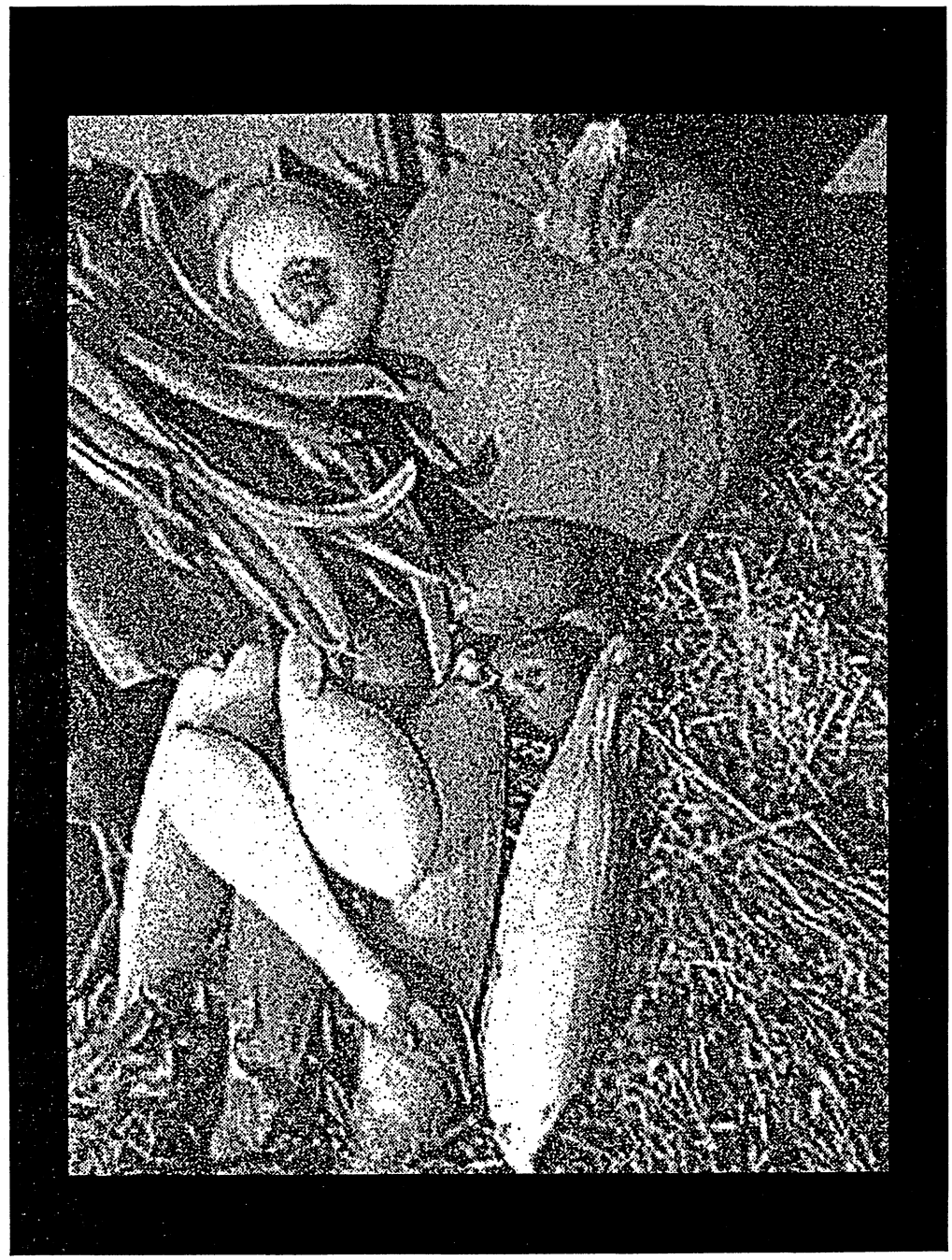

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Fruit & Vegetable Research Report

Effect of Six-Carbon Volatiles on Plant Pathogens

Fenny Dane, Jennifer Warr, and Bob Ebel

Plants are constantly being challenged by microbial attack, but disease is rare. Why? Either (1) the plant cannot support the niche requirements of the pathogen, or (2) the plant possesses pre-formed structural barriers or toxic compounds that confine infections to a small number of microbes, or (3) upon recognition of the attacking pathogen, defense mechanisms are turned on and the invasion remains localized. Successful pathogen invasion and disease occur when the pre-formed barriers are inappropriate, the plant does not detect the pathogen or the activated defense responses are ineffective. The defense mechanisms used by the plant take many different forms, but are the result of specific recognition of the pathogen. Upon recognition a cascade of defense reactions is initiated.

Even though plant resistance has been studied, little is known about the triggering and early signaling events of this cascade of defense reactions. It is known that volatile compounds are produced upon pathogen attack or other stress-related events. The biological activity of many of these substances is poorly understood, but some might produce signal molecules important in host-pathogen interactions. In this research we explored the possibility that lipid-derived C6 volatiles, produced ultimately as a result of a so-called lipoxygenase enzyme activity in the plant, might also have a direct effect on the pathogens themselves.

To this purpose we used a unique tool, a bioluminescent plant pathogen that can be followed nondestructively on petri plates and inside the plant with special computer-assisted camera equipment. Light-producing genes from a fish-associated bacterium were introduced into the bacterium *Xanthomonas campestris* pv. *campestris*, that causes black rot disease of crucifers. The effects of different C6 volatiles (trans-2-hexanal, trans-2-hexen-1-ol, and cis-3 hexenol) on growth of this bioluminescent bacterium were investigated. After plates were inoculated with bacterial suspension, a volatile was added onto a filter paper wick in the center of each plate. Different volatile concentrations (0, 0.1, 1, or 10% v/v using propanediol as solvent) were used. Plates were sealed and incubated and measurements of light production per plate were taken over time with the special computer-assisted camera equipment. Treatment with trans-2-hexanal appeared to be bactericidal at low concentrations (1% and 10%), while treatments with the other volatiles were not inhibitive to bacterial growth. The effect of trans-2- hexanal was uniform over the entire plate and not just in the area surrounding the filter disk. These experiments demonstrate that some lipid-derived compounds, that may be involved in the defense mechanisms of plants to pathogens, possess antimicrobial activity. Studies with the generation of C6-volatiles in pathogen resistant or susceptible plants and their effect on bacterial growth will be initiated to study this process in more detail.

DNA Markers Linked to Fusarium Wilt Resistance in Watermelon

Leigh Hawkins and Fenny Dane

Genetic linkage maps consist of several closely-spaced DNA markers, such as restriction fragment length polymorphisms (RFLP), random amplified polymorphic DNA (RAPD), and/or amplified fragment polymorphisms (AFLP). These maps make it possible for plant breeders and geneticists to evaluate traits in the plant genome, such as resistance genes, that are segregating in a population. Molecular markers (1) assist in the preservation and exploitation of germplasm, (2) allow marker-aided selection, and (3) facilitate in generating particular combinations of resistance genes. The better a marker is in detecting differences (polymorphisms), then the greater its potential value to germplasm management and breeding strategies.

By using these markers to "tag" certain areas of the genome that contribute to the plant's phenotype, it is possible to

observe the "tags" versus studying the whole plant phenotype through selections. In many organisms, such as watermelon, genetic maps are unavailable because few morphological and isozyme differences have been found. Thus generating a map would be beneficial in map-based pre-selection that could reduce the number of plants to be grown for selection.

Worldwide, Fusarium wilt of watermelon, caused by the soilborne fungus, *Fusarium oxysporum* f.sp. *niveum*, is the most economically important disease of watermelon. The fungus invades the plant through wounds, the root tip, or other natural openings plugging the plant's water conducting vessels thus reducing water movement and leading to the wilt and eventual death of the plants. Symptoms of the disease can appear at any stage of growth. Germinating seed might rot in the soil, or young seedlings might die. Leaves of older plants wilt in midday for several successive days and then shrivel permanently. At the soil line, when the epidermis and the cortical tissue on the main stem are removed, a light-brown discoloration of the vascular tissue is apparent.

There are three races of this fungus: race 0, race 1, and race 2. Most commercially available watermelon cultivars are resistant to race 0 and race 1. Race 2, however, is more aggressive overcoming all currently known commercial cultivars. Race 2 has been found in Texas, Oklahoma, and Florida.

F. oxysporum f.sp. *niveum is* capable of surviving from season to season in old infected vines, on seed, or in the soil. The fungus can be spread to new areas on seed or in soil transported by equipment, drainage water, or humans. Cultural practices for control of the disease include planting on virgin land, long crop rotations, steam-cleaning equipment, and the use of resistant cultivars. Though sometimes successful, these control measures are not always acceptable or practical to the grower. Many times, widely used commercial cultivars are highly susceptible to Fusarium wilt and long-term rotations or fallow periods are not economically feasible. By using DNA markers, it would be possible to develop a much-needed genetic map for watermelon with high density or to map the genomic regions around the genes of interest. Currently, we are developing a genetic map in watermelon populations segregating for Fusarium wilt resistance. F_2 populations have been generated using the susceptible cultivar New Hampshire Midget and the wilt-resistant PI 296341. Results have been encouraging, several RAPD and AFLP markers have been found that generate many polymorphisms in watermelon.

Gummy Stem Blight Resistance Tagging in Watermelon

YOUNG-SEOK KWON AND FENNY DANE

Cucurbits are affected by a number of fungal diseases, one of which is gummy stem blight, that can affect leaves, stems, and fruits of all cucurbits. The pathogen, *Didymella bryoniae*, is found throughout Alabama, and this year reduced watermelon production. Symptoms first appear as circular, tan to dark brown spots on the leaf margins that can rapidly enlarge until the entire leaf is blighted. Stem cankers can develop and brown, gummy exudates (ooze) are commonly produced on their surface. Small fruiting bodies may appear as black specks on the cankers. On fruit the disease is known as black rot. The pathogen survives between seasons on diseased vines and crop debris and may be seed borne. This disease occurs primarily under high moisture conditions and can be avoided using treated seeds and a two-year rotation.

Although plant breeders have identified resistance genes in several cucurbits, no commercially acceptable resistant cultivars of watermelon, melon, or cucumber have as yet been developed. Satisfactory chemical control may be obtained by regular applications of protectant fungicides, but isolates of the fungus resistant to the benzimidazole (Benlate) fungicides have been detected in cucurbit fields in the eastern U.S.

Research was initiated at Auburn University to identify molecular markers linked to gummy stem blight resistance in watermelon. Plant improvement relies on the evaluation and selection of the right combination of genes. The recognition of important genes and their chromosomal location has been difficult to determine, but since the development of DNA-based technologies, valuable genes can be tracked in segregating populations using genetically-linked molecular markers. Extensive sets of genetically mapped molecular markers have been produced for many species, but little research has been conducted on watermelon germplasm, even though the crop is cultivated world wide. Watermelon populations segregating for gummy stem blight resistance have been developed and will be used to identify several different types of DNA markers. Linkages between molecular markers and gummy stem blight resistance genes will be determined by screening DNA bulked from resistant or susceptible seedlings for polymorphic markers.

This research will greatly facilitate the evaluation and selection of watermelon populations segregating for gummy stem blight resistance and provide a first step toward the identification of the structure and cloning and manipulation of disease resistance genes in this and related cucurbit species.

Genetic Diversity Evaluation of the American Chestnut

FENNY DANE AND HONGWEN HUANG

The American chestnut (*Castanea dentata*) was once a dominant species in the eastern hardwood forest before chestnut blight, caused by the fungus *Cryphonectria parasitica*, arrived on the North American continent near the turn of the century. Prior to blight, the native range of the American chestnut extended from Maine to Mississippi. The species was commercially important for its outstanding timber quality and abundant nut production. Chestnut blight spread rapidly, however, eventually destroying the entire species. This species is threatened and a conservation plan is needed.

