hour variety, was selected and set up in a randomized complete block design with five replications. Ethephon was applied at a rate of 100 ppm plus a nonionic surfactant (0.25% v/v) at 0% chill hour accumulation (E0), 18% chill hour accumulation (E18), and 36% chill hour accumulation (E36). An untreated control (NE) was also used in the study. Dates of ethephon applications were November 20, December 1, and December 30, respectively.

Bud counts made on January 13 after all treatments had been applied were significantly different between NE and E0, and the trend from highest to lowest bud number per foot was NE, E36, E18, and E0. By March 2 the number of live buds per foot of shoot were significantly affected by treatments with mean values of 4.4, 4.0, 3.3, and 2.1 for NE, E36, E18, and E0, respectively (see table). While fruit bud reduction occurred to all treatments during the winter period, E0 had significantly fewer live buds than both E36 and NE by the March 2 sample date.

Delay in flowering and delay intensity was apparent by separation of the buds into stages from swell to open bloom. On March 2 there were no open blooms and the most advanced bud stage was pink bud. There was no significant difference between ethephon-treated buds with regard to number of pink buds. However, NE-treated trees had significantly higher pre-pink and pink buds than both E0 and E18, and E36 had significantly higher pre-pink buds than E0.

Fruit harvests were made June 29, July 2, July 6, July 9, and July 13. Total number and weight of fruit did not differ significantly between treatments. The only significant difference occurred at harvest 1, June 29. A higher number of fruit were harvested from NE than both E0 and E18.

The results indicate that chill hour accumulation is a good indicator of efficacy of fall-applied ethephon to peaches. Efficacy of ethephon on bloom delay and bud mortality decreases with increased chill hour accumulation. Over the past 43 years, the average number of chill hours accumulated by November 15 would provide a favorable range for ethephon application to most varieties. However, chill hour accumulation the past 10 years provided four years below 66, five years above 131, and one year with zero chill hours by the same date.

EFFECT OF CHILL HOUR ACCUMULATION ON FALL-APPLIED ETHEPHON TO 'FIREPRINCE' PEACH[1]

Treatment	Bud data[2]				Fruit yield[3]					
	C1	C2	PP	P	H1	H2	H3	H4	H5	Total
NE	10.2a	4.4a	2.0a	0.5a	119a	124	395	94	6	738
E0	7.8b	2.1b	0.1c	0.0b	14b	107	379	143	24	667
E18	8.1ab	3.3ab	0.5bc	0.1b	41b	190	416	144	25	816
E36	9.0ab	4.0ab	1.3ab	0.25ab	63ab	92	374	92	10	631

[1] Means within columns followed by the same letter are not significant, $p<0.05$.
[2] Bud data collected 1-13-99 (C1) and 3-2-99 (C2); PP=pre-pink, P= pink.
[3] Fruit yield as number of fruit; H1, H2, H3, H4, and H5 represent harvests 1, 2, 3, 4, and 5.

WHEN SHOULD SATSUMAS BE HARVESTED?

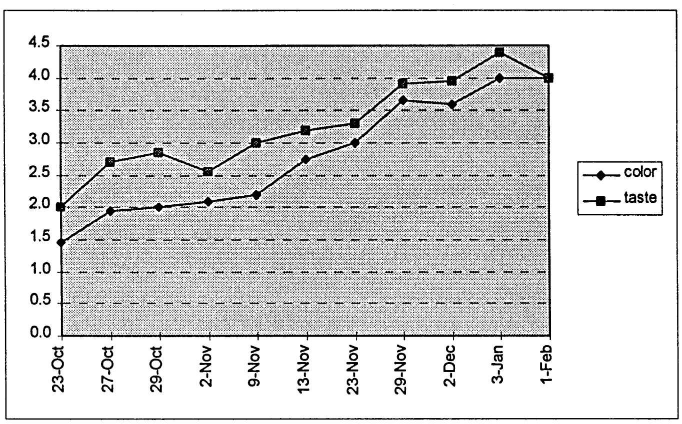
Monte Nesbitt, Arlie Powell, and Bob Ebel

Satsuma mandarin oranges ripen in southern Alabama from September through November depending on variety and environmental conditions. Optimum eating quality or taste depends on the sugar and acid contents; however, the optimum ratio of these for flavor does not necessarily develop at the same times as peel color, which is the current determinant of harvest date. All three processes are affected by many factors especially night temperatures, which can vary substantially from year to year. Since fruit peel color develops independently of sugars and acids, peel color is not a good indicator of eating quality (Figure 1). To address this problem, Florida and Louisiana have implemented maturity standards to reduce marketing of poor eating-quality citrus, which tends to suppress market price even later in the season when optimum eating-quality citrus are available. Alabama currently has no citrus maturity standards.

Two major chemical factors that influence flavor are sugars, also called soluble solids or Brix, and acid content which gives fruit its tart characteristic. The Brix to acid ratio best describes the eating quality of citrus. As Satsuma oranges approach the optimum harvest date, Brix increases and total acidity decreases (Figure 2). Growers often pick Satsuma oranges at first color break, but fruit acidity is too high. Optimum eating quality is most often associated with a mottled green and yellow peel color. Growers also often wait to pick until fruit are fully gold to orange in peel color; however, peak eating quality is usually passed. Measuring changes in Brix and total acidity is therefore necessary to determine harvest date for optimum eating quality. These two measurements are used in Florida and Louisiana to determine when citrus can be sold. In Florida, tangerines can be sold when a 50% color break is observed, when Brix measures at least 9.1, and when the Brix to acid ratio is 9 to 1. In Louisiana, Satsuma oranges must meet a 10 to 1 Brix to acid ratio.

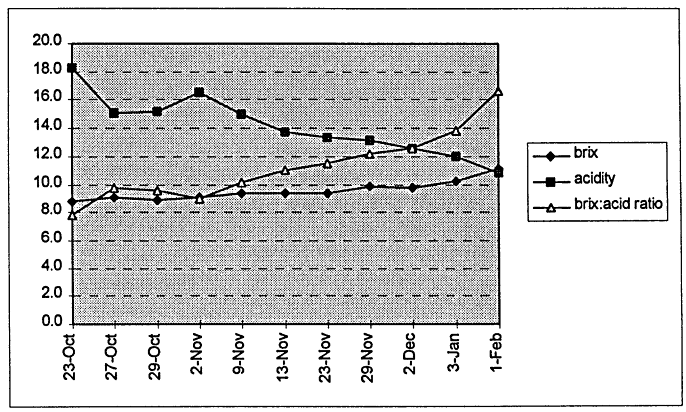
To demonstrate how color break and taste relate to chemical changes in Satsumas in Alabama, 'Owari' fruit growing at the Gulf Coast Research and Extension Center in Fairhope, Alabama, were harvested from October 1998 to February 1999. At each harvest, 20 to 30 fruit were rated for color and taste, and then measurements of Brix and total acidity were made. Peel color was green to yellow from October 23 to November 13, after which it progressed to gold/orange. Green coloration in the peel did not disappear until after December 2. Taste was perceived as predominantly sour until November 9, and sweetness increased after that. From December to January, fruit was perceived as having very little tartness. As anticipated, Brix increased and acidity decreased with the increase of colder temperatures. Using the Lousisana state standards as a guide for marketing, November 9 was the ideal date to harvest and market the fruit. By that date, 'Owari' fruit had a Brix to acid ratio of 10 to 1. Fruit was also rated as "sweet and sour" on that date. Peel color was highly variable, but most were green and yellow and not much different than they were in late October. These data represent a start in understanding the changes in eating quality parameters for determining optimum harvest date for Satsuma orange groves in southern Alabama.

Figure 1. Color and taste ratings of 'Owari' satsumas, 1998.



Color rating scale: 1= solid green, no color break; 2 = predominantly green with yellow color break; 3 = moderate color break–green/yellow/orange; 4 = fully golden orange, no green color. Taste rating scale: 1 = super sour; 2 = moderately sour; 3= sweet and sour (pleasing); 4 = sweet (pleasing); 5 = bland (not pleasing).

Figure 2. Chemical changes in 'Owari' fruit, 1998.



PRODUCTION DYNAMICS OF SATSUMAS

Monte Nesbitt, Bob Goodman, Bob Ebel, Bill Dozier, and Ron McDaniel

Satsuma mandarins have been grown sporadically in southwestern Alabama since the early 1900s, and there is great local interest in the crop today. Many Baldwin and Mobile County natives remember Satsuma groves from their childhood, and some remember that in the 1920s and 1930s there were packing houses and cooperative marketing organizations for Satsumas along the Gulf Coast. Severe freezes killed the trees every few years, and prevented this crop from becoming a permanent and strong commercial industry. In those days, tree trunks were mounded with soil to protect the graft union or protected from freezing with coal fires, smudge pots, and return stack heaters. These methods failed to prevent death of the canopy in a severe freeze event. Since the 1970s, irrigation has become the most important means of protecting citrus crops during severe freezes. In 1996, seven year-old 'Owari' Satsumas growing on Trifoliate Orange rootstock were successfully prevented from structural freeze damage at a low temperature of 15°F with elevated microsprinklers having an output of 11 to 48 gph. Good results were obtained with a single emitter situated at a height of five feet and having a delivery rate of 24 gph. Unfortunately, most of the crop was lost that year because a freeze occurred in March when flower buds were active and tender (Table 1). The trees returned to full production the following year (1997).

With irrigation technology now available to prevent death of the canopy of a satsuma tree, many people are wondering, "what are the production dynamics of this crop?", "how long does it take to get trees in production?", "what kind of yields can be expected?", or "what costs are incurred?" The freeze protection trial established in 1990 at the Gulf Coast Research and Extension Center in Fairhope provides answers to some of these questions. The trees were planted at 15 by 25 feet, giving 116 trees per acre. Individual tree yields have been measured each year since 1992, the first year

TABLE 1. YIELD OF 'OWARI' SATSUMAS, 1990-1998

Year	Yield *(lbs/tree)*
1990	0
1991	0
1992	38
1993	79
1994	174
1995	245
1996 (freeze year)	9
1997	337
1998	345
Total (1990-98)	1225

of production. Annual variable costs (fertilizer, pesticides, mowing, harvesting) were recorded and analyzed against yield and marketing data (Table 2).

These tables show that it takes about six years without freezes to break even over orchard establishment expenses including the irrigation system. If a freeze occurs after this, killing the crop but not the trees, that loss can be recouped in a single year. The combination of irrigation freeze protection and NAP insurance could provide growers a "fail-safe" system. NAP would provide some liquidity in years where the crop is lost due to freeze, and microsprinklers would assure tree survival such that full production would occur the following year. If trees survive to maturity, and if Satsuma prices remain at or near current levels, Satsuma production has the potential to provide significant economic returns.

TABLE 2. ANNUAL GROSS INCOME, NET INCOME, AND ACCUMULATED DEBT OF SATSUMA PRODUCTION IN BALDWIN COUNTY, ALABAMA[1]

Year	Annual gross income/acre	Annual net income/acre	Accumulated debt/acre
1990	$0	$-2,237	$2,237
1991	$0	$-2,173	$5,090
1992	$1,299	$-1,096	$6,929
1993	$2,718	$201	$7,375
1994	$6,001	$2,974	$5,108
1995	$8,462	$5,157	$-55
1996 (freeze year)	$0	$-1,855	$2,016
1997	$11,636	$8,183	$-6,906
1998	$11,929	$8,485	$-17,239

[1]This table assumes establishment cost of $500 per acre, plus 116 trees per acre, costing $8.00 each. It assumes Satsumas are sold at $0.30/lb (wholesale price) in all years. It assumes no charges for land cost, operator's management, or labor.