While American species in the genus (American chestnut and the closely related chinkapin) are susceptible to the fungus, Asian species have different levels of blight resistance and have been used in American chestnut breeding programs. Recent studies on isozyme diversity indicated that the Chinese chestnut species has higher levels of genetic diversity than other species in the genus. Research at Auburn University, supported by the USDA Plant Germplasm program, was conducted to study levels of genetic diversity in wild populations of the American chestnut in order to use this information toward effective breeding and conservation strategies.

Dormant buds from 11-30 trees collected from 12 different populations along the range of the species were subjected to molecular marker analyses. Isozymes and DNA-based markers were used to investigate the genetic variation within and between the populations. It was discovered that the American chestnut has lower levels of genetic diversity as compared to closely related species in the same genus (see table). A clear distinction could be made between the southern population (AL), the south central Appalachian populations (GA, NC-1, NC-2, VA-1, OH, VA- 2), north central Appalachian populations (PA-1, PA-2), and northern Appalachian populations (NY, CT). Based on the results of this study, the establishment of at least three regional reservations–a southern, central, and northern Appalachian population–should be considered.

Representative trees from these populations should be used in backcross breeding programs aimed to restore blight resistant American chestnut trees to their native habitat.

GENETIC DIVERSITY STATISTICS FOR SEVERAL CHESTNUT SPECIES

Species	P	A_e	H_{obs}	H_e
Chinese chestnut	60.0	1.49	0.334	0.328
Seguine chestnut	68.4	1.25	0.218	0.203
European chestnut	76.9	1.47	0.256	0.317
Ozark chinkapin	70.0	1.52	0.360	0.282
American chestnut	60.0	1.25	0.184	0.167

P is the percent polymorphic loci; A_e is the effective number of alleles per locus: H_{obs} is the observed heterozygosity; and H_e is the expected heterozygosity.

Chemical Mowing in Mature Pecan Orchards

MONTE NESBITT AND BOB GOODMAN

The recommended commercial program for orchard floor management in pecan is the "sod and strip system." A weed free strip is maintained in the tree row, and sod is grown in the row middles to facilitate equipment passage and ground harvesting. The sod species in most orchards are bermudagrass, bahiagrass, or mixed grasses, that are strong competitors for water and nutrients. Most growers mow sod middles throughout the season to keep their orchards clean, and because they believe unchecked grasses may reduce yield and nut quality. Research, however, has not shown that mowing orchards improves pecan production.

Chemical mowing is an alternative practice for controlling grass. With chemicals, growth of grasses and other weeds is slowed by treatment with non-lethal rates of postemergence herbicides such as glyphosate or paraquat. This practice can maintain grasses at a desired height, with potential savings in time, equipment wear, and fuel cost. This study was done in 1996 to compare economic costs of mechanical and chemical mowing in a mature pecan orchard, and to determine if horticultural factors (soil moisture, nutrition, yield, nut quality) were affected.

The experiment was conducted on 15-year-old, non-irrigated Cape Fear trees in a private, commercial orchard near Fairhope. The trees were planted 35 feet x 70 feet, with a young (seven-year-old) center tree. A five-foot-wide weed free strip was maintained in each tree row, so the sod middle area was 30 feet wide between rows. The primary grasses in the sod middles were bahiagrass and common bermudagrass, with some grass weeds

(smutgrass, rescuegrass, green foxtail), and a low percentage of broadleaf weeds. The control treatment was not mowed from June 1 to Oct. 7. The standard treatment was mechanically mowed as dictated by the orchard owner from June to October. Four chemical mowing treatments included two rates of Roundup Ultra (4 oz. and 8 oz. per acre), and two start dates (June 1 and Aug. 10). Both rates of Roundup Ultra were applied in a total solution volume of 12.5 gallons per acre.

Bahiagrass in the unmowed plots reached heights of 14 inches, and bermudagrass grew to 9.5 inches. At termination of the trial, the unmowed plots required multiple mowings and hand removal of the clippings to make nut harvest possible. Regardless of horticultural or economic effects, grasses must be mowed regularly through the season to prevent heavy buildup of clippings that interfere with harvest.

TABLE 1. YIELD, NUT QUALITY, AND LEAF ANALYSIS OF NITROGEN (N), PHOSPHORUS (P), AND POTASSIUM (K)

Treat	Yield (lb.)	Nuts/lb.	Kernel %	N (%)	P (%)	K (%)
4 oz/ June	32.45	45.15	52.28	2.02	0.13	1.05
8 oz/ June	28.93	43.77	52.58	2.06	0.12	0.96
4 oz/ August	33.02	48.77	51.40	2.10	0.12	0.99
8 oz/ August	40.24	45.00	52.52	2.05	0.12	0.97
Mech. mowing	41.08	46.43	52.08	2.22	0.12	1.03
No mowing	34.78	46.72	53.73	2.03	0.12	0.95

TABLE 2. COST COMPARISON OF MOWING TREATMENTS

	No. of treatments (June-Oct.)			Cost per acre of treatment[1]			
	Chem. 4	Chem. 8	Mech.	Chem. 4	Chem. 8	Mech.	Total cost/acre
June/ 4oz	3	0	1	$4.32	$5.70	$6.62	$19.58
June/ 8oz	0	3	1	$4.32	$5.70	$6.62	$23.71
Aug/ 4 oz	1	0	5	$4.32	$5.70	$6.62	$37.42
Aug/ 8 oz	0	1	5	$4.32	$5.70	$6.62	$38.80
Mech.	0	0	8	$4.32	$5.70	$6.62	$52.96
No mowing	0	0	0	$4.32	$5.70	$6.62	0

[1]These cost per acre values are based on the following assumptions: labor cost per hour-$7.50; spray application cost per acre–$2.95; Roundup cost per gallon–$44; and mowing cost per acre–$6.62.

Both chemical mowing rates applied on June 1 required two additional applications through the season (July 11 and Sept. 6) to control grass growth. Total elimination of growth was not achieved with either rate, and plots needed a single mechanical mowing treatment on July 30. Single applications of both rates on Aug. 10 did not require additional treatments to control grass growth up to harvest, and saved three mechanical mowings.

The 8-oz. rate of Roundup Ultra caused excessive dead patches in this orchard, because of the variable sensitivity of the mixed grass species to glyphosate. This could vary among orchards, and is affected by the sod stand composition and level of shading on the orchard floor. Grasses growing on a shaded orchard floor have a lower tolerance for herbicide exposure. The 8-oz. per acre rate could be beneficial in some situations, where undesirable grasses, such as bahiagrass could be selectively eliminated from the sod stand in favor of bermudagrass.

Mowing treatments did not affect tree nutrient levels, nut size, percent kernel, or yield in this study in 1996 (Table 1). The percent kernel values were numerically highest in the control treatment that had no mowing of the row middles from June to October. Rainfall was not limiting in 1996. The economic comparison (Table 2) shows that chemical mowing offers growers a definite reduction in annual production costs.

Effect of Trap Design on Capture of Pecan Nut Casebearer Moths

MONTE NESBITT AND JOHN MCVAY

Pecan nut casebearer (PNCB) is an unpredictable nut feeding pest of pecans in Alabama. In 1996, PNCB damage in Alabama pecan orchards was widespread and severe, causing crop loss of 25-45% in some cases. In most years, this pest is unpredictable and damage may be light or confined to isolated areas. PNCB has several generations per year, but usually the first summer generation (occurring in May) is the only economic threat. Effective control of first generation PNCB requires diligent scouting to determine if and when insecticides should be applied. A pheromone has been recently developed that effectively lures male PNCB moths, and gives growers a tool to aid in scouting.

Four pheromone trap designs were compared in 1997 with the objective of identifying the best design for capturing PNCB moths. The test was conducted in a commercial pecan orchard near Fairhope. The four trap types were commercial products from TRECE Inc. (Salinas, CA): (1) Pherocon III-D, (2) Pherocon 1-C Wing Trap, (3) Pherocon II, and (4) Pherocon II-B. Traps were hung on a low-hanging, nut bearing terminal branch. One

pheromone lure was placed in each trap, and lures were replaced at 14-day intervals. One trap was placed per tree, and trees within blocks were the same variety, similar in size, and no farther than 150 feet apart. There were 10 replications of each treatment. The traps were placed in the orchard on April 22, 1997, and monitored every two to three days for 30 days.

The first PNCB moth was captured on April 24. The highest moth capture was on May 5, with a second peak capture on May 12. Previous studies with the trap suggests that moth captures occur 10-14 days prior to first significant nut entry by first summer generation larvae. In this study, nut entry was observed in the orchard as early as May 7, with peak nut damage observed on May 21. The Pherocon 1-C Wing Trap had a significantly higher capture of moths than the other three trap types. Trap captures were low compared to captures in the same orchard in 1995 and 1996, but nut damage from the pest was also lower. Use of the pheromone can provide growers with a better understanding of when to scout orchards for PNCB. Use of the Pherocon 1-C Wing Trap may improve moth capture, and would be especially beneficial if a low number of traps are deployed in an orchard.

Average Total Capture of Pecan Nut Casebearer Moths

Pherocon 1-C	10.4
Pherocon II	2.7
Pherocon II-B	4.5
Pherocon III-D	3.4

Yield of Microsprinkler Irrigated Satsumas in a Freeze Year

Monte Nesbitt, Ron McDaniel, and Bill Dozier, Jr.

A single freeze event can be a major setback to satsuma production. If the canopy of a satsuma tree is frozen, production may be lost for four to five years while the canopy regrows. The recent frequency of freezes in Alabama has impaired attempts to establish markets for this high quality fruit. Microsprinklers have been used successfully in other regions to protect tropical and subtropical fruits from frost and freeze, and could provide growers with a means to reestablish the satsuma industry in southern Alabama.

A test was initiated at the Gulf Coast Substation in Fairhope to compare placement and flow rates of microsprinklers in Owari satsumas for freeze protection. Budded trees were planted in March 1990. Tree spacing was 15 feet x 25 feet. Seven treatments were applied including: control with no protection, control with typical soil banking around the crown of the tree, low volume (11 gph) microsprinkler placed on ground under tree, high volume microsprinkler (24 gph) placed on ground under tree, high volume microsprinkler placed in canopy, high volume microsprinkler placed in canopy with low volume microsprinkler on ground, and high volume microsprinkler placed in canopy with high volume microsprinkler on ground. No significantly damaging frost or freeze events occurred until 1996.

On Feb. 2, 1996, an advective freeze occurred at the Gulf Coast Substation. No buds, blooms, or fruit were present. The lowest recorded temperature was 15°F. Temperatures ranged from 15°F to 34°F for a period of 85 hours. Irrigation was activated when temperatures dropped to 33°F, and ran continuously for 87 hours. A second significant freeze event occurred on March 8, 1996, with nightly low temperatures ranging from 27 to 32°F over a four-day period. During this freeze, irrigation was applied at night, because daytime temperatures were well above freezing.

As reported last year, high volume microsprinkler treatments significantly decreased loss of foliage during the 1996 freezes. The best treatment was two 24 gph sprinklers; one placed in the center of the canopy and one under the tree. Trees under all treatments had moderate shoot/stem dieback in the outer periphery of the canopy. Control trees rebounded with new leaves and shoots as did the trees with microsprinklers. It is believed that temperatures were elevated across the entire test plot by the microsprinklers, which helped the unprotected trees. (Unprotected trees in another

Average Yield and Fruit Number of Owari Satsumas for Each Treatment in 1996

Treatment	Avg.yield/tree (lb.)	Avg. marketable yield/tree (lb.)	Fruit/tree (#)
Control (no protection)	0.27	0.75	3.2
Control (banked)	3.47	0.17	0.2
11 gph ground	3.47	2.14	9.2
24 gph ground	3.78	1.61	8.8
24 gph canopy	8.68	5.06	21.8
24 gph canopy/11 gph ground	8.22	2.97	20.4
24 gph canopy/24 gph ground	12.25	7.17	31.2

orchard on the substation had a much higher loss of major limbs.).