MUNICIPAL YARD WASTE AS A SOURCE OF NUTRIENTS FOR APPLE TREES

Robert C. Ebel, Arnold Caylor, and Bryan Wilkins

The EPA has passed legislation that requires municipalities to reduce the amount of solid waste going into landfills. One potential outlet for yard waste is agriculture. This study was conducted to compare tree and fruit response of Fuji, Golden Delicious 'Smoothee', and Red Delicious 'Scarlet Spur' apple trees to composted yard waste and other conventional forms of fertilization. Calcium nitrate and sulfur-coated urea were applied at 15, 30, and 60 lbs/acre/year and composted municipal yard waste was applied at 0.5-, 1-, and 2-inch depths, within the tree row, and out to three feet from the trunk. The trees were planted in 1993 at the North Alabama Horticulture Station in a complete randomized block with four blocks. Treatments were applied to four adjacent trees per block, but only the middle two trees were used for data collection. There was no effect of nitrogen form on foliar N; however, P, K, Mg, Mn, Zn, and B varied, but none were in the toxic or deficient range for any treatment.

Composted yard waste promoted greater growth than calcium nitrate and urea. Growth was promoted with higher nitrogen rates but not necessarily yield or yield efficiency. Precocity (yield in 1995) was higher for yard waste than the other two forms for 'Scarlett Spur' and 'Smoothee' but not Fuji. Average yield from 1995 through 1998 was highest for yard waste, although yield efficiency was not highest. Fruit weight, firmness, and soluble solids were not adversely affected by the composted yard waste. This study indicates that composted yard waste provides sufficient fertilization for apple tree growth and yield early in the life of an apple orchard.

Effect of Nitrogen Form and Rate on Vegetative Growth, Yield, Yield Efficiency, and Fruit Quality of Three Apple Cultivars During the First Six Years After Planting

	TCA growth rate (cm^3/year)	Shoot length (cm)	Yield in 1995 (kg/tree)	Average yield (kg/tree)	Yield efficiency (kg/cm^2 TCA)	Fruit weight (g)	Fruit firmness (lbs)	Fruit soluable solids (%)
Scarlett Spur								
Nitrogen form								
Yard waste	8.6	60	4.2	22.7	14.2	235	15.7	11.9
Calcium nitrate	6.3	60	3.4	23.6	15.0	226	16.3	11.7
Urea	6.5	54	3.4	20.4	11.3	222	16.1	11.4
Nitrogen rate (kg/ha)								
Low	6.7	55	3.1	22.0	7.7	226	16.0	11.3
Medium	6.7	58	3.8	22.6	12.3	227	16.2	11.3
High	8.0	57	4.2	22.1	20.0	230	15.9	12.3
Smoothee								
Nitrogen form								
Yard waste	16.4	76	8.9	15.9	8.4	259	16.1	14.6
Calcium nitrate	15.4	71	8.2	15.1	9.9	204	16.7	15.2
Urea	15.2	73	6.4	12.4	7.0	202	16.4	17.4
Nitrogen rate (kg/ha)								
Low	14.2	72	7.3	14.8	5.7	207	16.4	15.1
Medium	16.0	75	7.5	15.3	5.0	263	16.5	17.0
High	16.8	74	8.7	13.4	9.8	195	16.3	14.9
Fuji								
Nitrogen form								
Yard waste	21.7	86	13.7	12.6	7.4	197	16.5	16.1
Calcium nitrate	21.0	86	16.9	12.5	6.0	201	16.9	16.1
Urea	19.3	89	16.5	11.9	8.7	197	16.7	16.5
Nitrogen rate (kg/ha)								
Low	19.2	85	13.3	11.3	5.5	200	16.8	15.6
Medium	20.9	87	15.9	12.3	12.8	193	17.0	16.9
High	22.0	89	17.9	13.4	3.8	202	16.3	16.2

Asian Pear Performance in Baldwin County

Monte L. Nesbitt, Bob Ebel, Bill Dozier, Ron McDaniel, and Malcomb Pegues

Asian pears may have potential as a commercial crop in Baldwin County because tourism and urban growth create demand for fresh fruit. Grocery stores retail Asian pears for as much as $1.50 each or more, making them a high value commodity. Homeowners and hobby growers are interested in them as well. Ten Asian pear cultivars were planted in the spring of 1989 at the Gulf Coast Research and Extension Center in Fairhope, Alabama, to identify those most suitable for the area. Four trees of each cultivar were planted at a spacing of 15 by 25 feet. Important selection criteria were productivity, bloom date, fruit quality, and resistance to Fireblight. Trees were not irrigated, and low rates of fertilizer (0.25 to 0.50 lbs N/tree/year) were applied to minimize vegetative growth, which is susceptible to Fireblight. Chill hours varied considerably from as little as 475 hours (1999) to as much as 912 hours (1994) during the experiment.

In general, insect and disease pests were not serious, although fruit was regularly damaged and destroyed by birds and mammals. Crop loss was significant with Hurricanes Erin (August 3, 1995) and Danny (July 29, 1997), but no trees were destroyed. Fireblight was damaging to 'Doitsu', 'Erishinge', 'Hosui', '20th Century', and 'Kikusui', while the others showed good resistance (Table 1). Late summer defoliation from Pear Leaf Spot was severe on 'Seuri' in 1999. Spring freezes in March caused total crop loss in 1993 and 1998. Inadequate chilling caused a poor bloom crop and low yields in 1999 on all culti-

TABLE 1. DATE OF 50% FULL BLOOM IN 1994[1] AND FIREBLIGHT DAMAGE IN THE SPRING OF 1999

Cultivar	Date of 50% full bloom	Fireblight damage
20th Century	Mar. 14	moderate-severe
Chojuro	Mar. 21	none
Doitsu	Mar. 21	none-moderate
Erishinge	Mar. 16	moderate-severe
Hosui	Mar. 9	severe
Kikusui	Mar. 21	severe
Megeitsu	Mar. 17	none
Seuri	Mar. 5	none
Shinko	Mar. 22	none
Ya-Li	Feb. 28	none

[1] 1994 was a high chilling year (912 hours).

vars, except 'Doitsu'. The top yielding cultivars were 'Ya-Li', 'Seuri', 'Doitsu', and 'Erishinge'. Of these four, 'Ya-Li' and 'Seuri' are very early blooming cultivars, making them highly susceptible to spring freeze damage.

Flavor has been disappointing in all ten cultivars. All cultivars demonstrated good crisp texture, but were very bland or flavorless. In 1999, fruit were held in cold storage for six weeks after harvest to see if flavor improved. The cultivars with the best flavor after six weeks of cold storage were 'Kikusui', 'Doitsu', and 'Erishinge'. All others still had no flavor. Of the cultivars in this test, 'Doitsu' and 'Erishinge' had the best combination of yield (Table 2), quality, and bloom traits for suitability to Baldwin County; however, both showed some susceptibility to Fireblight. Thus, none of these ten cultivars appears to be ideally suited to the area.

TABLE 2. AVERAGE TREE YIELDS OF ASIAN PEAR CULTIVARS, GCREC, FAIRHOPE, ALABAMA

Cultivar	1992	1994	1995	1996	1997	1999	Total six yrs
Ya-Li	8.6	42.3	106.5	248.4	91.2	20.6	517.5
Seuri	1.8	47.0	59.7	133.2	181.2	11.3	434.1
Doitsu	0.3	18.2	20.2	111.5	177.1	90.1	417.2
Erishinge	13.1	75.0	33.1	93.9	162.6	23.4	401.0
Hosui	4.7	25.2	14.4	161.1	133.8	4.9	344.1
20th Century	14.5	29.0	34.6	84.3	135.1	14.8	312.2
Shinko	4.2	108.3	28.8	94.0	46.2	8.8	290.2
Kikusui	11.2	23.3	22.7	63.4	54.8	12.5	187.8
Chojuro	0.7	21.9	10.8	78.4	43.3	5.0	160.0
Megeitsu	5.5	69.6	1.8	45.3	12.1	1.3	135.5

HOT WATER TREATMENT ALTERS VITAMIN C CONTENT IN STRAWBERRY

Floyd M. Woods, Cecilia Mosjidis, Robert C. Ebel, David G. Himelrick, and James A. Pitts

Strawberry fruit are a highly perishable commodity in which preharvest handling conditions and storage environment have a profound effect on fruit quality and postharvest shelf life. Strawberry fruit have a short storage and shelf life principally because of decay microorganisms such as *Rhizopus* spp., *Botrytis cinerea* (gray mold), and *Colletrotricum* spp. (anthracnose). Refrigeration is currently the primary method for retarding decay, but significant losses can still occur. Consumer demand for minimal use of pesticides has stimulated interest in the use of non-chemical approaches to pathogen control in addition to refrigeration to preserve quality. Recent studies have shown that hot water treatment enhanced strawberry shelf life by delaying ripening and reducing decay by pathogens. Our understanding of the impact of heat treatment on strawberry metabolism and therefore nutritional status is minimal.

Ascorbic acid functions in a variety of metabolic processes, which ultimately protect plant cells against damage caused by oxygen free radicals and the development of lipid peroxidation. These cellular functions include the ability to serve as an antioxidant, an enzyme cofactor, and an electron donor. During normal cellular metabolism, active oxygen species—such as hydrogen peroxide, hydroxyl radicals, singlet oxygen, superoxide anion radicals, and lipid hydroperoxides—are produced and can cause oxidative damage in food systems that can ultimately lead to the development of "off-flavors" and decay. Plant tissues have developed a complex antioxidative system, comprised of enzymatic and non-enzymatic mechanisms, to protect cellular membranes and organelles from the damaging effects of toxic activated oxygen species. In senescing tissues, increased contents of ascorbic acid may correlate with reduced incidence of cellular membrane damage and thus prolong shelf life.

Strawberry fruit are one of the best sources of ascorbic acid, and rank among the highest in antioxidant capacity of 12 common fruits. Since submersion of strawberries in hot water can effectively reduce postharvest softening and decay and increase soluble solids, postharvest heat treatment may have a positive effect on enhancing ascorbic acid content. The objective of this study was to determine the effect of hot water treatment on the nutritional quality in fresh strawberry fruit after cold storage.

Vitamin C is relatively labile and postharvest storage environments dramatically influence its stability and content. Therefore, its retention may be a reliable indicator of nutritional status in fruits and vegetables. Total ascorbate content for heat-treated samples within the first day after treatment was equal to the control. Total vitamin C content was reduced in heat-treated fruit at three days of storage, and then increased. Between days three and four, total ascorbate content in heat-treated strawberries rapidly increased while control samples declined significantly. These changes may reflect differences in oxidized and reduced forms, its redox recycling capacity, and associated regenerative enzyme systems.