Fruit were harvested from the experimental plot on Nov. 26, 1996. Trees without irrigation produced only one to three fruit per tree, while irrigated trees produced as much as 31 fruit per tree. There was a moderate amount of hard-fleshed unmarketable fruit in each treatment. While the marketable yield in the best treatment is low, it does demonstrate that trees can be kept in production using microsprinkler protection. Freezes occurred in mid January 1997 with low temperatures ranging from 23-30°F and microsprinkler treatments were again applied. All treatments incurred some foliage loss, and all treatments set a large crop of fruit. Yield comparisons will be continued.

A Desiccating Surfactant for Thinning Peach Blossoms

Bob Ebel, Arnold Caylor, Jim Pitts, and David Himelrick

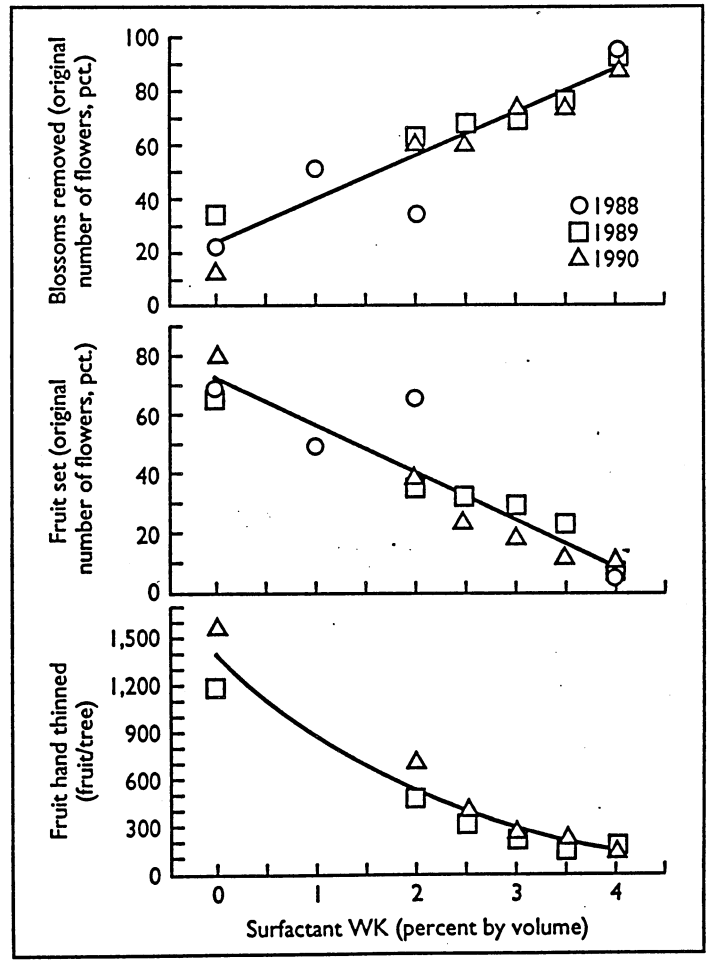
Peach trees normally set too many fruit for optimum size at harvest. Hand-thinning is expensive and commercial chemical thinners currently used are not reliable. In the late 1980s, preliminary studies were conducted on peach to identify alternative chemical thinning agents for use during bloom. From these studies, a product called Surfactant WK was found to be effective.

Following our preliminary trial a more thorough three-year test of Surfactant WK was conducted at the Chilton Area Horticulture Substation. Various concentrations of Surfactant WK were sprayed during full bloom on Harvester peach trees. Blossoms died rapidly so that within two days dead blossoms could be distinguished easily from live blossoms or fruit set. The extent of thinning was proportional to the amount of surfactant applied (see figure). The percent of blossoms killed and fruit set were similar over the three-year trial indicating the reliability of thinning. After treatment, all trees were hand-thinned to equalize crop load across all treatments. Twice as much or more fruit had to be hand-thinned from the untreated controls than chemically thinned trees. Surfactant WK did not reduce fruit weight, yield, or fruit quality at harvest.

The highest concentrations (3.5 and 4.0%) are not recommended for use because they over-thinned blossoms in the center of branches and caused some limb injury. The moderate concentrations of Surfactant WK (1.5 to 2.5%) provided the best distribution of fruit along the branches and did not damage the limbs.

Studies conducted in Virginia using Surfactant WK showed excessive damage to limbs at a concentration of 2.0%. We do not know why there was less limb injury at 2.0% concentration in our studies than the studies conducted in Virginia, however, we believe the reason may be due to faster drying times in Alabama than in the cooler climate of Virginia. We sprayed our trees in mid to late morning when air temperatures were between 75 and 85°F.

Based on the effectiveness, consistency, and lack of phytotoxicity at moderate concentrations, Surfactant WK has



Effectiveness of Surfactant WK on thinning Harvester peach blossom and fruit set, and the amount of handthinning necessary to equalize croploads across treatments.

potential as a valuable chemical thinner of peach blossoms in Alabama. More research needs to be conducted to determine conditions that cause limb injury. Although the Dupont deNemours & Co., Inc., no longer markets Surfactant WK, the Gowan Company (Yuma, AR) has recently expressed interest in seeking a label for this chemical. Surfactant WK is currently not registered for this use.

Performance of Peach and Nectarine Cultivars in the Gulf Coast Area

Bob Ebel, Monte Nesbitt, Bill Dozier, Jr., Arnold Caylor, Arlie Powell, Ron McDaniel, and Dick Okie

Many of the peach and nectarine cultivars grown in the central and northern areas of Alabama will not perform satisfactorily in the Gulf Coast area because of low accumulation of chilling hours. Test plantings were established in 1979 and 1985 at the Gulf Coast Substation in Fairhope to determine varieties that would perform satisfactorily in this low-chilling region. Only peach and nectarine varieties with low to moderate chilling requirements were selected for testing. Thirteen nectarine and 42 peach varieties were selected for the 1979 test, and 13 nectarine and 40 peach varieties were selected for the 1985 test.

Performance was evaluated based on harvest date, number of years blossoms were frozen out, number of years the chilling requirement was met, yield, and fruit quality. Fruit quality measurements included overall attractiveness, skin and flesh color, firmness, stone freeness, dessert quality (based on sweetness, acidity, and astringency), fruit shape (especially incidence of enlarged sutures and prominence of tips), and the number of split pits. The best performing peach and nectarine varieties and some of their characteristics are listed in the table. Fruit of the best performing varieties had acceptable to excellent appearance and flavor in most years.

Performance of low-chilling peach and nectarine varieties at the Gulf Coast Station

				Fruit quality						
	Bloom date	Harvest date	Yield	Fruit Size	Pubescence[1]	Skin color rating[2]	Firmness	Stone freeness[3]	Flesh color	Split pits
			lb./tree	*in.*			*lb.*			%
Peach varieties										
Flordaking	201-227	426-513	126	2.8	3.7	5.5	8.7	1.3	yellow	80
Sunbrite	301-331	508-601	68	2.4	3.2	8.9	8.7	1.9	yellow	23
Suzi Q	219-323	508-601	91	2.3	3.8	8.8	8.2	1.0	yellow	21
Starlite	219-323	508-606	125	2.6	4.9	6.2	8.9	1.4	yellow	70
Texstar	212-309	508-610	166	2.4	3.8	5.9	8.2	4.4	yellow	12
Bicentennial	301-411	521-610	96	2.2	4.3	6.8	7.5	1.4	yellow	1
June Gold	223-323	521-610	128	2.6	4.1	6.9	8.1	1.0	yellow	62
Magnolia	223-331	528-604	70	2.4	5.1	8.1	6.9	3.5	yellow	11
Rio Grande	209-304	531-623	105	2.7	5.4	6.7	8.9	7.4	yellow	23
Idlewild	214-323	601-622	95	2.6	4.1	6.0	8.7	5.6	yellow	9
Brighton	301-331	606-622	83	2.5	3.5	7.1	8.0	9.6	yellow	10
Flavorcrest	301-405	607-623	116	2.5	4.3	8.6	9.1	7.9	yellow	8
Sam Houston	223-323	607-629	95	2.6	3.2	8.1	9.0	9.4	yellow	1
La Feliciana	212-313	607-707	105	2.7	5.1	5.4	8.3	9.8	yellow	0
Sunland	301-331	613-713	121	2.7	4.9	7.1	8.7	8.2	yellow	8
Nectarine varieties										
Sunlite	207-310	528-620	112	2.3	1.0	8.3	8.4	9.6	yellow	3
Carolina Red	309-411	531-618	83	2.1	1.0	9.3	9.0	2.6	yellow	15
Karla Rose	307-321	608-629	95	2.4	1.0	8.4	9.0	7.6	white	31
Roseprincess	318-328	621-702	71	2.4	1.0	7.9	8.8	7.7	white	10

[1] "1"=none, "10"=fuzzy
[2] "1"=poor, "10"=excellent
[3] "1"=cling, "10"=free

Evaluation of the Systemic Insecticide Marathon for Tomato and Cucumber in Research Greenhouses

Byron Wallace, Bob Ebel, and Charles Elkins

Marathon (Bayer Corporation, Agriculture Division, Kansas City, MO) is a systemic insecticide containing imidacloprid as the active ingredient. Imidacloprid provides prolonged protection from many insects. It belongs to a new chemical class, the chloronicotinyls, that exhibits a mode of action different from all other insecticides. Much is known about imidacloprid's efficacy towards insects but there is little information concerning its effects on plants.

Marathon is currently only labeled for ornamentals in greenhouses. Soon after it became available, we incorporated Marathon, the only imidacloprid formulation labeled for greenhouse use, into the insect control program that included crops other than ornamentals in the research greenhouses at the Plant Science Research Center (PSRC) at Auburn University. In 1996 we observed necrotic leaf tissue on tomato, Irish potato, and bell pepper and suspected that Marathon was phytotoxic to these plants.

Two experiments were conducted on cucumber and tomato in a greenhouse at the PSRC to determine if Marathon was phytotoxic to these plants, especially at the rate currently recommended for ornamentals. Tomato and cucumber were grown in Pro-Mix BX in 4.5-inch pots. Five days after transplanting tomatoes and when the first primary leaves were fully expanded on cucumbers, Marathon was applied at 0, 0.5, 1, 2, 3, and 4 times the label rate of 0.25 teaspoon for a 4.5-inch pot. Leaf chlorophyll content was measured periodically with a Minolta Chlorophyll Meter and marginal necrosis was visually rated on cucumber using a 0 to 5 (none to severe) scale. The plants were harvested seven and 11 days after treatment for tomato and cucumber, respectively, and total leaf area and undamaged leaf area were measured.

The Effect of Varying Rates of Marathon on Greenhouse-Grown Cucumber and Tomato

Fraction of recommended rate of Imidaclorprid	Chlorophyll readings				Damage rating	Shoot dry weight	Total leaf area	Undamaged leaf area
	First primary leaf		Second primary leaf					
						g	cm^2	% of total
Cucumber	7 DAT	11 DAT	7 DAT	11 DAT				
0 x	47	45	50	57	0.0	30.4	1019	100
1/2 x	46	40	50	46	1.0	29.5	1072	96
1 x	41	36	45	38	2.1	30.1	1015	95
2 x	40	30	43	36	2.9	28.2	975	93
3 x	35	24	39	30	4.3	28.7	903	90
4 x	31	16	35	28	4.8	27.7	868	85
Tomato	5 DAT	7 DAT						
0 x	41	42	—	—	—	14.9	1102	100
1/2 x	39	40	—	—	—	18.2	1178	98
1 x	37	38	—	—	—	12.7	1090	95
2 x	37	37	—	—	—	12.8	1086	93
3 x	36	35	—	—	—	12.1	889	86
4 x	35	32	—	—	—	9.6	790	86

Yellow and brown leaf tips and margins appeared on cucumber and tomato in less than one week after Marathon application and visual ratings showed an increase in damage at higher rates of Marathon applied to cucumber. The severity of marginal leaf and interveinal necrosis increased on the older leaves of tomato and cucumber until plants were harvested. Five days after application to tomato and seven days after application to cucumber the recommended rate of Marathon for a 4.5-inch pot caused a reduction in leaf chlorophyll.