In summary, the results of the present investigation suggest that postharvest heat treatment adversely affects ascorbic acid content and metabolism. Further detailed studies of antioxidant participation in the ripening and senescence process of strawberry are needed in order to evaluate the full extent of altered metabolism in response to heat treatment. Such efforts would aid in identification of optimal time to harvest for fruit nutritional quality as well as identify storage potential.

EFFECTS OF COLD STORAGE OF PLANTLETS USED IN PLUG PLANT PRODUCTION ON YIELDS OF 'CHANDLER' STRAWBERRY IN ALABAMA

David G. Himelrick, Timothy D. Crawford, Jeff L. Sibley, and James A. Pitts

Current practice for strawberry plug propagation requires approximately four weeks from the time that plantlets are placed in soil media until root growth is sufficient for field planting. The plugs are then placed in cold storage until planting. This study was conducted to look at the effects of cold storage on 'Chandler' yield.

Rootless, healthy runner plantlets were collected approximately four months, three months, two months, and one month before the expected date of field planting. Plantlets were placed under refrigeration at 38° F in sealed polyethylene bags. There were four treatments based on the length of time that plantlets were maintained in refrigerated storage before propagation: three months, two months, one month, and zero months. Since field performance would be conducted at the Chilton Area Horticultural Station (CAHS), a mid-October planting date would be expected for fresh-dug plants. The study was conducted during two seasons: 1992-1993 and 1993-1994. The plants were planted into the field using the plasticulture system.

Results were separated into total seasonal yield as well as first half of the harvest season, April 26 to May 17, 1993, and second half of the harvest season, May 19 to June 7, 1993. In 1994, fruit production began earlier resulting in the first half of the harvest season being recorded from April 13 to April 29 and the second half of the harvest season being recorded from May 2 to May 26.

In the first half of the harvest season, yields, seasonal berry weight, and berry weight differed among treatments from all three planting dates in both years. Yield was lowest when plantlets received no chilling while yield was highest for plantlets stored for 60 days before propagation. Plantlets stored for approximately 90 or 60 days also produced higher yield than plantlets not stored, but there were no differences in yield when comparing the 90-day and 60-day treatments. Overall berry weight was lowest for plantlets which had received no chilling before propagation, but there were no differences among the three treatments receiving chilling. Berry weight was highest for the plantlets receiving 60 days of storage. Plantlets receiving 30 days or 90 days chilling produced higher berry weights than those not stored, but there was no difference in berry weight between the 30- and 90-day treatments. When comparing the late October plantings for both years, yield was different for the two years although total marketable yield was not different for the late planting in 1994. Storage of plantlets for 60 days before insertion for propagation produced the highest yields. There were no differences in yields for plantlets stored 30 or 90 days. Berry weight was also different among treatments in the late plantings. The 60-day treatment produced higher overall and first half of the harvest berry weights. Plantlets stored 30 days and 90 days had similar berry weights. Berry weights for plantlets not chilled were significantly lower than those stored 30 days, 60 days, or 90 days before propagation.

Planting date affected total yields in 1994, the only year in which both an early and late planting was made. Total yield was greater for each of the early-planted treatments in comparison to those treatments planted in late October. Comparison of early planting date with late planting date in the 1993 season showed that plantlets receiving 90 days of storage and no storage produced higher first half of the harvest season yields when planted earlier. Planting date was not a factor for plantlets stored 30 or 60 days.

No storage, 60-day storage, and 90-day storage treatments planted in early October produced higher total yields than the 30-day treatment. The late-planted 60-day treatment produced higher total yields than no storage, 30-day storage, and 90-day storage treatments planted in late October.

Treatments responded in a similar manner for first half of the harvest season marketable yield. When planted late, plantlets stored for 60 days produced greater marketable yields than other treatments. Among earlier plantings, there was no difference among the no-storage, 60-day, and 90-day treatments, but the 30-day treatment produced less than these three treatments. There was no interaction of berry weight with planting dates.

There were no differences in total yield in 1994 among the treatments. Plantlets stored for 30 days produced lower total yields than the other three treatments.

Chilling of plantlets may provide advantages to growers who wish to propagate plug plants for field production. A period of approximately 60 days storage at 38° F would enhance production since chilling for this particular treatment resulted in the highest overall berry weight and first half of the harvest season berry weight. In addition, chilling for approximately 60 days produced higher total yields and, more importantly, higher first half of the harvest season marketable yields than no storage, especially for late plantings in central Alabama.

Consideration of transplant survival should be studied further since it was observed that survival rate seemed to be inconsistent and optimal storage temperature for physiologically active runner tips has not been determined. The storage temperature for this study was higher than the typical 30° F used for dormant daughter plants. It could be that 38° F is not necessarily the optimal storage temperature for runner plantlets since plant growth has been shown to be best when runner plants had been stored at 30° F.

EFFECT OF ROOT CELL VOLUME DURING PLUG PLANT PRODUCTION ON YIELDS OF 'CHANDLER' STRAWBERRY

David G. Himelrick, Timothy D. Crawford, Jeff L. Sibley, and James A. Pitts

Four sizes of plastic cell packs were chosen to determine the effect of cell size used in strawberry plantlet propagation and production on fruit yield. Strawberry plantlets were rooted in cell packs of four different volumes commonly available for bedding plant production: 32-cell, 48-cell, 60-cell, and 72-cell. Strawberry plantlets were collected from mother plants of 'Chandler' that had fruited the previous spring at the Chilton Area Horticultural Station (CAHS). Collected plantlets were inserted in cell packs of the various sizes containing Pro Mix BX media on September 16, 1992 and September 21, 1993. Also, on August 27, 1993, plantlets of 'Chandler' grown in Canada obtained from Strawberry Hill, Inc., Mooresville, North Carolina, were inserted in three sizes of cell pack containers: 48-cell, 60-cell, and 72-cell, containing Pro Mix BX media for field planting at the CAHS.

Plantlets were placed in a greenhouse under intermittent mist with an on/off cycle of 5 sec/2 min under natural light conditions for a period of one week until root formation. Plants were then placed on a greenhouse bench receiving manual overhead watering twice daily, fertilization weekly, and fungicidal sprays twice weekly for approximately three weeks.

Plants were field planted at Gulf Coast Research and Extension Center (GCREC) on October 23, 1992 and October 13, 1993 and at CAHS on October 4, 1992 on raised beds covered with black plastic mulch. At GCREC, the two outside plants on either end of each plot served as guard plants and were not harvested, leaving the interior 10 plants for harvest. In 1993, harvest began February 15 and continued at three- to five-day intervals until May 31. In 1994 harvest began March 21 and continued at three- to five-day intervals until May 23. At CAHS all plants in each plot were harvested at three- to five-day intervals beginning April 13 and ending May 26, 1994.

Total yield and berry weight did not vary across cell pack sizes at the GCREC over the two-year study (Table 1).

TABLE 1. EFFECT OF CELL PACK SIZE ON YIELD AND BERRY WEIGHT FOR 'CHANDLER' PLUG PLANTS, GULF COAST RESEARCH AND EXTENSION CENTER, 1993 AND 1994

	1993				1994			
	Harvest season[1]			Berry weight	Harvest season[1]			Berry weight
Treatment	First half	Second half	Total	*(g)*	First half	Second half	Total	*(g)*
32 cells	133.7a[2]	366.4a	500.0a	14.8a	538.5a	192.3a	730.4a	6.0a
48 cells	124.5a	430.7a	555.3a	14.5a	470.3a	181.5a	651.8a	5.4a
60 cells	100.3a	315.2a	415.5a	14.3a	461.7a	208.1a	669.8a	5.3a
72 cells	128.6a	404.4a	533.0a	14.3a	498.7a	190.9a	689.6a	5.6a

[1]Yield per plant (g). [2]Means within columns followed by different letters are significantly different at $p \leq 0.05$.

In the one-year trial at CAHS involving 48-cell, 60-cell, and 72-cell packs, there were no significant differences in any of the yield factors including total yield, total marketable yield, early yield, early marketable yield, berry weight, or early berry weight (Table 2).

Because there were no significant differences between 60-cell packs and 72-cell packs, growers might consider using the smaller cell packs. Utilizing 72-cell packs over 60-cell packs would offer the advantage of producing more plug plants in the same greenhouse area without compromising total yields, early yields, or berry size.

Table 2. Effect of Cell Pack Size on Yield and Berry Weight of 'Chandler' Plug Plants, Chilton Area Horticultural Station, 1994

Treatment	Harvest season[1] First half	Harvest season[1] Second half	Total	Berry weight (g)
48 cells	324.7a[2]	206.6a	531.3a	14.6a
60 cells	292.6a	529.1a	529.1a	14.2a
72 cells	250.4a	235.9a	486.3a	14.3a

[1]Yield per plant (g). [2]Means within columns followed by different letters are significantly different at p≤0.05.

Effect of Runner Plantlet Size on Performance of Strawberry Plug Plants

David G. Himelrick, Timothy D. Crawford, Jeff L. Sibley, and James A. Pitts

This study was conducted to determine the effect of plantlet size on performance of 'Chandler' strawberry grown under the plasticulture production system. On September 22, 1992, runner plantlets were taken from 'Chandler' mother plants that had fruited in the spring at the Chilton Area Horticultural Station. Plantlets were placed in refrigerated storage overnight. In 1993, plantlets were collected and stored in the same manner on August 26.

Treatments for this study included three plantlet sizes categorized by plantlet length measured from the base of the crown to the tip of the longest leaflet of a trifoliate leaf. This type of determination has more practical application for industry than methods used previously. Plantlet size classifications (treatments) used in this study were: small plantlets, those with lengths of two inches or less; medium plantlets, those from two to four inches; and large plantlets, those greater than four inches.

On September 23, 1992 and August 27, 1993 plantlets were inserted in 60-cell plastic flat inserts with an unamended ProMix BX media and placed in a greenhouse under intermittent mist with an on/off cycle of five seconds/two minutes under natural lighting. After one week, plants were transferred from mist to overhead watering twice daily in the greenhouse until transplanting to field plots. Plants were transferred to the Chilton Area Horticultural Station and field planted on October 23, 1992 and October 4, 1993 in a complete randomized block design consisting of six replications of 14 plants each for each treatment.

Plantlet size did not affect total fruit yield (Table 1). Average berry weight for either early or late harvest was not different for the three treatments (Table 2), nor was total berry weight for either year.

The findings for plantlet sizes in 'Chandler' strawberry plug production support research in the United States reporting no influence on yield or berry weight of 'Santa Ana' and 'Sequoia' due to runner order, and no influence on fruit production in preliminary findings for 'Chandler'. Similar findings have been reported for tomato plug production in which plants of the same physiological age produced similar yields, even though plants varied in size at transplanting.

Small transplants may reduce early yields in some crops and have little affect on others, but strawberry plantlet size is

Table 1. Effect of Plantlet Size at Time of Propagation on Yields of 'Chandler' Strawberry, 1993 and 1994[1]

Treatment	1993 Harvest season First half	1993 Second half	1993 Total	1994 Harvest season First half	1994 Second half	1994 Total
Large	106.0a[2]	72.0a	178.0a	149.3a	124.8a	274.1a
Medium	111.4a	71.4a	182.7a	219.3a	168.7a	388.0a
Small	89.8a	65.2a	154.9a	253.7a	197.0a	450.8a

[1]Yield per plant (g). [2]Means within columns followed by different letters are significantly different at p≤0.05.