We concluded from these experiments that in our research greenhouse environment we should not use Marathon on tomato and cucumber at the rate recommended for ornamentals, and from previous observations that we should not use it on Irish potato or bell pepper. Others using imidacloprid formulations should be aware of the possibility of phytotoxicity on these plants. To date, we have not observed phytotoxicity of Marathon on plants for which it is labeled.

Survey of Irish Potatoes for Viral Diseases

JOHN MURPHY, EDWARD SIKORA, STEVEN SLACK, AND LEWIS TAPLEY

Irish potato production is one of the largest vegetable industries in Alabama. Production is centered in Baldwin, Cullman, Dekalb, and Jackson counties. Viral diseases are a constant threat to Alabama vegetable production. For example, the fresh-market tomato industry in North Alabama has sustained severe losses from a cucumber mosaic virus epidemic. No information is available, however, on viruses infecting Irish potato in Alabama. Potato is generally susceptible to many of the viruses commonly identified in other vegetable crops grown in Alabama. Those counties in the northeastern part of the state in which potato is heavily cultivated (Jackson, Cullman, and Dekalb counties) are in close proximity to the epicenter of the virus epidemic in tomato (Blount and St. Clair counties).

We were interested in determining if any plant viruses, particularly three of the viruses [cucumber mosaic virus (CMV), potato virus Y (PVY), and tobacco etch virus (TEV)] identified in the tomato epidemic, might occur in Irish potato crops grown in Alabama. All three viruses are known to infect potato; however, CMV and TEV are rarely detected in commercial potato plantings. Furthermore, since Irish potato represents an early season vegetable crop, determination of virus incidence with respect to field location might identify sources of viral inoculum for vegetable crops grown later in the season.

Commercial potato fields in Baldwin, Dekalb, and Jackson counties were surveyed for plants expressing virus-like symptoms. Samples were collected and tested for the presence of virus infection. Twenty samples, consisting of at least three young leaves selected from a single plant, were collected from the center two acres of each field and each sample was tested by ELISA for the presence of CMV, potato virus A (PVA), potato virus M (PVM), potato virus X (VX), potato virus S (PVS), potato virus Y (PVY), potato leafroll virus (PLRV), and TEV.

Virus-like symptoms varied with location and potato cultivar. There were more plants expressing viral symptoms in Baldwin County than in Dekalb or Jackson counties. Potato plants at the Gulf Coast Substation in Fairhope (Baldwin County) were the most severely affected by virus; most plants were severely stunted with deformed leaves. Potato plants in most other fields in Baldwin, and especially, Dekalb and Jackson counties were in good condition. Plants in these fields expressed viral symptoms infrequently with a random distribution throughout the field.

PLANT VIRUSES AND ASSOCIATED FOLIAR SYMPTOMS IN IRISH POTATO SAMPLES COLLECTED FROM BALDWIN, DEKALB, AND JACKSON COUNTIES

Virus	Symptoms
Potato leafroll virus	curled/rolling, reddish color
Potato virus A	mosaic (light and dark green areas)
Potato virus X	blistered surface and mosaic
Potato virus S	no symptoms to mild mosaic
Potato virus Y	blistered surface and mosaic

The viruses identified and their associated symptoms are listed in the table. Four of the viruses were detected in samples collected from Baldwin County: PLRV, PVS, PVX, and PVY. Samples from Dekalb and Jackson counties contained PVA, PVS, PVX, and PVY. CMV, PVM, and TEV were not detected in any samples. These results show that potato probably does not serve as a source of CMV or TEV inoculum for vegetable crops, such as tomato and pepper, that are grown later in the season. CMV has a very broad natural host range and is transmitted by many aphid species; the lack of detection of this virus may stem from the early season cultivation of potato, i.e., aphid vectors probably are not active early in the season. However, PLRV and potato viruses A, S, and Y are all transmitted from one plant to another by aphid vectors and each was detected in potato samples. We did not observe aphid populations in any of the potato fields surveyed suggesting that the viruses that were detected may have originated from the potato seed.

Decreased Incidence of Cucumber Mosaic Virus in Tomatoes in North Alabama

MAHEFATIANA ANDRIANIFAHANANA, EDWARD SIKORA, AND JOHN MURPHY

Since 1992, there has been a cucumber mosaic virus (CMV) epidemic in fresh-market tomatoes in some counties in North Alabama, resulting in crop yield reductions of approximately 20-25% per year. Each year, these CMV outbreaks in tomato were preceded by enormous increases in aphid populations, consisting primarily of cotton aphids (*Aphis gossypii*). Coincidentally, cotton aphid populations have been high each summer in cotton-growing areas of the Tennessee Valley.

In North Alabama, tomatoes are commonly planted at two-week intervals from April through July. This practice is conducive to the establishment and spread of CMV within the cropping system as it provides a continuous source of young, susceptible plants throughout the season. Management of CMV in tomato, or for that matter any crop, is difficult because of the broad natural host range of the virus, which includes many vegetable crops and weeds. In addition, CMV is transmitted in a non-persistent manner (rapid acquisition and transmission of the virus) by a large number of aphids. This situation may have contributed to the persistence of the virus in the area over years.

Through the implementation of the Southern Region Integrated Pest Management (SR-IPM) program, selected tomato fields in Blount and St. Clair counties were scouted for diseases and insects. One aspect of the program included monitoring of CMV through observation of symptoms and laboratory tests, and scouting for its aphid vectors throughout the season. In conjunction with the scouting program, an on-farm experiment was conducted in Blount County to identify the sources of CMV inoculum, to determine the correlation of CMV infection with the dynamics of aphid populations, and to correlate plant age at the time of infection with disease severity. Seven tomato settings were planted at two-week intervals from May 8 through July 29. Tomato plants were routinely checked for the presence of aphids and monitored for the development of CMV symptoms. Leaf samples were taken every two weeks and tested for the presence of CMV.

A number of fungal and bacterial diseases were identified through the scouting program. Diseases most commonly identified included late blight, gray mold, Septoria leaf spot, and bacterial spot and speck. Interestingly, in contrast to previous years, CMV was not observed in any of the fields scouted, and none of the tomato samples tested were positive for the presence of CMV. Aphid populations remained relatively low throughout the season although occasional increases in the number of aphids on plants were observed in late May and in late July, with no apparent effect on CMV incidence. CMV was detected in pepper plants from a nearby field, indicating the presence of the virus in the area, although the virus apparently did not spread into tomato fields. Also, there were reports of CMV incidence in neighboring tomato fields. It appears as though the unusually wet weather, which would have favored the development of fungal and bacterial diseases, may have prevented the build-up of aphid populations, thereby reducing the chances of establishment and/or spread of CMV within the tomato crop. Furthermore, the low aphid population observed in Blount and St. Clair counties may also have resulted from reduced aphid populations observed in the Tennessee Valley. Observations made within the past two years in cotton revealed the occurrence of a natural control of aphids by a parasitic fungus.

Although data showed a decrease in CMV incidence in tomatoes in 1997, which appears to be related to the lack of aphid population build-up, caution should be made as CMV outbreaks may resume if conditions favorable to the development and spread of the disease are met.

Comparison of Guardian to Other Peach Rootstocks for Use on Peach Tree Short Life Susceptible Sites

Bryan Wilkins, Bill Dozier, Jr., Bob Ebel, David Himelrick, Joe Eakes, Tom Beckman, Andy Nyczepir, and Jim Pitts

Peach tree short life complex (PTSL) is one of the most limiting factors in peach production in the Southeast, making an orchard non-profitable by the fourth or fifth year in the most severe instances. 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 growing season. The Guardian rootstock appears to be tolerant to ring nematodes but there is little data comparing its performance to other widely used rootstocks. The performance of 12 rootstocks, two standard (Lovell, Nemaguard), eight Guardian selections (BY 520-9) three of Guardian's sister lines (BY 520-8), and two others (Flordaguard, 14DR51) all grafted with Cresthaven were evaluated for three seasons in a field study at the Chilton Area Horticulture Substation in Clanton.

Although the results were variable, there were some differences in performance between the Guardian selections and the other rootstocks evaluated. Where different, some Guardian rootstock selections had lower vigor and smaller trunk cross sectional areas (TCAs) compared to other Guardian selections and the other rootstocks. In 1996 and 1997, SL 2170 had the highest photosynthetic rate of all rootstocks evaluated, was the most vigorous, and had the largest TCA, but had one of the poorest yields of any rootstock. Yield was highest for SL 1923 and fruit size was adequate, but it also had the lowest survival rate of any rootstock tested. Fruit weight was similar among all rootstocks. Fruit from trees on Lovell and Nemaguard tended to have the least amount of red flesh color and Flordaguard the highest. Bud survival after the February 1996 freeze was highest with Lovell and SL 1923 and lowest for Nemaguard and several of the Guardian selections. Where different, percentage of tree mortality was greater in two of the three BY 520-8 selections than the other rootstocks evaluated.

The threshold level for ring nematode in an Alabama peach orchard is 50 nematodes per 100cc of soil. There were no significant numbers of ring nematodes present when this study began but by the third year of the study they were found throughout the orchard in significant concentrations. SL 1923 had the highest population density of ring nematodes, (512 nematodes per 100cc of soil), where the 14DR51 selection had the least amount with (87 nematodes per 100cc of soil). Lovell, the standard rootstock, harbored 96 nematodes per 100cc of soil. The data indicate that most of the Guardian selections were able to tolerate the same or higher nematode populations and perform similar to or better than the standard rootstocks.

Comparison of Guardian Rootstock Selections to Other Peach Rootstocks

	Tree vigor rating	Trunk cross sectional area	Photosynthesis		Yield	Fruit weight	Fruit color	Bud survival after early Feb. freeze	Tree survival	Nematode count
	1995	1995	1996	1997	1997	1997	1997	1996	1996	1997
		$in.^2$	$\gamma moles\ CO_2/m^2/sec.$		lb./tree	lb.	%	%	%	no./100 cc
Standard rootstocks										
Lovell	3.8	5.0	11.8	14.5	102	0.381	56	21	100	96
Nemaguard	3.3	4.7	13.6	14.7	73	0.399	59	13	100	229
Miscellaneous rootstocks										
Flordaguard	3.8	5.1	10.8	14.9	118	0.392	70	17	100	88
14DR51	3.1	4.7	12.1	14.5	97	0.350	63	19	98	87
Guardian rootstock selections										
BY520-9 selections										
SL1089	3.6	4.9	10.3	14.0	118	0.394	69	15	100	96
SL1090	3.1	4.7	13.3	14.8	97	0.388	58	13	98	123
SL2165	3.1	4.0	12.4	14.3	108	0.427	72	11	100	491
SL2170	3.6	5.3	14.0	15.9	82	0.419	61	17	97	187
SL3576	3.2	4.2	10.9	12.9	124	0.368	69	12	94	477
BY520-8 selections										
SL1923	3.3	4.2	9.8	14.4	177	0.394	63	20	88	512
SL2243	3.4	4.5	11.5	15.1	106	0.410	57	14	97	382
SL4028	2.9	3.4	12.7	14.8	128	0.407	59	14	86	261

Appearance and Performance of Selected Irish Potatoes in North Alabama

JOE KEMBLE, ERIC SIMONNE, ARNOLD CAYLOR, AND TONY DAWKINS

The Alabama Irish potato industry has changed a great deal over the past 10 years. Over 13,000 acres of Irish potatoes were produced in 1997. In past years, most of this production was grown for processing, but now, most of the acreage is devoted to production for the fresh-market (table stock). New research initiatives are underway to identify varieties that perform well in Alabama and are acceptable to retailers and consumers. Most of the acreage of Irish potato is grown without the benefit of irrigation, but it is likely that they would gain from it. Research is being conducted to demonstrate the benefit of supplemental irrigation for the production of Irish potatoes.

Cooperative research projects with the Irish potato breeding programs in North Dakota, Idaho, Oregon, Wisconsin, Minnesota, and the USDA are underway to evaluate selected Irish potatoes from these programs under Alabama's growing conditions. Thirteen varieties were grown at two locations (see table), North Alabama Horticulture Substation (NAHS) in Cullman and at Sand Mountain Substation (SMS) in Crossville. Seed pieces were planted in April and harvested in July. All the varieties in these trials were red-skinned potatoes with white interior flesh with the exception of Yukon Gold, which has yellow skin and a yellow interior flesh color.

Overall yields were greater at SMS than at NAHS (see table). At NAHS, weather adversely affected the crop. Excessive rains and cloudy weather contributed to early decline of plant foliage limiting tuber production. Yields were often half of those produced at SMS. At SMS, COO 86107-1, ND 2225, and Red LaRouge produced the highest marketable yields compared to the other red-skinned entries. At NAHS, ND 2225, Red LaSoda, Ida Rose, and LaRouge produced the highest total marketable yields compared to the other red-skinned varieties. At both locations, most varieties produced higher percentage of Grade A sized potatoes than Grade B.

IRISH POTATO YIELDS FROM NORTH ALABAMA HORTICULTURE SUBSTATION (NAHS) AND SAND MOUNTAIN SUBSTATION (SMS) IN 1996

Variety	U.S. A (CWT/acre)		U.S. B (CWT/acre)		Cull (CWT/acre)		Total marketable (CWT/acre)	
	NAHS	SMS	NAHS	SMS	NAHS	SMS	NAHS	MS
Red LaSoda	93.99	48.77	44.93	48.31	39.98	N/A	152.94	107.42
LaRouge	89.78	107.50	34.56	45.97	33.59	N/A	132.95	160.78
Ida Rose	78.80	45.74	52.58	24.50	22.23	N/A	150.20	74.99
ND 5084-3R	68.18	81.13	33.05	51.96	56.12	N/A	110.58	141.96
Red Norland	63.30	84.94	15.74	37.57	2.47	N/A	82.18	128.19
Yukon Gold	59.75	100.35	29.46	26.45	6.59	N/A	99.69	131.15
ND 2225	55.56	130.21	80.13	36.25	1.52	N/A	160.55	171.29
NorDonna	49.95	107.43	43.34	40.92	3.20	N/A	110.18	154.25
NDO 2438-6	49.46	56.47	44.74	36.64	11.35	N/A	109.70	102.91
MN 17572	41.00	107.97	49.88	30.42	10.95	N/A	108.72	141.65
NDO 2686-6	35.86	123.60	33.19	28.94	2.83	N/A	78.60	157.52
COO 86107-1	31.55	158.84	28.65	40.29	8.22	N/A	70.66	204.89
Red Ruby	26.62	88.29	37.44	46.52	25.96	N/A	87.74	148.34

Profitable Crop for Alabama–Asparagus

JOE KEMBLE, ERIC SIMONNE, JIM PITTS, JAMES BANNON, AND ARNOLD CAYLOR

There are many possibilities for growers in Alabama. Many small and part-time growers in Alabama who truck farm, have road-side stands, or sell their vegetable crops wholesale rely on more traditional vegetable crops, such as southernpeas, collards, and watermelons, for the bulk of their production and profit. Sometimes, a non-traditional approach can really pay off. Although not a traditional part of the southern diet, asparagus is becoming more common on dinner plates in Alabama. Presently, little is grown in Alabama. Most of the asparagus sold in Alabama is grown in California, Washington, Michigan, and various islands in the Caribbean. As well as being valuable from a nutritional standpoint, asparagus also demands a high wholesale price. Alabama's unique climate and growing areas should be well suited to in-state production.

In order to explore the feasibility of asparagus production in Alabama, three sites were selected to establish asparagus plantings

in 1995. Transplants of Jersey Giant, an all-male hybrid, were planted at the E.V. Smith Research Center in Shorter, at the Chilton Area Horticulture Substation in Clanton, and at the North Alabama Horticulture Substation in Cullman. Jersey Giant has shown good adaptation and consistent, high yields throughout many regions of the U.S. The term "all-male" refers to the fact that there are male and female asparagus plants. The female plants produce seeds, which can germinate forming volunteers and produce smaller spears than male plants. An all-male cultivar such as Jersey Giant is more tolerant of diseases and produces large, high quality spears. Once established, an asparagus planting can last more than 15 years if proper care is provided. It takes three seasons for the asparagus to become fully established. The AAES asparagus study will be ready for harvesting in late February and early March of 1998.

In other parts of the country where asparagus is grown, weeds tend to be the greatest production challenge. Initially, most of the AAES research will focus on weed control using more novel devices such as a flame-cultivator in combination with new herbicides to control weed problems. Research will also focus on the use of row covers to blanch (whiten) developing asparagus spears. Blanched asparagus commands a higher price in the fresh-market, but has a very limited market acceptance.

1997 has proven to be a difficult year for anyone growing vegetables or fruits. Early spring floods were quickly followed by a lengthy drought. Since asparagus is a deeply rooted crop, it required no additional water to keep it alive during the dry weather. Generally, asparagus only requires irrigation during its first year while it is becoming established. No major insect or disease problems were noted in 1997.

Small Potatoes Can Bring Big Returns

Joe Kemble, Eric Simonne, and Arnold Caylor

In the fresh-market, earliness brings the highest price and generally bigger is better. With Irish potatoes, however, earliness is important but also small size. Growers in Alabama are paid more for Grade B (1.5-inch minimum diameter to 2.25-inch maximum diameter) to size potatoes than they are for the larger Grade A (minimum diameter >17/8 inch) sized potatoes. These smaller potatoes often sold as "new potatoes" to restaurants and grocery store chains. Research conducted in 1997 revealed that by manipulating plant spacing (population density), a grower could increase the amount of Grade B potatoes.

Current production practices call for planting seed pieces 12 inches apart. This spacing produces 50 to 60% more Grade A potatoes compared to Grade B potatoes. Research was initiated in 1997 at the North Alabama Horticulture Substation in Cullman to see if we could increase the amount of Grade B potatoes by decreasing in-row spacing. In March, seed of LaRouge was planted into furrows at five different in-row spacings: 4-, 6-, 8-, 10-, and 12-inch in-row spacings. As a result the number of seed pieces increased as in-row spacing decreased. The closest spacing, four inches, required three times as many seed pieces as the 12-inch spacing. Tubers were dug in July.

Total marketable yield and Grade A potato yield did not differ between the five in-row spacings and averaged 255.1 CWT per acre and 150.6 CWT per acre, respectively. Cull yield also did not differ between the in-row spacings averaging only 2.8 CWT per acre. The percentage of Grade B potatoes produced increased as the in-row spacing decreased (see table). At the four-inch in-row spacing, over 50% of the total marketable yield was Grade B sized potatoes, while at the 12-inch in-row spacing (the conventional treatment) only 24.4% of the total marketable yield was Grade B sized potatoes. More of the potatoes at the 12-inch in-row spacing fell into the Grade A category.

So, by decreasing in-row spacing, growers can produce more Grade B sized potatoes. This however will require more seed (three times the amount at the four-inch in-row spacing) per acre. The increased seed cost would have to be offset by the 25% increase in the production of Grade B sized potatoes. This research will continue next year and include an economic analysis.

The Effect of In-Row Spacing on Yield Components of LaRouge Irish Potato

In-row spacing	Grade B	Total marketable yield[1]
in.	*CWT/acre*	%
4	131.44	51.5
6	94.67	37.1
8	83.51	32.7
10	71.30	29.9
12	62.29	24.4

[1] Percent Grade B is of total marketable yield.

Use of Various Mulch Colors to Enhance the Growth of Collards

JOE KEMBLE, JAMES BROWN, ERIC SIMONNE, AND JAMES BANNON

Black polyethylene mulches are commonly used to enhance the growth and earliness of many vegetable crops. Other colors have been employed when special needs arise such as the use of white plastic during the summer and silver or reflective mulch to deter insects. Recent research has shown the benefits of other colors such as red and blue colored mulch. Red colored mulch has been shown to increase marketable yields of fresh-market tomatoes in South Carolina, Tennessee, and Pennsylvania. Red mulch increases the yield of reproductive growth (fruit), while other colors, such as blue, seem to increase vegetative growth. If this is the case, a crop such as collards may benefit from production on other mulch colors such as blue. Collards are a high dollar crop in Alabama and the production of large, uniform, early heads can mean a substantial return for a grower.

Four-week-old Vates collards were transplanted in the fall 1996 and spring 1997 into raised, black plastic-covered beds on an 18-inch in-row spacing. The plastic mulch was sprayed with one of five different colors (red, blue, yellow, silver, white) of exterior oil-based enamel paint (two parts paint: one part paint thinner). Plots were also left black (unpainted) or the plastic mulch was removed to simulate bare ground production. Four weeks after transplanting in the fall and six weeks after transplanting in the spring, a final harvest was done.

In both years, yields on bare ground were lower than those of any other treatment (see table). In the fall test, total marketable yields did not differ between any of the mulch treatments, but were all greater than that of the bare ground treatment (see table). In the spring test, total marketable yields were greatest for the black and white mulch treatments compared to the other mulch treatments. Average head weight was lower in the spring test as compared to the fall test.

TOTAL MARKETABLE YIELD AND AVERAGE INDIVIDUAL HEAD WEIGHT OF VATES COLLARDS IN FALL 1996 AND SPRING 1997

	Total marketable yield		Avg. head weight	
Treatment	Fall 1996	Spring 1997	Fall 1996	Spring 1997
	lb./acre	*lb./acre*	*lb.*	*lb.*
Black	5,016	12,506	3.0	2.2
White	5,259	9,991	3.2	1.7
Blue	4,849	9,355	2.9	1.6
Yellow	4,974	8,900	3.0	1.5
Red	5,229	8,888	3.2	1.5
Silver	5,354	7,475	3.2	1.3
Bare	4,096	2,336	2.5	0.4

It seems that mulch color may be more critical in the spring where the black plastic mulch treatment outyielded the other treatments producing the highest total marketable yield. In the fall, mulch color did not make as great an impact. One aspect of this research, however, is clear: the use of plastic mulches does result in greater total marketable yields and greater average head weight as compared to bare ground production. This research is continuing.

Mechanical Bloom Thinning as a Means to Reduce Amount of Hand Labor Needed to Thin Peaches

BOBBY BOOZER, BOB EBEL, AND JIM PITTS

Peach production in the Southeast is not highly mechanized, but relies primarily on hand labor. One area that has received much attention in reducing the amount of hand labor has been the area of fruit thinning. In 1995 a study was conducted to evaluate a mechanical rope thinning device (Phil Brown Welding Corp.) to remove blooms. The study was conducted in a grower's field utilizing Encore peaches. This study evaluated the effect of using the mechanical rope thinning equipment as a clockwise single pass (CSP), clockwise double pass (CDP), or a clockwise/counter clockwise double pass (CCDP) on bloom removal and affected positions within the fruiting canopy. A mechanical shaker was also used. Tractor speed was the same for all treatments, 1.5 miles per hour.