Table 2. Effect of Plantlet Size on Berry Weight, 1993 and 1994[1]

Treatment	1993 Harvest season First half	1993 Second half	1994 Harvest season First half	1994 Second half
Large	13.6a[2]	9.0a	15.0a	13.5a
Medium	14.9a	9.1a	14.2a	12.2a
Small	11.7a	7.9a	16.1a	14.2a

[1]Grams per berry. [2]Means within columns followed by different letters are significantly different at p≤0.05.

likely to have little influence on ultimate plant performance since small plantlet size was not found to influence yield. Grading of plantlets appears to be an unnecessary expense for successful yields from strawberry plug plants. However, establishment of plantlets, survival in the field, and vigor of small plantlets appeared to be lower than other treatments from subjective observations. Small strawberry runner plants graded by fresh weight (5g) have been found to have lower survival than medium (5 to 10g) or larger (greater than 10g) plants. Therefore, plug plantlet size influence on survivability, not evaluated in this study, may be a worthwhile consideration in grading, and warrants further investigation.

Genetic Diversity Evaluations of American Chestnut and Chinkapin Populations

Fenny Dane

American *Castanea* species, the American chestnut and chinkapin, are susceptible to chestnut blight, a disease caused by the Asian fungus *Cryphonectria parasitica*. The fungus was introduced at the beginning of this century in the New York area possibly on wood from Japanese chestnut trees. Blight reduced the American chestnut from an important timber and nut producing tree to an understory shrub. Although the plight of the American chestnut is well known, the chinkapin has been neglected. Taxonomic studies indicated two varieties: the Ozark chinkapin, which is now limited to the Ozark Highlands of Arkansas, Missouri, and Oklahoma; and the Allegheny chinkapin, found from New Jersey to Texas. Blight has severely affected the chinkapins in the Ozarks, but the Allegheny chinkapin is reported to be somewhat resistant although heavily cankered trees have been found in Alabama, Georgia, and Florida.

Any effort to conserve *Castanea* germplasm will increase chances of success if as much as possible is known about the genetic diversity of the species. Populations that lack variation for specific traits such as disease resistance often lack the ability to adapt to new and changing environmental conditions and are prone to extinction. The specific objectives of this research were to assess the level of genetic diversity within and among Allegheny chinkapin populations in order to develop appropriate conservation strategies and to relate the structure of this species to the evolution of the American and Chinese chestnut species.

Chinkapin nuts were collected from several populations of trees along the natural range of the species in Florida, Alabama, Mississippi, Virginia, and Ohio in the fall of 1998 and 1999. Each nut was subjected to molecular marker analyses. Standard population genetic statistics were generated and indicated that the genetic variability of the Allegheny chinkapin is higher than that of the American chestnut, but lower than that of the Chinese and European chestnut. Significant differences in genetic diversity were observed among the populations. While low values were observed in the naturalized population from Ohio, high values were detected for populations in Virginia and Florida. Conservation of genetically diverse populations in Virginia and Florida should be a priority since this would improve the chances of tree survival in habitats whose environmental conditions might change over time.

Plant-parasitic Nematodes and Pecans

Edward Sikora, R. Rodriguez-Kabana, and Bill Goff

There are few reports of specific plant-parasitic nematodes causing damage to pecans. Research has indicated that lesion *(Pratylenchus vulnus)* and root-knot nematodes *(Meloidogyne javanica)* can parasitize pecan but that susceptibility varies among cultivars. In 1995, a microplot study was initiated at Auburn University to determine the host suitability of five pecan cultivars to multiple species of plant parasitic nematodes.

Rooted seedlings of five pecan cultivars ('Elliot', 'Stuart', 'Desirable', 'Cape Fear', and '4 Po') were transplanted into microplots in late May 1995. The microplots had previously been filled with soil infested with plant-parasitic nematodes including root-knot *(Meloidogyne)*, lance *(Hoplolaimus)*, lesion *(Pratylenchus)*, spiral *(Helicotylenchus)*, stubby-root *(Trichodorus)*, and sting *(Xiphinema)*. Half of the microplots were fumigated with Telone II in order to determine the effects of plant-parasitic nematodes on tree growth. The trees were fertilized, irrigated, and hand weeded throughout the study. Soil samples were taken periodically to monitor the nematode population over time. Unfortunately, adverse environmental conditions and transplant shock during the first summer of the experiment made growth data unreliable.

By November of 1995, the populations of all the plant-parasitic nematodes had dropped dramatically from their initial level in May of that year. However, populations of lance, stunt, spiral, and dagger increased to low to moderate levels among all cultivars by 1997 (see table). It would appear that all five cultivars were equally suitable hosts of the plant-parasitic nematodes present (data not shown). Lance nematodes had an average population size of 98 nematodes/100 cc of soil across all pecan cultivars. Stunt nematodes averaged over 80 individuals/100 cc of soil. Spiral nematodes averaged nearly 30 nematodes/100 cc of soil, while dagger nematodes were barely detectable. There were no differences in the types of nematodes present or in population level among pecan cultivars or between fumigated and nonfumigated treatments. It is likely that some nematodes were introduced into the microplots after fumigation by way of the soil attached to the root balls on transplanted trees.

PLANT-PARASITIC NEMATODE POPULATION DEVELOPMENT ON FIVE PECAN CULTIVARS 1995-1997[1]

Nematode genera	Average population/100 cc of soil November 1995	December 1997
Lance	5.4	98.1
Stunt	1.3	82.6
Spiral	3.7	28.9
Dagger	Not detected	2.0

[1]Average nematode population on five cultivars of pecan (Elliot, Stuart, Desirable, Cape Fear, and 4 Po) grown in non-fumigated microplots.

Lance, stunt, and spiral nematodes have been reported to damage the roots of many types of trees. Lance nematodes are endoparasites that can cause cortical lesions and feeder root necrosis. Stunt nematodes are ectoparasites that can cause a reduction in feeder roots, while spiral nematodes can be ectoparasites or semiendoparasites and can cause a reduction in feeder roots and feeder root necrosis.

VEGETABLE PAPERS

VIRUSES IN COMMERCIAL PUMPKIN AND WATERMELON FIELDS IN ALABAMA

John F. Murphy, Ruhui Li, Hernan Garcia-Ruiz, Joseph Kemble, Daniel Porch, Mary Baltikauski, and Jessie Scott

In collaboration with county extension personnel and growers, pumpkin and watermelon fields in Geneva and Blount Counties were evaluated visually for the occurrence of virus-like symptoms, in June and August 1999, respectively. In addition, foliar samples were collected and tested for the presence of *Cucumber mosaic virus* (CMV), *Papaya ringspot virus* (PRSV), *Watermelon mosaic virus* (WMV) and *Zucchini yellow mosaic virus* (ZYMV). For visual assessments, plants in each field were examined for typical virus-like symptoms such as vein-clearing (leaf veins are yellowish in color), mosaic (leaves are light green with dark green islands at random locations throughout), and leaf distortion (leaves have dark green blistery areas and appear to be stretched or strap-like, similar to herbicide damage). For identification of viruses, leaf samples were collected from plants at random locations throughout the field and tested for the presence of each virus using the serological detection system ELISA.

WMV was detected in five of the seven watermelon fields surveyed in Geneva County (see table). Samples infected with WMV ranged from 29% (5 of 17 samples) to 100% (20 of 20 samples) within a field. Two of the fields had 100% infection. (Note: these values represent a percentage of the samples tested, and do not necessarily represent all plants within a given field.) Only a single plant was shown to be infected by CMV. Plants infected with WMV usually had a mild mosaic symptom on leaves, although some infected plants did not express any apparent symptoms.

Growth conditions for the watermelon fields in Geneva County varied rather dramatically. Some fields were well maintained and kept clean of weeds while others were essentially overgrown with weeds. Extensive WMV infection occurred in both weedy and weedless watermelon fields. These observations suggest that virus was introduced into the crop early in the season prior to extensive weed growth. Also, one watermelon field had an extensive amount of wild mustard expressing bright yellow foliar symptoms caused by *Turnip mosaic virus*. This virus is not known to be a problem in watermelon and was not detected among any of the watermelon samples.

At least two viruses, PRSV and WMV, were detected from samples of pumpkin and watermelon from each field in Blount County with three viruses, PRSV, WMV and ZYMV, detected from one field. Infected watermelon plants in Blount County tended to have more pronounced mosaic symptoms than those in Geneva County. This may have resulted from plants being infected with more than one virus. In contrast to the generally mild symptoms observed in watermelon, pumpkin plants were severely affected by virus. Most plants were infected with PRSV and WMV, which resulted in severe leaf mosaic and leaf distortion. Interestingly, no CMV was detected in any of the pumpkin or watermelon samples even though this virus was widespread in tomato crops throughout the county.

Management of these viruses is difficult when resistant varieties are not available, primarily because each virus is transmitted by aphids in a nonpersistent manner. Generally, this means that control of the aphid vectors through application of insecticides is not an effective means to manage virus. Without availability of resistant varieties, management strategies may have to focus on elimination of sources of virus and vector.

VIRUSES DETECTED IN PUMPKIN AND WATERMELON CROPS IN ALABAMA IN 1999

Field/crop	Viruses
Geneva County	
Field 1/watermelon	WMV (20/20 samples)
Field 2/watermelon	WMV (16/19 samples)
Field 3/watermelon	WMV (20/20 samples)
Field 4/watermelon	WMV (14/20 samples) CMV (1/20 samples)
Field 5/watermelon	No virus (0/15 samples)
Field 6/watermelon	No virus (0/18 samples)
Field 7/watermelon	WMV (5/17 samples)
Blount County	
Field 1/watermelon	PRSV (10/15 samples) WMV (15/15 samples)
Field 2/watermelon	PRSV (5/15 samples) WMV (14/15 samples) ZYMV (3/15 samples)
Field 3/watermelon	PRSV (1/10 samples) WMV (10/10 samples)
Field 4/watermelon	PRSV (1/8 samples) WMV (8/8 samples)
Field 5/pumpkin	PRSV (12/14 samples) WMV (12/14 samples)
Field 6/pumpkin	PRSV (5/9 samples) WMV (9/9 samples)

USING COVER CROPS TO DEVELOP A MORE SUSTAINABLE COMMERCIAL PUMPKIN PRODUCTION SYSTEM FOR ALABAMA

Joe Kemble and Arnold Caylor

Sustainable production agriculture is a goal for growers across the United States. Previous studies examining conservation tillage using residues from a cover crop grown before pumpkins have been infrequent and inconclusive. Researchers have reported, however, that reduced tillage is more promising than no-till as a strategy for vegetable production. Strip-tillage is a method in which a portion of the soil surface is tilled and subsoiled, usually the in-row portion, and the row middles are maintained undisturbed with residues. This provides a loose friable bed capable of accepting transplants or seeds. Seedbeds prepared by strip-tillage can be planted into without the need for specialized equipment, i.e., transplanting equipment used in conventional production can be used instead of a no-till planter. Developing a production system that uses cover crops and strip-tillage for commercial pumpkin production would help conserve soil moisture, protect the soil from erosion, provide a suitable crop for rotation, and supply the pumpkins with a source of N beside the addition of inorganic N. All of these items would increase the sustainability of pumpkin production.

Commercial pumpkin production in Alabama has grown from less than 200 acres in 1994 to more than 1,200 acres in 1999. Much of this growth has been due to small and part-time growers looking for alternative crops with which they can diversify their operations. Many of these operations have limited resources, not just in term of economics but also in terms of land and human resources.

The most limiting factors for pumpkin producers in Alabama are moisture availability and weed control. Droughts are common in summers in Alabama, limiting yields of pumpkins and negatively impacting the quality of fruit that are produced. Pumpkins that develop under moisture stress can be misshapen, off color, and/or undersized.

Currently, there are few herbicides available that can provide season long control of many grass and broadleaf weed species. Many growers end up relying on hand-pulling to maintain season long weed control. This is often too costly for many growers and they end up with inadequate weed control. Cover crops help to suppress early season weed growth. A production system that incorporates the use of residues for moisture conservation and weed suppression would be of great value.

Land availability is often limiting to growers in Alabama. Growers commonly use all of their available land in the production of crops without any crop rotation. The use of a winter cover crop would provide a rotation possibly decreasing pest pressure.

In en effort to address the concerns of this growing industry in Alabama, a three-year study which will focus on side-by-side comparisons of growth and development of pumpkin as affected by different cover crops, tillage systems, and rates of N was initiated in the fall of 1998 at the North Alabama Horticulture Station in Cullman. Three different cover crop systems are being evaluated: arrowleaf clover, hairy vetch, and wheat combined with crimson clover. Within each of these cover crops, three nitrogen rates (0, 45, and 90 lb/acre) are being evaluated. At the writing of this article, pumpkin harvest was not yet complete. Next year, a summary of the 1998-1999 season will be presented in the *Fruit and Vegetable Research Report.*

GENERATION OF A WATERMELON GENOME MAP

Leigh Hawkins, Fenny Dane, Tom Kubisiak, Bob Jarret, and Bill Rhodes

Watermelon (*Citrullus lanatus* var. *lanatus*) is the most economically important cucurbit crop worldwide and is an important horticultural crop in the southeastern United States. The production of the crop is hampered by the susceptibility of the available cultivars to several fungal pathogens, including *Fusarium oxysporum* sp. *niveum* (FON), which causes the devastating Fusarium wilt and *Didymella bryoniae*, which causes gummy stem blight. Although sources of disease resistance have been identified for the genetic improvement of this crop, very little effort has been made to date to use molecular breeding techniques for the improvement of watermelon.

The goal of the watermelon research program at AU has been to develop a comprehensive linkage map of the *Citrullus* genome using a variety of molecular markers and to tag genes for disease resistance and other economically important traits. The identification of markers linked to disease resistance would aid tremendously with the incorporation of genes of interest from wild watermelon relatives. The information being garnered is increasing our understanding of how resistance genes function, how they evolve new characteristics, and how they can be manipulated to provide useful disease control.

Segregating (F_2 and F_3) populations derived from a cross between Fusarium wilt susceptible watermelon cultivar 'New Hampshire Midget' and Fusarium wilt resistant *C. lanatus* var. *citroides* 'PI 296341' were used. F_3 seedling populations were screened for their level of resistance to race 1 and race 2 of FON by dipping roots in a fungal suspension. Disease ratings were conducted after two to three weeks. Inheritance to Fusarium race 1 resistance was observed to be controlled by a single gene, while inheritance to race 2 resistance was governed by several genes.

The advent of DNA technology of the past 20 years has revolutionized plant genetic analysis and has opened many new possibilities for studies of horticultural traits. Some of these new marker systems are Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphisms (AFLP), and Simple Sequence Repeat (SSR). All these different techniques have been used for the detection of polymorphic DNA fingerprints in the above mentioned watermelon populations. More than 150 RAPD primers, more than 100 SSR primers, and more than 10 AFLP primers have been screened to detect polymorphism between the watermelon parents. A genome map was developed, consisting of one large linkage group and several small ones. A possible biological explanation for the unusually large linkage group might be that selection pressure for horticultural traits in the cultivated parent created one divergent area in the genome between the parents, which many of the molecular markers were detecting.

Bulked segregate analysis was used to identify molecular markers linked to FON 1 and FON 2 resistance. This technique uses DNA bulked from watermelon plants susceptible or resistant to FON in an attempt to identify those markers which can detect fingerprint differences between the different bulks. More than 300 primers were used for the RAPD analysis of the resistant and susceptible bulks. However, only loose linkages between molecular markers and disease resistance genes could be detected. More research needs to be conducted.

Segregating populations were also analyzed for important morphological traits such as seed and fruit characteristics. Morphological markers have long been used to identify cultivars and were the first genetic markers in scientific studies. In many species it is often difficult to find a number of morphological traits for a comprehensive study thus limiting their applicability to genetic mapping and plant breeding. Often, several genes are involved in the inheritance of morphological traits. Development of molecular marker linkage maps makes it possible to locate and manipulate individual genetic factors associated with complex traits. Single factor analysis of variance was used for pair-wise combinations of morphological traits and molecular markers. While only a few of the molecular markers were found to be linked to seed and fruit size, several molecular markers were linked to fruit color, one of the main selection criteria in a watermelon breeding program.

ENHANCING THE GROWTH AND PRODUCTION OF IRISH POTATOES WITH PLANT GROWTH REGULATORS

Joe Kemble, Arnold Caylor, and Tony Dawkins

In Alabama, well over 90% of the potato market is devoted to the production of table stock in the form of red-skinned potatoes. This industry has been struggling a great deal over the past several years because of poor growing conditions and fluctuating market prices. Hitting the market with exactly what the market demands at a given moment has become a significant challenge. Growers are constantly on the lookout for some way in which they can modify their production practices in order to provide them with an edge over their competition. Ideally, this edge would increase their yields and/or decrease their production costs.

Each year new compounds with reported growth promoting or growth enhancing capabilities become available for growers to use. Many of these compounds contain various formulations of plant growth regulators such as auxins or gibberelic acid, both of which are produced naturally in plants. Many of these products claim that they are able to enhance production by increasing plant growth or by protecting plants from stressful growing conditions. Before recommendations for the general use of these products can be developed for these materials, their efficacy needs to be tested under growing conditions and specific crops in Alabama.

Two materials that have shown promising results in other parts of the United States and that are available for use on Irish potatoes are PGR Early Harvest (Griffin) and Auxigro (Auxein Corp.). A study was conducted at Sand Mountain Research and Extension Center (SMREC) in Crossville and at the North Alabama Horticultural Station (NAHS) in Cullman to determine the effect that these materials had on the growth and development of Irish potato.

The Irish potato 'Dark Red Norland' was used in this experiment. This variety produces a high quality, deep red potato, but does not produce the higher yields of newer cultivars such as 'Red LaSoda' and 'LaRouge'. Seed pieces were placed into a trench with 12 inches between pieces on March 26 and April 13 at SMREC and NAHS, respectively. All seed pieces were treated with Manzate 200 DF.

Six different treatments were evaluated:

1. PGR Early Harvest as a seed treatment.
2. PGR Early Harvest as a foliar application at tuber initiation.
3. PGR Early Harvest as a seed treatment plus a foliar application at tuber initiation.
4. PGR Early Harvest as a foliar application at bulking.

5. Auxigro as a foliar application at bulking.
6. No treatment – standard conventional production only.

At both locations, Irish potatoes were grown in accordance with accepted guidelines for producing Irish potatoes in Alabama. Plots were 40 feet long on 3.5-foot centers. There were few insect and disease problems at either location likely due to the dry weather during the late spring and early summer. Potatoes were harvested on July 20 and July 16 at NA and SMREC, respectively. Potatoes were separated based on size according to USDA standards: U.S. Extra #1 ("A"), U.S. #1 ("B"), U.S. #2 ("C"), and cull.

There were no differences among the treatments between the two locations of this experiment. Each compound performed similarly at each location as compared to conventional treatment. Average yields of the various grades are presented in the table. Yield at NAHS was lower than at SMREC. This is likely due to the shorter time the potatoes were in the field at NAHS. Planting was delayed at NAHS due to the weather.

There was an early growth spurt observed in the top growth of the plants that were treated with PGR Early Harvest as a seed treatment; however, the other treatments caught up to this initial early growth. Although these plots were irrigated at both locations, it is likely that the prolonged high soil temperatures coupled with the lack of rain may have overcome any beneficial effects from the various treatments. This study will continue next year with the addition of several other red-skinned cultivars.

AVERAGE YIELDS OF THE VARIOUS GRADES OF POTATO

Grade	SMREC	NAHS
	CWT/acre[1]	
Total marketable[2]	130.2	61.5
A	108.4	43.5
B	19.4	15.5
C	2.3	2.5
Cull	2.1	4.9

[1] All yields are in CWT/acre (1 CWT/acre = 100 lb/acre).
[2]Total marketable yield is calculated as the sum of A, B, and C grade potatoes.

MORE ON ALTERING SIZE AND YIELDS OF IRISH POTATOES

Joe Kemble, Arnold Caylor, and Tony Dawkins

In the past two years, we reported on a study that examined the effect of in-row spacing on yields of Grade B Irish potatoes. These smaller potatoes are often sold as "new potatoes" to restaurants and grocery store chains. In 1997, we reported that by decreasing in-row spacing, potato growers can produce more Grade B sized potatoes (1.5-inch minimum diameter to 2.25-inch maximum diameter). At a 4-inch in-row spacing, 51.5% of the total marketable yields were Grade B potatoes. In 1998, poor growing conditions adversely affected this experiment. Yield of Grade A, B, C, or total marketable potatoes did not differ significantly at any in-row spacing at the Sand Mountain Research and Extension Center (SMREC) in Crossville. No statistical differences were observed at any in-row spacing although there was a trend towards a higher percentage of Grade B potatoes as in-row spacing decreased as in 1997. In 1998, no data was reported by the North Alabama Horticulture Station (NAHS) in Cullman due to adverse growing conditions.

Results from 1997 appeared promising. In 1999, this study was repeated at NAHS and also conducted at SMREC. In March, seed of the red-skinned Irish potato 'LaRouge' was planted into furrows at five different in-row spacings: 4, 6, 8, 10, and 12 inches. As a result, the number of seed pieces increased with decreasing in-row spacings. The narrowest in-row spacing, 4 inches, required three times as many seed pieces as the 12-inch spacing (the 12-inch spacing is presently the conventional spacing used by growers).

At both locations, Irish potatoes were grown in accordance with accepted guidelines for producing Irish potatoes in Alabama. There were few insect and disease problems at either location likely due to the hot, dry weather that predominated. Potatoes were harvested in mid July at NAHS and SMREC. Potatoes were separated based on size according to USDA standards: U.S. Extra #1 ("A"), U.S. #1 ("B"), U.S. #2 ("C"), and cull.

At SMREC and NAHS, the 4-inch in-row treatment produced more Grade B sized potatoes as was found in 1997 (see table), but the overall percentage of Grade B potatoes was lower in 1999 than in 1997. In 1997, 51.5% of the total marketable yield was Grade B while in 1999, only 30.1% and 23.3% of the total marketable yield at SMREC and NAHS, respectively, were Grade B sized potatoes. In addition, the yield of Grade B sized potatoes did not differ significantly between the 4- and 6-inch in-row spacing (see table).