In 1997, a second study was conducted at the Chilton Area Horticulture Substation in a block of Fireprince peaches. Number of rotations and direction were the same as those used in the previous study, but ground speed was varied; one, two, and three miles per hour. In addition to varying ground speed, one treatment was made at shuck-off (1 mph - SO,CDP).

Speed affected the number of blooms removed, but the number of passes had a more significant effect (tables 1 and 2). Delaying thinning until shuck off, at a speed of one mile per hour and making two passes did as well as all treatments and better than the two-mile-per-hour and three-mile-per-hour-single-pass treatments. Limb breakage was not a problem either year.

Time required to hand thin was reduced by each of the mechanical rope thinning treatments, but was only significantly reduced by the two-mile-per-hour CCDP. Time required to hand thin control trees (hand thin only) averaged 14.7 minutes longer than the CCDP treatment and would require 35.5 man hours more per acre. At a cost of $5 per hour for labor, a gross savings of $177.50 per acre would be realized based on the cost difference in these two treatments. Using the rope thinner (CCDP) would cost approximately $30 per acre. The rope thinner could be paid for from its use in the first 30 acres.

TABLE 1. EFFECTS OF MECHANICAL ROPE THINNING IN ENCORE PEACHES—1995 STUDY

Treatment	Blooms removed	Shoot position			
		Left	Right	High	Low
	%	*no. of blooms removed*			
CCDP	57	15	15	17	13
CDP	55	12	15	15	12
CSP	42	9	13	11	10
MS[1]	73	18	17	15	20

[1]MS = mechanical shaker used 48 days after bloom.

TABLE 2. EFFECTS OF MECHANICAL ROPE THINNING IN FIREPRINCE PEACHES—1997 STUDY

Treatment	Blooms removed per shoot	Hand thinning time required	Total number harvested fruit per tree
	%	*min./tree*	
Hand thin only	–	35	764
1 mph - CSP	28	25	525
2 mph - CSP	23	30	631
3 mph - CSP	22	31	762
2 mph - CDP	38	30	654
2 mph - CCDP	36	20	504
1 mph - SO,CDP	41	25	568
MS[1]	–	–	375

[1]MS= mechanical shaker used 38 days after bloom

Reduction of Crop Density and Hand Labor Using Ralex in Harvester Peach

BOBBY BOOZER, BOB EBEL, AND JIM PITTS

Peach production requires immense hand labor to produce and market a crop. One large component of hand labor is fruit thinning. In order to reduce the amount of hand labor the use of chemical bloom thinners and mechanical bloom thinners have been utilized by many growers. Recently, a plant hormone was labeled (Ralex, GA_3) in California for reducing the number of flower buds that are initiated (formed) during the current growing season for fruit development the following season.

TABLE 1. EFFECT OF RALEX ON VARIOUS HORTICULTURAL ASPECTS OF HARVESTER PEACH

Treatment		Total number of fruit per tree	Total weight per tree	Average individual fruit weight	Hand thinning, time	Number of thinned fruit per tree	Individual weight of thinned fruit
Ralex conc.	Conc. water						
	vol./acre		*kg*	*g*	*min.*		*g*
0 ppm	–	777	94	121	38.6	77	6.0
50 ppm	150 gal	538	74	140	23.7	54	6.5
50 ppm	300 gal	380	57	155	15.7	37	6.1
50 ppm*	150 gal	385	60	161	18.3	42	6.7
50 ppm*	300 gal	282	49	175	10.6	28	7.8
50 ppm* + Ethrel	150 gal	266	41	159	8.4	29	3.6
150 ppm* + Ethrel	300 gal	279	45	161	9.6	21	3.4
100 ppm*	150 gal	349	56	161	17.1	34	7.2

*Indicates that Kinetic, a surfactant, was added.

To investigate the effectiveness of Ralex to reduce crop density in peaches, a study was initiated at the Chilton Area Horticulture Substation on Harvester peach. All Ralex treatments reduced the total number of harvested fruit significantly compared to trees receiving no Ralex. Time required to hand thin fruit (38 days after bloom) was also significantly lower where Ralex was used compared to no Ralex. Average fruit weight was significantly lower (smaller fruit) where no Ralex was applied compared to all Ralex treatments (Table 1.)

In the Southeast, the peach crop is often reduced or eliminated by freezes during bloom and early fruit development. High fruit bud numbers are considered advantageous going into winter. Reducing fruit bud numbers using a chemical such as Ralex prior to entering winter months could present a cropping consistency problem. To reduce the potential for additional fruit bud loss, two treatments using Ralex also received Ethrel, a chemical that increases bud hardiness and delays bloom by as much as 10 days, in mid November. Total fruit number did not differ from Ralex treatments receiving Ethrel compared to all other Ralex treatments. While damaging cold temperatures did not occur at this location, Ethrel did delay bloom as evidenced by significantly lower average fruit weight at time of hand thinning (Table 1.)

TABLE 2. DOLLARS PER ACRE BASED ON METHOD OF FRUIT THINNING AND COMBINED TOTAL COST PER ACRE

Treatment		Hand thinning	Ralex	Ethrel	Total
Ralex conc.	Conc. water				
	vol./acre	*dollars/acre*	*dollars/acre*	*dollars/acre*	*dollars/acre*
0 ppm		466	0	–	466
50 ppm	150 gal	286	338	–	624
50 ppm	300 gal	190	676	–	866
50 ppm[1]	150 gal	221	38	–	559
50 ppm[1]	300 gal	128	676	–	804
50 ppm[1]	150 gal	102	338	–	440
+ Ethrel				7	447[2]
150 ppm	300 gal	116	676	–	692
+ Ethrel				7	697[2]
100 ppm[1]	150 gal	207	676	–	883

[1]Indicates that Kinetic, a surfactant, was added.
[2]Total cost including Ethrel. Note: Ethrel is not presently labeled for peaches in Alabama.

Reduction of hand labor by the use of Ralex was demonstrated by the reduction in average time needed to hand thin fruit. Among other concerns growers have, is the cost per acre for the use of Ralex. Costs per acre were calculated based on the amount of time needed for hand thinning at a wage rate of $5 per hour, Ralex at $379 per quart and Ethrel at $53 per gallon (Table 2). These results are based on one year of data and will be repeated another two years before any recommendations can be made.

Fertigation of Peaches May Reduce Nitrogen Fertilization Requirements

BOBBY BOOZER, BOB EBEL, AND JIM PITTS

Irrigation is utilized in many peach orchards in Alabama solely for supplemental water during final fruit swell. In 1996, a study was initiated at the Chilton Area Horticulture Substation to determine the potential of applying nitrogen (N) via irrigation (fertigation) using micro spray and drip emitters compared to standard surface applied nitrogen. Fertilization consisted of surface applied calcium nitrate, 1N rate (2/3 spring, 1/3 fall and 1/3 spring, 2/3 fall) compared to 1/2N, 3/4N, and 1N micro spray, and 1N drip (Table 1). Rates of nitrogen used in 1996 and 1997 were 24 and 76 pounds, respectively (1N).

Fruit harvested during the 1997 growing season were counted, graded, and weighed. Total number of fruit from all treatments averaged 382 and were not significantly different from one another. Size and number of fruit in the upper three grade categories (2.75 inches, 3 inches, and larger than 3 inches) were not significantly different. Fruit firmness and soluble solids did not vary between treatments.

FERTILIZATION LEVELS OF NITROGEN TO HARVESTER PEACH, 1996 AND 1997

Treatment	Total pounds nitrogen/acre 1996	Total pounds nitrogen/acre 1997	Total number fruit harvested per tree in 1997	Average total fruit weight in 1997
				lb./tree
Surface				
2/3N	16	56 (86)[1]	400	125
1/3N	8	30		
Micro-spray				
1/2N	12	38 (68)	375	121
3/4N	18	57 (87)	406	127
1N	24	76 (106)	366	114
Drip				
3/4N	18	57 (87)	375	119
Surface				
1/3N	8	28 (58)	369	120
2/3N	16	30		

[1]"( )" = total for 1997, which includes a late summer application of approximately 30 pounds per acre inadvertently made to all plots

In 1996, no fruit were available for evaluation due to late spring freeze damage. Trunk diameter measurements were taken during the winter of 1995 and 1996 to evaluate tree growth as affected by treatments. Trees receiving fertigation of 1/2N rate had smaller trunk diameters than all other treatments except those receiving 1N rate split 1/3 in spring and 2/3 in fall.

This study will be continued for several years before any final conclusions are reached. If current trends continue, fertigation may be able to reduce the nitrogen input while maximizing production. This system also reduces the cost of a one-time nitrogen application made in a year when late spring freezes reduce the cropping potential to low levels. In those years, more fertilizer is supplied than is needed and excessive vegetative growth results. This system would provide a higher degree of nutrient management than is currently afforded by surface applications.

Evaluation of Kocide 2000 for Black Rot Control on Cabbage

EDWARD SIKORA, BOBBY BOOZER, AND JIM PITTS

Black rot, caused by the bacterium *Xanthomonas campestris*, is considered the most important disease affecting cabbage production in Alabama and the Southeast. It is not uncommon to lose an entire crop to black rot when weather conditions favor its development and spread. The best control for black rot would consist of growing a black rot-resistant variety on land that had not previously been in a Cruciferous (plant in the cabbage family - broccoli, collards, kale) crop for a minimum of two years. In situations where a black rot-susceptible variety is to be grown then the use of a copper-containing fungicide/bactericide is a grower's only alternative when attempting to control the disease. This study was initiated to evaluate the copper-containing material Kocide 2000 for black rot control on cabbage. Kocide 2000 was used alone at varying rates either weekly for the entire growing season or on an abbreviated three-week schedule. It was also evaluated as a tank-mix with the fungicide Manex to determine if combining these products would improve the efficacy of copper in controlling black rot.

The experiment was conducted at the Chilton Area Horticulture Substation during the spring 1997 using the black rot-susceptible cabbage variety Early Jersey Wakefield. Kocide 2000 treatments included the product at both 0.75- and 1.5-pound-per-acre rates applied on seven-day intervals, full season, or for the first three weeks after transplanting only. A tank-mix of Kocide 2000 (0.75 pound per acre) plus Manex (1.2 quarts per acre) was also evaluated following both the full season and abbreviated spray schedule. An unsprayed control treatment was also included to determine the severity of black rot at the location. Disease severity was determined on June 10 just prior to harvest using a 1 to 6 rating scale where "1" indicated no disease and "6" indicated that black rot lesions were visible on the head. Heads were also rated as being marketable or unmarketable based on the severity of black rot symptoms.

Weather conditions were cool and wet and favored black rot development. Black rot pressure was high based on the severity of the disease in the unsprayed control plots (5.1 average disease

KOCIDE 2000 EVALUATION TRIAL: DISEASE SEVERITY RATINGS AT HARVEST

Treatment (rate/acre)	Spray schedule[1]	Average disease severity rating[2]	Percent marketable heads
Unsprayed control	FS	5.1	44.8
Kocide 2000 (0.75 lb)	3-wk	4.3	82.3
Kocide 2000 (0.75 lb)	FS	3.3	96.4
Kocide 2000 (1.5 lb)	3-wk	4.2	85.2
Kocide 2000 (1.5 lb)	FS	3.3	87.5
Kocide 2000 (0.75 lb) + Manex (1.2 qt)	3-wk	4.6	73.9
Kocide 2000 (0.75 lb) + Manex (1.2 qt)	FS	3.6	84.0

[1]Spray schedule was either every seven days, full season (FS), or every seven days for the first three weeks after transplanting only (3-wk).