At SMREC and NAHS, the total marketable yield of Grade A sized potatoes did not differ significantly between any treatment except the 10-inch in-row spacing (see table). The 10-inch spacing produced fewer Grade A sized potatoes. It is interesting to note that the conventional 12-inch spacing did not produce a significantly different number of Grade A potatoes compared to the closer in-row spacings.

As in-row spacing decreased, there was a corresponding increase in the amount of Grade C sized potatoes at SMREC, but not at NAHS (see table). At SMREC, the 4- and 6-inch i row spacing produced more Grade C potatoes than any other spacing. At NAHS, there was no significant difference between any of the in-row spacings in terms of Grade C potatoes. Additionally, the amount of culls produced did not differ among any of the in-row spacings at either location.

What does all of this mean? The response to changes in in-row spacings differed between 1997 and 1999 studies. As in-row spacing decreased, there was an increase in the percentage of Grade B potatoes produced in 1997 and in 1999. This increase was not as dramatic in 1999 as it was in 1997. From these two years of data, an increase in the percentage of Grade B potatoes can be expected when using a 4-inch in-row spacing. However, at this spacing a grower would need three times as many seed pieces as he would at the 12-inch spacing. If you have a market that is looking for more Grade B sized potatoes, the use of closer in-row spacings will result in the production of a higher percentage of Grade B potatoes. This study will be repeated in 2000.

THE EFFECT OF IN-ROW SPACING ON YIELD COMPONENTS OF 'LAROUGE' IRISH POTATO AT SMREC AND NAHS

CWT/acre[1]	—A—		—B—		—C—		Total marketable[2]		% Grade B[3]	
In-row Spacing	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS
4	138.5	220.5	65.7	79.9	14.5	9.3	218.6	343.0	30.1	23.3
6	144.8	183.6	59.7	70.8	14.0	13.5	218.6	297.2	27.3	23.8
8	146.6	185.4	42.3	34.9	6.5	5.8	195.4	267.1	21.6	13.1
10	74.1	155.7	43.1	44.6	6.5	8.8	123.7	231.8	34.8	19.2
12	117.3	171.7	33.6	57.9	5.6	10.7	156.5	266.7	21.5	21.7
LSD[4]	42.7	56.6	22.5	23.3	5.2	ns[5]	49.3	56.2		

[1] All yields are in CWT/acre (1 CWT/acre = 100 lb/acre).
[2] 11 Total maruetable yield is calc lated as the s m of A, B, and C grade potatoes.
[3] Percent Grade B potatoes is of the total maruetable yield.
[4] Least significant difference ($p \leq 0.05$). [5] ns = no significant difference.

EVALUATION OF RED-SKINNED IRISH POTATO CULTIVARS

Joe Kemble, Arnold Caylor, and Tony Dawkins

The Irish potato industry has been struggling a great deal over the past several years because of poor growing conditions coupled with fluctuating market prices. Combined, these effects have squeezed margins ever tighter. Early in the season, rainfall prevented many growers from planting on time. By the time the spring rains ended, the heat began. Many growers complained of poor storage life for their potatoes as well as low prices offered to them by brokers. Irrigation would have benefitted some growers, but irrigation was not the answer to all of their production problems.

By far, the most important types of Irish potatoes grown in Alabama are those with red skins. Last year, we reported on the appearance and performance of several selected red-skinned Irish potato cultivars grown at the North Alabama Horticulture Station (NAHS) in Cullman and at the Sand Mountain Research and Extension (SMREC) in Crossville. In 1999, we continue to evaluate new releases as compared to industry standards to determine which cultivars are best suited to the growing conditions in Alabama.

At NAHS and SMREC, seed pieces of each Irish potato cultivar (see table) were sown into plots 40 feet long and 3.5 feet wide with a 12-inch in-row spacing. Seed potatoes were provided by Irish potato breeding programs in North Dakota, Oregon, and Idaho. Potatoes were sown on March 25 and April 13 at SMREC and NAHS, respectively, and harvested on July 19 and July 14 at SMREC and NAHS, respectively. Potatoes were separated based on size according to USDA standards: U.S. Extra #1 ("A"), U.S. #1 ("B"), U.S. #2 ("C"), and cull. Standard cultural practices were followed with the exception of relying on calcium nitrate as the primary nitrogen source at both locations. It was hoped that use of calcium nitrate would help extend the storage life of the potatoes.

At SMREC, 'Red LaSoda' (201.2 CWT/acre), 'Ida Rose' (185.4 CWT/acre), and 'LaRouge' (171.1 CWT/acre) produced higher total marketable yields than the other cultivars tested (see table). The same trend followed for Grade A sized potatoes where 92%, 89%, and 89% of the total marketable yields of 'Red LaSoda', 'Ida Rose', and 'LaRouge' were Grade A sized potatoes. With the exception of 'Dark Red Norland', 'Yukon Gold' produced fewer Grade B sized potatoes at SMS than the other cultivars tested.

At NAHS, 'Red LaSoda' (120.5 CWT/acre) and 'Yukon Gold' (108.4 CWT/acre) produced higher total marketable yields than the other cultivars tested. 'Ida Rose' produced the lowest total marketable yields (49.6 CWT/acre). In terms of grade distribution, 'Red LaSoda' and 'Yukon Gold' produced more Grade A sized potatoes than the other cultivars tested. More than 70% of the total marketable yield of 'Red LaSoda' was classified as Grade A. While more than 80% of the total marketable yield of 'Yukon Gold' was classified as Grade A. There were no differences between any of the cultivars tested in terms of Grade B sized potatoes.

In general, yields of each cultivar tested at SMREC were greater than those at NAHS. Large differences existed between SMREC and NAHS in terms of the performances of 'Yukon Gold' and 'Ida Rose.' These differences may be due in part to rainfall and temperature pattern differences between the two locations.

Skin color was also measured to determine just how red each cultivar was as compared to the others. An instrument that quantified the redness of the skin was used to rate how close the skin color of each potato was to true red (i.e., how intense the redness of each potato was). Cultivars are listed in order from most red to least red: 'Ida Rose' > ND 3574-5R > 'LaRouge' > 'Red LaSoda' > 'Dark Red Norland.' (Note: there was only a small difference in skin redness for 'Ida Rose' and ND 3574-5R.)

YIELD AND GRADE DISTRIBUTION OF SELECTED IRISH POTATO CULTIVARS AT SMREC AND NAHS

CWT/acre[1]	Total marketable[2]		Total yield[3]		A		B		C		Cull	
	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS	SMREC	NAHS
Red LaSoda	201.2	120.5	n/a	140.3	184.7	86.0	14.0	31.0	2.6	4.0	n/a	19.8
Ida Rose	185.4	49.6	n/a	56.6	164.1	14.2	17.9	24.1	3.4	11.3	n/a	7.0
LaRouge	171.1	n/a	n/a	n/a	151.5	n/a	17.1	n/a	2.4	n/a	n/a	n/a
ND 3574-5R	125.1	88.6	n/a	104.3	105.4	58.5	17.7	21.0	2.0	9.1	n/a	15.8
Yukon Gold	121.7	108.4	n/a	115.8	111.9	87.0	8.7	18.4	1.0	3.0	n/a	7.5
Dark Red Norland	108.7	74.9	n/a	78.5	92.6	50.0	13.5	21.2	2.6	4.0	n/a	3.5
LSD[4]	21.2	32.3	n/a	35.8	21.4	36.3	5.0	ns[5]	1.2	ns	n/a	9.4

[1] All yields are in CWT/acre (1 CWT/acre = 100 lb/acre).
[2]Total marketable yield is calculated from the sum of weights for A, B, and C grade potatoes.
[3]Total yield is calculated as the sum of weights for total marketable yield and cull.
[4]Least significant difference ($p \leq 0.05$). [5]ns = no significant difference.

EVALUATION OF BORDEAUX FOR DISEASE CONTROL ON TOMATO

Edward Sikora, Arnold Caylor, and Derenda Hagemore

This test was conducted at the North Alabama Horticulture Station in Cullman, Alabama.

The product Bordeaux (ELF ATOCHEM) was evaluated alone or in a tank-mix at various rates with Penncozeb 75 DF, or in a program where it was alternated with Bravo Weatherstik or Abound. A tank-mix of Penncozeb 75 DF plus Kocide 2000 was used as the commercial standard. The tomato variety 'Solar Set' was used in the trial. Early blight severity was rated on July 28, August 5, and August 11, 1999, by estimating the amount of diseased foliage/plot. Tomatoes were harvested weekly and total yield was determined (data not available at printing).

Early blight pressure was relatively low compared to previous years at this location. With low disease pressure, probably due to dry conditions, all seven programs performed very well. The highest early blight rating was detected on the unsprayed control on August 11 (24.4%). Early blight averaged less than 1% on all the fungicide treatments.

FUNGICIDE EVALUATION TRIAL, WEEKLY DISEASE (EARLY BLIGHT) SEVERITY RATINGS

Treatment[1] (rate/acre)	% Early blight 7/28	8/5	8/11
Bordeaux (8 lb)	0	0	0.4
Bordeaux (8 lb) + Penncozeb 75DF (3 lb)	0	0	0
Bordeaux (6 lb)+ Penncozeb 75 DF (3 lb)	0	0	0
Bordeaux (4 lb) + Penncozeb 75 DF (3 lb)	0	0	0.2
Bordeaux (6 lb) **alternated with** Abound (6 oz)	0	0	0
Bordeaux (8 lb) ***alternated with*** Bravo Weatherstik (3 pt)	0	0	0
Penncozeb 75 DF (3 lb) + Kocide 2000 (3 lb)	0	0	0.2
Unsprayed control	10	17.8	24.4

[1]All treatments applied on seven- to ten-day intervals.

THE USE OF RED POLYETHYLENE MULCH FOR SUPPRESSION OF NEMATODES IN TOMATOES

Joe Kemble, Ed Sikora, and Arnold Caylor

With the impending phase out of methyl bromide, many research efforts at Auburn and other universities are focusing on finding suitable replacements. This has been an uphill struggle with results indicating that there is likely no magic bullet that will replace methyl bromide; rather growers are going to have to make management decisions based on the specifics of their situation, i.e., what crop, what time of year, or what specific weeds or diseases need to be managed, etc. No one material or cultural practice will replace the broad spectrum control provided by methyl bromide.

Nematodes are one of the major limiting factors of production in many of the soils in Alabama. In terms of managing nematodes, fumigation with methyl bromide is by far one of the least expensive and most effective methods available. With methyl bromide's impending phase out, alternatives are needed. One method that has shown promise relies on the use of a specific type of polyethylene plastic. Called SMR-Red, this plastic mulch material has been reported to enhance the yields of tomatoes and also has been found to reduce nematode populations when used without the benefit of fumigation. This research project evaluated the effect SMR-Red polyethylene plastic mulch for control of nematodes and for enhancement of tomato production.

Four treatments were evaluated in this study:

1. Black plastic mulch fumigated with methyl bromide/chloropicrin (98/2) and Sencor.
2. Black plastic mulch with Tillam and Sencor (no nematicide).
3. SMR-Red plastic mulch with methyl bromide/chloropicrin (98/2) and Sencor.
4. SMR-Red plastic mulch with Tillam and Sencor (no nematicide).