[2]A 1-6 rating scale was used to measure disease severity with 1 = no disease; 2 = small lesions (<1 inch diameter) on outer leaves; 3 = large lesions (1 inch diameter) on outer leaves; 4 = small lesions on outer and wrapper leaves; 5 = large lesions on outer and wrapper leaves; and 6 = lesions on head.

severity rating). Black rot was most severe and fewer heads were considered marketable (44.8%) in the unsprayed control treatment compared to those treated with Kocide 2000 or the Kocide 2000/Manex tank-mix. The low rate of Kocide 2000 (0.75 pound per acre) alone, used full season, produced the most marketable heads (96.4%). In all cases, disease severity was lower with the full season spray programs compared to the abbreviated programs regardless of products or rate used. However, the abbreviated program produced significantly more marketable heads and had significantly less disease compared to the unsprayed control. Tank-mixing Manex with Kocide 2000 did not improve the efficacy of copper in controlling black rot.

Based on this preliminary study, it would appear that Kocide 2000 used alone at either the low or high rate will control black rot when used full season. Kocide 2000 should be considered by Alabama growers considering growing a cabbage variety that is susceptible to black rot especially when weather conditions favor development of the disease.

Evaluation of Abound for Peach Scab and Brown Rot Control on Peaches

EDWARD SIKORA, BOBBY BOOZER, AND JIM PITTS

Peach scab and brown rot (blossom blight and fruit rot) are two common diseases that limit peach production in Alabama. In 1997, an experiment was conducted to evaluate a newly registered fungicide product Abound developed by Zeneca for control of peach scab and brown rot.

The experiment was conducted at the Chilton Area Horticulture Substation near Clanton on the cultivar Alred Elberta. Treatments were replicated five times with three trees per replicate in a randomized complete block design. Fungicides were applied using an air blast sprayer at 100 GPA. Bloom spray treatments were applied on March 19 and 25 and April 7 and 21. Cover sprays for all treatments (except the unsprayed control) consisted of sulfur at nine pounds per acre and were applied on April 29, May 5 and 21, June 2 and 19, and July 2. Preharvest spray treatments were applied on July 8 and 15. Fruit were harvested on July 21. Samples of 30 fruit were picked from the center tree of each replicate. These fruit were rated for percent scab incidence at harvest and percent brown rot seven days after harvest after storage at 77°F.

EFFECT OF BLOOM AND PREHARVEST APPLICATIONS OF ABOUND ON PEACH SCAB AND BROWN ROT

Bloom treatments/ Preharvest treatment	Fruit with scab	Scab severity[2]	Brown rot
rate/acre[1]	%		%
Unsprayed control/ Unsprayed control	98.3	4.2	74.1
Bravo 720 (4 pt)/ Orbit 4 (oz)	35.0	2.0	5.7
Abound 2SC (0.10 lb ai)/ Abound 2SC (0.15 lb ai)	70.0	2.9	0.6
Abound 2SC (0.15 lb ai)/ Abound 2SC (0.175 lb ai)	64.1	2.7	0.2
Abound 2SC (0.20 lb ai)/ Abound 2SC (0.20 lb ai)	48.6	2.1	40.6
Abound 2SC (0.25 lb ai)/ Abound 2SC (0.25 lb ai)	7.3	2.0	44.0

[1]All treatments were sprayed with sulfur during the cover period with the exception of the unsprayed control.
[2]Scab rating was on a 0-5 scale with a rating of 3.5 or higher considered unmarketable.

The weather conditions in 1997 were warm and wet favoring disease development. Brown rot blossom blight incidence in the orchard was extremely low so disease ratings for this disorder were not taken. Peach scab pressure was high and differences among bloom treatments were observed. The Bravo 720 and the two high rates of Abound provided the best control of scab. The two low rates of Abound provided better scab control then the unsprayed control but was not as effective as the two high rates of Abound or Bravo 720. All treatments produced marketable fruit with the exception of the unsprayed control.

Incidence of brown rot fruit rot was high as noted on the unsprayed control (74.1% disease). There was no significant difference among the varying rates of Abound. All performed equally well to the grower standard (Orbit, four ounces per acre). Based on these results it would appear that Abound applied at the higher rates during the bloom period provides scab control similar to Bravo 720. It would also appear that the low rate of Abound would work as well as Orbit for brown rot control.

Evaluation of Fungicide Spray Programs for Peach Scab and Brown Rot Control on Peaches

EDWARD SIKORA, BOBBY BOOZER, 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. Growers should be aware that overuse or abuse of a fungicide can lead to development of fungal strains resistant to that fungicide, as well as all other fungicides within its class.

Peach producers in Alabama commonly use sulfur as part of their fungicide spray program. Its is relatively cheap compared to synthetic fungicides and can control a number of fungal diseases (such as peach scab and brown rot). Sulfur, however, is not considered as effective as Captan for scab or brown rot control when used in bloom and/or cover sprays.

An effective resistant management spray 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. Growers following these practices reduce the chances for the development of a resistant fungal strain developing in their area. In Alabama, peach growers usually apply two or three sprays of the fungicide Orbit in the preharvest period due mainly to its relatively low cost as well as its overall effectiveness in controlling brown rot. Continued use of Orbit in this manner could lead to the development of resistant strains of brown rot and loss of Orbit, as well as other fungicides (such as Indar, Elite, Funginex) in its class.

In this study we compared fungicide spray programs that consisted of sulfur or Captan throughout the bloom and cover period. Each of these programs were followed with a preharvest spray program that evaluated alternatives to the industry standard (two to three sprays of Orbit) that follow a resistant management strategy.

The experiment was conducted at the Chilton Area Horticulture Substation near Clanton on the cultivar Monroe. Treatments were replicated four times with four trees per replicate in a randomized complete block design. Fungicides were applied using an air blast sprayer at 100 GPA.

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

Fungicide program[1]				Fruit with scab	Marketable fruit	Brown rot	Rhizopus rot
B	C	H1	H2	%	%	%	%
U	U	U	U	100.0	37.0	18.5	7.4
C	C	O	O	94.4	90.0	10.0	2.2
S	S	O	O	100.0	40.2	4.3	3.2
C	C	C	O	74.0	89.0	5.5	0.0
C	C	R	O	8.4	89.0	5.4	0.0
S	S	C	O	96.9	61.2	6.1	1.0
S	S	R	O	100.0	53.6	2.1	1.0

[1]B = bloom sprays, C = cover sprays, H1 = first preharvest spray, H2 = second preharvest spray, U= unsprayed, C = Captan 50WP (five lb./acre), O = Orbit (four oz./acre), S = sulfur 80% (nine lb./acre), R = Rovral 50WP (two lb./acre).

Fungicides were applied at bloom (March 17 and 25), as cover sprays (April 17,21, and 29; May 21; June 2 and 19; and July 2), and at preharvest (July 18 and 28). Fruit were harvested on July 28. A total of 25 fruit were picked from the center two trees of each treatment. Percent of fruit with scab and percent marketable fruit was determined. Incidence of brown rot and Rhizopus rot was determined seven days after harvest following storage of fruit at 77°F.

Weather conditions were warm and wet; favorable for both scab and brown rot development. Scab was observed on the majority of fruit in all treatments, however, the programs that used Captan during the bloom and cover periods had a significantly higher number of marketable fruit than programs that used sulfur. There were no apparent differences among spray programs with regards to brown rot or Rhizopus rot, though all programs had less disease than the unsprayed control plots. Programs that alternated among classes of fungicides (we used Rovral or Captan) in the preharvest period controlled brown rot as well as the program that used two consecutive sprays of Orbit.

Evaluation of Fungicides for Scab Control of Pecans

EDWARD SIKORA AND JAMES BANNON

Pecan scab is the most limiting factor to pecan production in the Southeast. To control the disease growers must maintain a calendar spray program from bud break through mid August. In 1997, a newly registered fungicide, Abound (Zeneca), was evaluated for its ability to control pecan scab.

The test was conducted at the E. V. Smith Research Center in Shorter on a block of Cheyenne pecan trees. The first three sprays of each fungicide treatment were applied at two-week intervals during the pre-pollination period. Cover sprays were applied at three-week intervals starting three weeks after the final pre-pollination spray and were continued through mid August.

Leaf scab ratings were taken on June 12 and nut scab ratings were taken on Aug. 29. Incidence of leaf scab was relatively low in 1997 and no differences were observed among fungicide treatments. Nut scab pressure was relatively high by late August. All fungicide treatments had significantly less disease then the unsprayed control. The fungicide program that rotated from Abound during the pre-pollination period to cover sprays of Enable followed by Abound resulted is significantly more nut scab than the other fungicide programs. Based on the results of this test it appears that growers have a number of viable alternatives when it comes to choosing a fungicide spray program for pecans in 1998.

EVALUATION OF FUNGICIDE SPRAY PROGRAMS FOR PECAN SCAB CONTROL, 1997

Fungicide (rate)[1]	Leaf scab	Nut scab
	%	%
Abound (9.6 oz) then Super Tin 80WP (7.5 oz)	0.4	18.5
Enable 2E (8 oz) then Abound (9.6 oz)	1.7	8.3
Super Tin 80WP (7.5 oz)	1.2	15.1
Abound (9.6 oz)	0.2	10.6
Abound (9.6 oz) then Enable 2E (8 oz) then Abound (9.6 oz)[2]	0.2	36.4
Unsprayed control	5.6	67.9

[1]Fungicide program consists of three applications of the first fungicide listed at two week intervals during the pre-pollination period then six applications of the second fungicide listed at 21-day intervals during the cover period.

[2]The program consisted of three applications of Abound at two-week intervals during the pre-pollination period then three applications of Enable at three week intervals followed by three applications of Abound also at three-week intervals, both at 21-day intervals during the cover period.

Reproduction of Reniform Nematodes on 10 Snap Bean Cultivars Commonly Grown in Alabama

EDWARD SIKORA, MAHEFA ANDRIANIFAHANANA, JEFFREY MICHEL, AND LEONARD KUYKENDALL

Reniform nematode, *Rotylenchus reniformis*, first reported in Alabama in 1959, has been found in over 25% of Alabama counties since then. It is considered the second most damaging nematode of cotton in the U.S. causing yield losses of up to 70%. Reniform nematodes have a wide host range that includes a variety of agronomic and horticultural crops. Fresh market beans, cowpeas, tomatoes, okra, and cantaloupe are particularly susceptible to damage from reniform nematode. Resistance to reniform nematodes has been reported in some soybean cultivars but has not been evaluated in snap beans.

This study was initiated in 1996 to evaluate reniform nematode reproduction on snap bean cultivars commercially available in the southeast. Ten cultivars were tested in a replicated field trial located in Chambers County in 1996 and 1997. Results from the 1996 study were presented in the 1996 Fruit and Vegetable Research Report and are also summarized here. The 1997 field test was planted on March 28. Soil samples were taken at planting and on June 13 (approximate time of harvest). Plots were not harvested due to low yields caused by severe nematode pressure and soil-borne diseases.

In 1997, reniform nematode populations increased on all 10 bean cultivars. Populations increased approximately two- to three-fold among most of cultivars tested, however, reproduction was significantly more on Rushmore and Strike. Reproduction was greater on all 10 cultivars in 1997 than in 1996. This was likely due to the more favorable growing conditions for the bean crop in

1997 that improved root growth providing nematodes with more feeding sites. Weather conditions during the 1996 test were extremely hot and dry, resulting in a weak stand and poor root growth among the plants that survived. The poor root growth likely inhibited reniform reproduction that year.

In 1996, reniform numbers appeared to only maintain themselves at "at planting" population levels on Mustang and Strike, while populations decreased on Goldrush. We were uncertain if this was due to cultivar tolerance or resistance or simply due to environmental factors. The 1997 results suggest that the poor nematode reproduction observed in 1996 was likely due to poor growing conditions due to environmental extremes rather than any inherent tolerance or resistance among bean cultivars.