Five-week-old transplants of FLA-47 were planted onto 18-inch centers into a nematode-infested soil on May 18 at the North Alabama Horticulture Station in Cullman. All plots were drip irrigated. Tomatoes were grown in accordance with accepted cultural practices used in Alabama. Plots were harvested three times. After the final harvest, roots were evaluated to determine the extent of nematode damage on the tomatoes. Little damage was found on roots for any of the treatments although the soil had a history of high nematode populations.

In terms of yield, there was no statistical difference among the four treatments for the number and weight of jumbo, large, and medium-sized fruit (table) or for the total marketable yield or culls. Each of these four treatments performed similarly. In addition, no growth promotion benefits were observed from the use of the SMR-Red plastic mulch as compared to the conventional treatment.

Although these tomatoes were placed into a field with a history of nematodes, this is not always an assurance that they will be a problem. The summer of 1999 was extremely dry and hot. This fact may have contributed to the lack of pressure from the nematodes. This study will be repeated in 2000.

YIELD PER ACRE OF TOMATOES MULCHED WITH RED POLYETHYLENE

Grade	*lb/acre*[1]
Jumbo	2,224.5
Large	5,531.1
Medium	1,929.6
Total marketable	9,685.2
Cull	3,013.0

[1]Total marketable yield is calculated as the sum of jumbo, large, and medium-sized fruit. Reported yield represents an average among the four treatments.

CHITOSAN-COATED TOMATO FRUIT HAS EXTENDED SHELF LIFE

Floyd M. Woods, Cecilia Mosjidis, and James E. Brown

Fruit firmness and turgidity are important quality determinants of tomato postharvest shelf life. These quality characteristics are associated with cellular integrity of membranes and structural cohesiveness of cell walls that are rich in pectic acids. Tomatoes are climacteric fruit, which ripen and soften quickly in response to ethylene synthesis and respiration. Textural modifications coincide with the synthesis of pectic enzymes such as polygalacturonase (PG) that is responsible for increased pectin solubility.

Transient periods of water stress resulting from elevated transpiration rates during postharvest handling and shipping further contributes to reduced quality and consumer acceptance. Prolonged periods of water stress are known to accelerate senescence and alter membrane permeability. The ability to maintain cell turgor by osmotic adjustments is an important physiological adaptation. Osmotically active solutes such as carbohydrates and amino acids especially proline are known to accumulate and are considered part of the adaptive response to water stress.

At present, low temperature storage and modified and controlled atmosphere storage are acceptable methods that delay the ripening process of tomato. It is well established that atmospheric modification (elevated or enriched CO_2 environments) during storage tends to reduce ethylene and respiration rates and thus extends the postharvest life of various commodities.

Edible coating (EC) materials such as chitosan, a by-product from the seafood industry, create a modified atmosphere surrounding individual fruit tissues. Previous studies have shown that chitosan-coated tomatoes suppressed the climacteric pattern while maintaining fruit firmness and overall quality.

It is not known whether the delay in ripening and maintenance in fruit turgidity in chitosan-treated tomato fruit is associated with suppressed levels of PG and accumulation of solutes. The present study was therefore undertaken to determine the effects of chitosan coating on PG activity, pectin content, electrolyte leakage, and accumulation of proline in tomato fruit at 20°C.

Textural changes observed in this study were found to be strongly correlated with treatment effects and enzyme activity. Chitosan-treated coated fruit (EC) resulted in a substantial reduction in total PG activity, which coincided with reduced pectin solubility (Figure 1, A and B). Accelerated senescence as a consequence of membrane deterioration occurred less in EC fruit (Figure 1C). EC fruit remained turgid longer and osmotically active as a consequence of proline accumulation (Figure 1D).

Results from this study indicate that chitosan coating markedly suppressed pectic enzyme activity, pectin solubility, and membrane deterioration and retained cellular turgidity longer by maintaining a high water-saturated environment. Thus, chitosan coating may offer commercial potential for delaying ripening and senescence in tomato without adversely affecting fruit quality. Ongoing studies are being conducted to determine the nutritional impact of EC-coated materials in tomato and other solanaceous commodities.

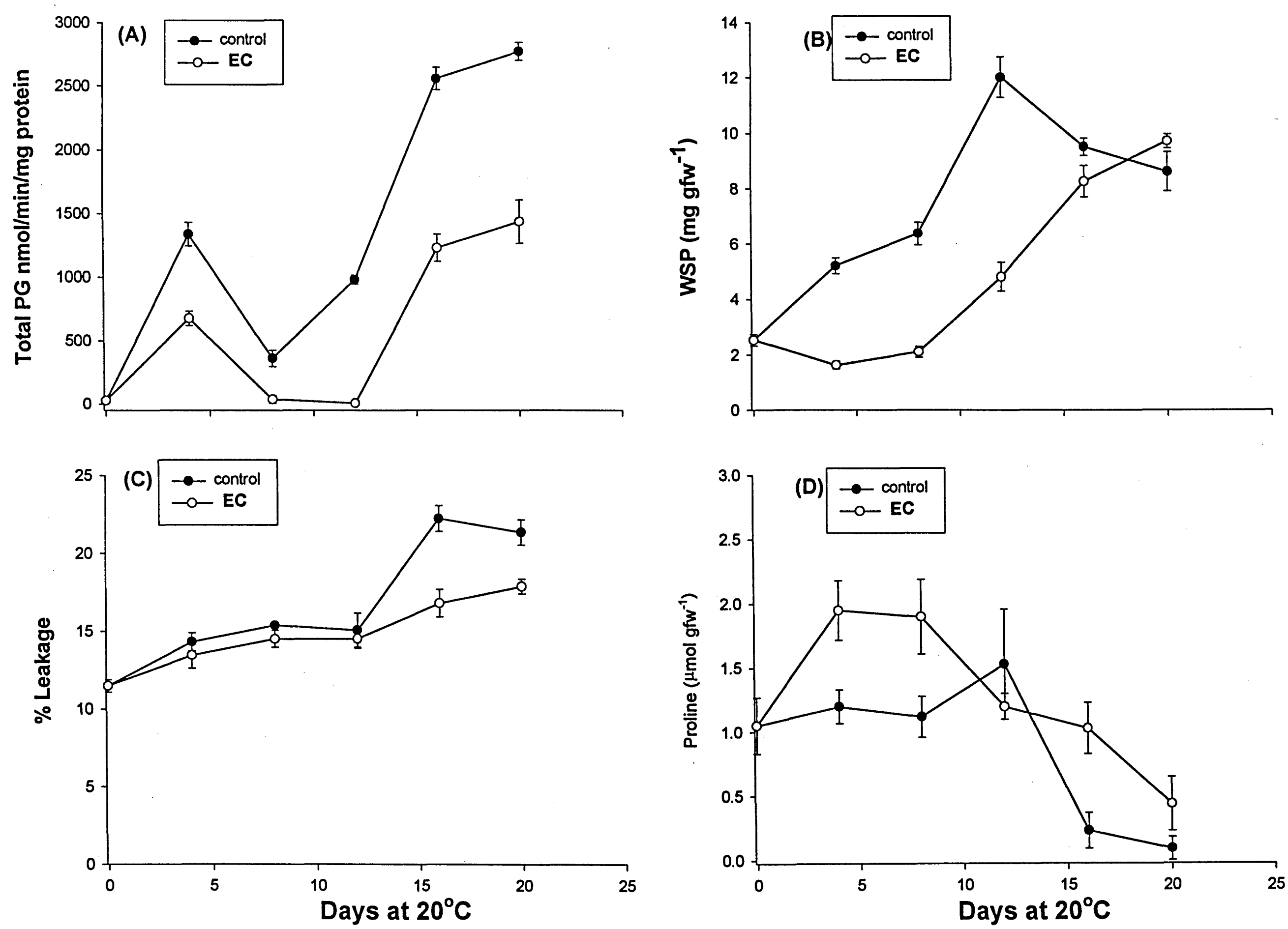


FIG. 1. Changes in total PG (A), water soluble pectin (B), electrolyte leakage (C) and proline content (D) of tomatoes stored at 20°C. Data represented are means of four replicates. Bars are SE of means.

MATURE PLANT RESISTANCE OF PEPPER AND TOMATO TO *CUCUMBER MOSAIC VIRUS* UNDER FIELD CONDITIONS

Hernan Garcia-Ruiz and John F. Murphy

A common practice to reduce losses caused by viral disease is the alteration of cultivation practices—a change in planting date in an attempt to avoid the availability of highly susceptible plants at a time when virus-vector densities are over a specific threshold. These and other agronomic practices are based on the fact that older plants can resist or tolerate virus infection better than young plants.

A field trial was conducted at the E. V. Smith Research Center in Shorter to determine the effect of plant age at the time of inoculation with *Cucumber mosaic cucumovirus* (CMV) on time of appearance of symptoms, disease incidence and severity, and yield of bell pepper ('Early Calwonder') and fresh-market tomato ('Mountain Pride'). Pepper and tomato plants were seeded into Speedling trays in the greenhouse and transplanted to the field 22 days after emergence. Seedlings were transplanted to the field on April 30, May 14, May 28, and June 11, 1999. On June 16 all plants were mechanically inoculated with CMV; at that time plants were 70, 55, 40, or 25 days old, respectively. Fifteen days post-inoculation (dpi) CMV was detected by ELISA in inoculated leaves of pepper and tomato plants of all ages, indicating no difference in susceptibility to infection in the inoculated leaves. However, there were differences in the time of appearance of symptoms, disease severity, and fruit yield. Young uninoculated leaves were tested by ELISA at 22, 36 (first harvest), and 50 dpi (second harvest).

Pepper plants within each age group developed CMV-induced systemic symptoms at a similar percentage by eight dpi. The occurrence of symptomatic plants continued to increase until reaching a maximum of 89% to 96% at 50 dpi. The oldest group of plants at the time of inoculation were less severely affected and produced more fruit than plants of the other three age groups. Plants in the second and third age group produced similar amounts of fruit. The youngest group of plants at the time of inoculation did not produce any fruit.

By eight dpi, the first tomato plants with CMV-induced symptoms occurred in the youngest group, which were the more severely affected by CMV and produced the least amount of fruit; in some cases no fruit was produced. Tomato plants that were 40, 55, or 70 days of age at the time of inoculation remained symptomless for at least 29 dpi. Once plants developed symptoms, they produced similar amounts of fruit.

These results show that CMV takes more time to induce systemic symptoms in older plants, and such plants are less affected by virus infection and, as a result, produce more fruit. These results suggest that maintaining tomato plants free of virus for at least 40 days after emergence, or pepper plants for at least 70 days, can result in a significant reduction in disease severity. Most importantly, yield losses in response to CMV infection are reduced if plants are allowed to achieve a state of maturity prior to infection.

DISEASE INCIDENCE, SEVERITY, AND YIELD OF PEPPER OR TOMATO PLANTS INOCULATED WITH CMV AT DIFFERENT STAGES IN PLANT DEVELOPMENT

Crop	Transplanting date	DAE[1]	Percentage of plants showing CMV symptoms at different times (days) after inoculation[2]						Disease severity	Yield[3] *(kg)*
			8	15	22	29	36	50		
Pepper	April 30	70	34 a	68 a	77 a	84 a	88 a	89 a	0.673 b	7.20 a
	May 14	55	48 a	81 a	86 a	88 a	92 a	94 a	0.970 a	1.33 b
	May 28	40	67 a	92 a	92 a	96 a	96 a	96 a	0.948 a	2.11 b
	June 11	25	75 a	88 a	88 a	88 a	92 a	92 a	1.000 a	0.00 c
Tomato	April 30	70	0 b	0 b	0 b	0 b	0 c	71 b	0.391 c	18.98 a
	May 14	55	2 b	6 b	6 b	4 b	17 b	77 b	0.484 cb	18.39 a
	May 28	40	0 b	0 b	2 b	8 b	33 b	77 b	0.552 b	16.41 a
	June 11	25	23 a	25 a	50 a	94 a	94 a	94 a	0.953 a	0.66 b

[1]DAE = Days after emergence at the time of inoculation.
[2]Values with different letter within each column are statistically different.
[3]Average of four replicates. Each replicate consisted of a single row plot with 12 plants.

MECHANISTIC STUDIES ON THE RESISTANCE OF *CAPSICUM ANNUUM* CV. 'AVELAR' (BELL PEPPER) TO *TOBACCO ETCH VIRUS*

Ruhui Li and John. F. Murphy

Host plant resistance is the most effective and economical way to control plant viral diseases. There are several types of resistance against viruses in plants: (1) plants may be immune to the virus and no infection can occur; (2) plants may be resistant to cell-to-cell movement of the virus (i.e. the virus cannot move out of the initially infected cell); and (3) plants may become infected and the virus can spread from cell to cell, but the virus cannot move to other plant organs (e.g. another leaf or fruit). Investigations into the mechanisms of resistance in crops will help us to identify, characterize, and manipulate potential sources of resistance that may be incorporated into a breeding program.

Tobacco etch virus (TEV) is one of the most important viruses infecting pepper (*Capsicum annuum*) in the United States. Resistance to TEV has been reported in several *C. annuum* cultivars, including 'Avelar'. However, such resistance is frequently overcome by emergence of different viral mutants. To understand the nature of 'Avelar's resistance, we studied the response of 'Avelar' to inoculation with resisted and resistance-breaking strains of TEV.

'Avelar' plants inoculated with the resisted strain (referred to as TEV-HAT) remained symptomless with the virus detected in inoculated leaves but not in any uninoculated leaves. In contrast, the resistance-breaking strain (referred to TEV-NW) systematically infected 'Avelar' plants with leaves expressing vein-clearing and mottle symptoms. TEV-NW was detected in both inoculated and uninoculated leaves. Detection of TEV-HAT in inoculated but not uninoculated leaves of 'Avelar' plants indicates that the virus was unable to move out of the inoculated leaf. These results were confirmed by testing the stem of TEV-HAT inoculated 'Avelar' plants which were shown to contain no detectable virus throughout the course of these experiments.

We are currently attempting to identify the viral gene involved in 'Avelar's resistance by evaluating the ability of selected hybrid viruses (i.e., viruses for which we have exchanged the genetic material in order to understand the function(s) of specific viral genes) to infect 'Avelar' plants.

EVALUATION OF COMMERCIALLY AVAILABLE DEER REPELLENTS ON SWEETPOTATO

Christine Harris, Eric Simonne, and Peggy Codreanu

Alabama sweetpotato growers make significant contributions to the American sweetpotato industry. Alabama sweetpotatoes accounted for approximately 6.5% of all sweetpotatoes shipped in the United States in 1994. Because of the palatability of sweetpotato to white-tailed deer, feeding damage during production poses a significant problem for commercial growers in Alabama. Possible strategies to control deer are fences, scare tactics, and in some cases shooting. Scare tactics work only temporarily as deer become accustomed to the nuisance. Fences are expensive and shooting is often an unacceptable alternative outside the legal hunting periods or seasons. Chemical repellency is one of the most selective and cost effective approaches to controlling deer feeding damage. Yet, few products are used because of a lack of efficacy. The objective of this study was to evaluate the efficacy of commercially available deer repellent products as feeding controls for white-tailed deer.

The study was conducted at the Auburn University Deer Research Facility in the summer of 1999. Two groups of six adult white-tailed deer were confined to two, one-acre study pens. No green vegetation was available to the deer other than that provided in the treatments.

Sweetpotato (*Ipomea batatas* L.) cv. 'Beauregard' slips were grown in trade-gallon pots following current production practices in June and July 1999. Groups of eight plants approximately 18 inches in length were sprayed with selected products outside the pens. A group of eight plants were left unsprayed as a control. Treatments were applied following the manufacturer's recommendations. Pots were placed randomly inside the pen and labeled according to treatment.

Selected treatments included Havahart Putrescent Egg Spray, Grant's, Ro-Pel, Hinder, and an untreated control. The fungicide, XP-20 (Thiram), was used as a reference product. All products were provided by Woodstream Corporation, Lititz, Pennsylvania.

Feeding damage on each plant was rated daily for four days. A rating scale of 0 to 3 was established to determine damage (0 = no damage; 1 = one-third of plant removed; 2 = two-thirds of plant removed; 3 = plant removed to the pot line or uprooted).

Damage ratings were analyzed. Products were ranked according to an overall rank sum index (ORSI). ORSI allowed for classification of the products by their relative efficacy. The number of days needed to reach 10% and 50% destruction were determined. 'Beauregard' sweetpotato is sensitive to leaf loss and 33% to 66% defoliation has been shown to decrease marketable yields.

All products tested provided some level of feeding deterrence compared to the untreated control. The egg-based Havahart spray provided the greatest protection for a longer period to sweetpotato than any other product in this test (see table). The Thiram-containing product, XP-20, also provided a high level of protection against deer feeding damage. There was not a significant difference in the level of protection provided by Grant's, Ro-Pel, and Hinder.

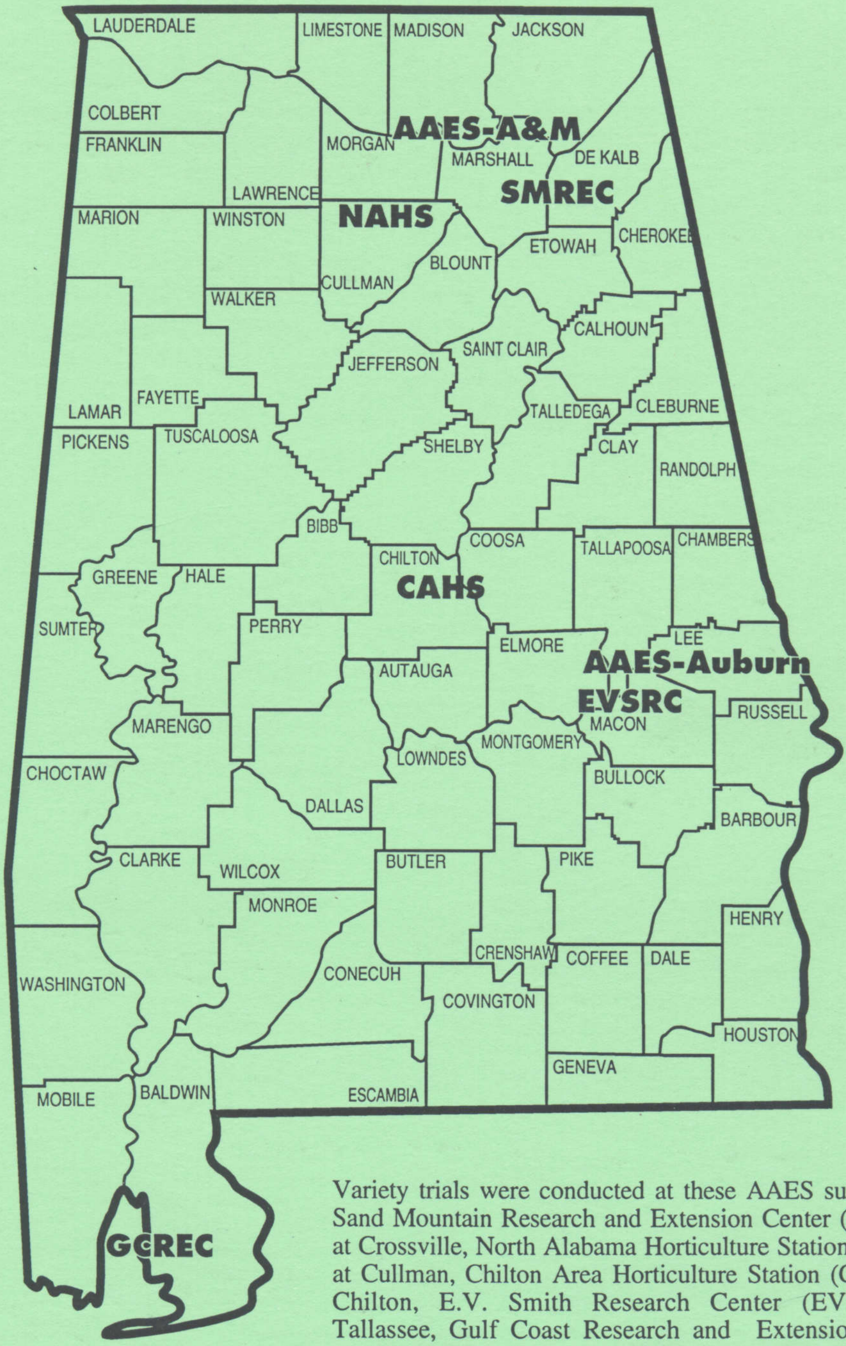
Despite increased pressure on remaining plants in the latter part of the test and the extremely high deer pressure, differences were found among treatments. Our results suggest that putrescent egg-based products may be effective as deer feeding controls. Future research is warranted to provide information about using egg-based deer repellents on other sweetpotato cultivars and to begin the process of labeling egg-based deer repellents for use on sweetpotato.

PERCENT DAMAGE RATING TO SWEETPOTATO[1]

Treatment	Days of exposure				Days to damage		Product rank
	1	2	3	4	10%	50%	(ORSI)
Havahart	4b	6c	25c	25c	3	-	1
XP-20	27b	37b	45b	54b	1	4	2
Grant's	10b	31b	54ab	58ab	1	3	4
Ro-Pel	14b	47ab	56ab	58ab	1	3	4
Hinder	25b	41b	50b	64ab	1	3	4
Control	50a	66a	70a	72a	1	1	6

[1] Percent destroyed based on daily observation. Means followed by different letters within a column are significantly different at the 5% level according to Duncan's Multiple Range Test.

Location of Participating Research Units



Variety trials were conducted at these AAES substations: Sand Mountain Research and Extension Center (SMREC) at Crossville, North Alabama Horticulture Station (NAHS) at Cullman, Chilton Area Horticulture Station (CAHS) at Chilton, E.V. Smith Research Center (EVSRC) at Tallassee, Gulf Coast Research and Extension Center (GCREC) at Fairhope, and Main Agricultural Experiment Station (AAES) at Auburn University and Alabama A&M University. Without the commitment of the substation personnel, results presented in this report would not have been presented in a timely manner.