Reproduction of Reniform Nematodes on 10 Snap Bean Cultivars, Chambers County, 1997

Cultivar	No. of reniform nematodes 3/28	No. of reniform nematodes 6/13	Population index (1997)[1]	Population index (1996)[1]
Mustang	209	695	3.32	1.15
Pod Squad	321	823	2.56	2.21
Opus	343	807	2.35	1.52
Blue Lake	178	538	3.01	1.62
Rushmore	104	642	6.14	1.44
Goldrush	332	930	2.80	0.38
Magnum	137	302	2.20	1.94
Strike	152	823	5.42	1.18
Green Crop	267	696	2.61	1.60
Bronco	561	1,218	2.17	1.36

[1]Population at harvest divided by population at time of planting

Results indicate that reniform nematode reproduction may vary among commercial snap bean cultivars. How these differences in populations levels effect yield is still unknown. This study will be continued in 1998 and will look more closely at the effects of reniform nematodes on yield and the effects of nematicides on yield response.

Evaluation of Fungicides for Early Blight Control on Tomato

Edward Sikora, Arnold Caylor, and Derenda Hagemore

In 1997 Quadris (Zeneca), a soon to be registered fungicide was evaluated for its ability to control the fungal disease, early blight, on tomato. The experiment was conducted at the North Alabama Horticulture Substation in Cullman. Quadris treatments consisted of the product used at three- or six-ounce rates applied at seven- or 14-day intervals. The commonly used fungicides Maneb 75WP and Bravo 720 were also included in the study as industry standards. All treatments, including the control, were sprayed with ManKocide at three pounds per acre beginning three days after transplanting and continuing at seven-day intervals for a total of three sprays. ManKocide was used to reduce incidence of bacterial spot in the study. All fungicide treatments were tank-mixed with Kocide 2000 at two pounds per acre beginning after the last ManKocide application. Kocide 2000 was applied alone at two pounds per acre on weeks when Quadris sprays were not required (for the two treatments evaluating Quadris on 14-day intervals). Disease severity was determined on Aug. 8 and 19. Tomatoes were harvested weekly and total yield was determined (data not presented).

Weekly Disease Severity Ratings of Fungicide Evaluation Trial

Treatment (rate/acre)	Spray interval[1]	Aug. 8[2] % EB	Aug. 8[2] %BS	Aug. 19[2] %EB	Aug. 19[2] %BS
Unsprayed control	–	17.2	27.7	31.5	43.7
Maneb 75WP (3 lb)	7	–	1.7	3.2	8.2
Bravo 720 (24 oz)	7	–	4.7	3.0	6.7
Quadris (3 oz)	7	–	2.0	1.0	3.0
Quadris (6 oz)	7	–	1.2	1.0	3.0
Quadris (3 oz)	14	–	1.5	1.2	3.5
Quadris (6 oz)	14	–	2.7	1.2	5.2

[1]Spray interval is in days.
[2]%EB = % early blight, % BS = % bacterial spot, (–) = no disease present

Early blight and bacterial spot pressure was moderate compared to previous years at the site. More early blight and bacterial spot was observed on the unsprayed control treatments at both rating periods than in the fungicide-treated plots. No significant differences were observed in disease severity among the fungicide treatments on either date. Yield did not differ among the fungicide treatments.

Quadris at the three- and six-ounce rates and at the seven- and 14-day spray intervals performed as well as the industry standards (Maneb or Bravo) for early blight control. Quadris should be considered an alternative for Alabama tomato growers for control of early blight, as well as other fungal diseases that attack the foliage (such as Septoria leaf spot). Because of the possibility of outbreaks of bacterial spot and/or speck on tomato, a copper-containing material such as Kocide 2000 or Kocide 101 should be tank-mixed with your standard fungicide when conditions favor the outbreak of these diseases.

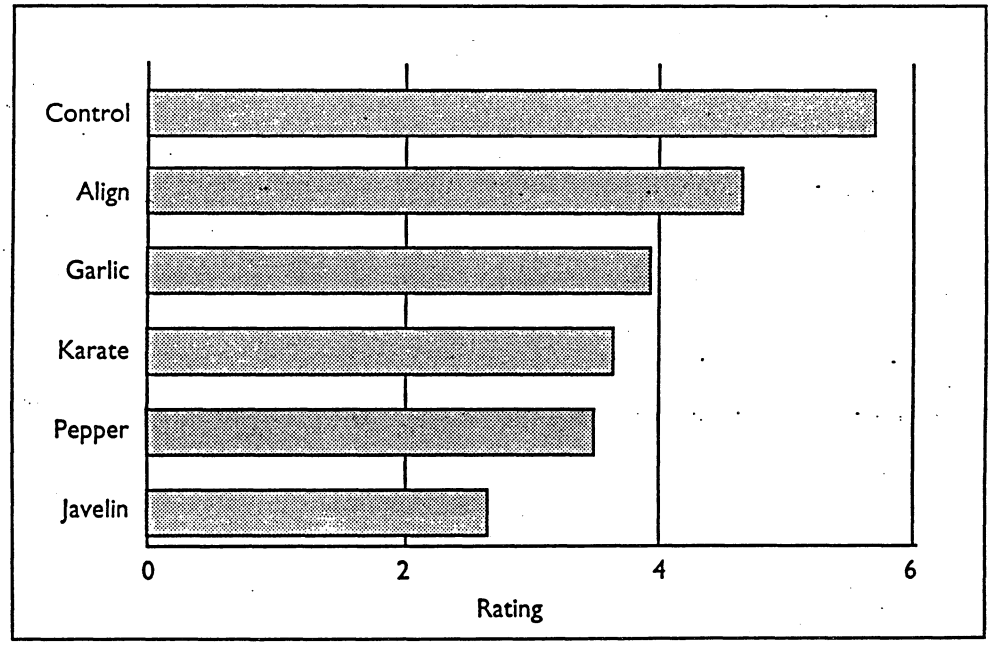
Organic Sprays Effective for Worm Control in Cabbage

GEOFF ZEHNDER, TERRI BRIGGS, AND JIM BANNON

Several caterpillar species are damaging to Alabama cruciferous crops (e.g., cabbage, collards, broccoli, kale, etc.), including larvae of the diamondback moth, cabbage looper, and imported cabbage worm. These pests feed on the outer leaves and heads reducing marketability of the crop. Application of synthetic insecticides is one method that growers can use to protect vegetable crops. Organic growers or growers interested in adopting integrated pest management (IPM) practices, however, are interested in alternative methods of insect management. Organic insecticides and insect repellents have a long history in agriculture, and reports vary as to their effectiveness. Few studies have been done to compare organic insect repellents with standard, synthetic insecticides. A study was done to compare commonly used synthetic insecticides with some readily available organic materials for control of worm pests in cabbage. This study demonstrated that application of garlic and some other organic materials provided levels of worm control sufficient to protect the marketable cabbage heads from insect attack.

Spring-planted field experiments were conducted with Fortuna cabbage at the E.V. Smith Research Center in Shorter in 1997. Cabbage plots were sprayed weekly using a backpack sprayer with three hollow cone nozzles per row with a spray volume of 55 gallons per acre. Karate, applied at the rate of 2.6 fluid ounces per acre in 55 gallons of water, served as the standard, synthetic insecticide. The organic materials tested in the cabbage trial were Garlic Barrier (garlic extract), Align (a botanical extract containing the active ingredient azadirachtin), Javelin WG (*Bacillus thuringiensis* var. *kurstaki*), and McCormick ground red pepper. Garlic Barrier is advertised as an insect repellent (GRAB-IT Enterprises). The active ingredient, 100% garlic juice, was mixed in water as recommended with an equivalent amount of fish oil obtained from the same manufacturer. The garlic mixture was applied as a foliar spray; 1% garlic, 1% fish oil, 98% water. Red pepper has also been reported as an insect repellent, and was applied at the rate of two tablespoons per gallon of water. Align, a natural insecticide obtained from seeds of the tropical Neem tree, was applied at the rate of 20 fluid ounces per acre. Javelin WG, which contains a bacterial toxin that is active only against caterpillar pests, was applied at the rate of one pound per acre. Ivory Snow liquid laundry soap (10 drops per gallon of water) was added to the spray mixture in all treatments to enhance even wetting of the cabbage leaves.

Worm counts indicated that the Javelin biological insecticide, Garlic Barrier, and red pepper treatments resulted in equivalent or better control of cabbage worms than the synthetic insecticide Karate. All treatments resulted in significantly lower numbers of worms than the non-treated control. Insect damage ratings taken at harvest indicated that the cabbage plants in the Javelin treatment exhibited the least worm damage, followed by red pepper, Karate, Garlic Barrier, Align, and the control, in order of increasing damage (Fig. 1). The average damage ratings in all organic treatments were below 4, indicating that most of the damage occurred on the outer leaves and did not affect marketability of the cabbage heads.



Worm damage ratings in cabbage spray treatments.

This study indicates that all the organic products, except for Align, were effective in reducing caterpillar populations and insect feeding damage in cabbage. Although treatments proved efficacious in our experiments, pest, crop, and environmental conditions may be different on individual farms or gardens. We recommend that growers who are interested in these alternative controls perform their own evaluation by comparing the efficacy of various materials in a small portion of their vegetable plantings.

PGPR: A Potential Alternative to Methyl Bromide Fumigation in Vegetable Production

GEOFF ZEHNDER, CHANGBIN YAO, GANG WEI, AND JOSEPH KLOEPPER

Methyl bromide is a widely used weapon for disease, nematode, and weed control in the U.S. Because the 1990 Clean Air Act has decreed that methyl bromide use will be phased out by the year 2001, alternative pest control methods are needed. One alternative for plant disease management is the use of biological control agents. Plant growth-promoting rhizobacteria (PGPR) represent one group of biological control agents that can be easily utilized in agriculture because they can be delivered by seed treatment, transplant drench application, or soil mix inoculation.

Research has demonstrated that plants have defense mechanisms against pathogens that can be activated by exposure of plants to stress or infection by pathogens. This phenomenon, called systemic acquired resistance (SAR) or induced systemic resistance, operates through the activation of defense genes and the accumulation of defense compounds at a site distant from the point of pathogen attack. We previously demonstrated that treatment of seeds or roots of cucumber with select strains of PGPR induces systemic resistance to multiple diseases of cucumber and to the cucumber beetle vector of bacterial wilt disease. However, these studies were done in fumigated soil, and the effects of soil sterilization on PGPR-induced resistance are not known. The objectives of this study were to evaluate PGPR-induced disease resistance in cucumber with and without methyl bromide fumigation, to evaluate multiple PGPR applications for growth promotion effects and protection against bacterial wilt disease in cucumber, and to determine if PGPR could be used as an alternative to methyl bromide fumigation to promote early growth that may be inhibited by soil borne disease pathogens.

Field experiments were conducted in 1994 and 1995 at the E.V. Smith Research Center in Shorter. In 1994, studies were done to compare PGPR treatment, with and without methyl bromide fumigation, to weekly applications of insecticide for control of bacterial wilt disease of cucurbits vectored by cucumber beetles.

TABLE 1. EFFECT OF PGPR AND INSECTICIDE TREATMENT WITH AND WITHOUT MEBR[1] FUMIGATION ON INCIDENCE OF CUCUMBER BEETLES AND BACTERIAL WILT INFECTION, AND YIELD OF CUCUMBER, 1994

	No. beetles/plant[2]		% wilted vines		Fruit wt. (kg/plot)	
Treatment	MeBr	NF	MeBr	NF	MeBr	NF
PGPR strain 90-166	1.0	0.8	27.7	10.8	2.9	3.3
Insecticide (esfenvalerate)	1.0	1.0	27.3	31.3	3.0	2.8
Non-treated control	2.6	2.0	43.0	36.7	2.2	2.4

[1]MeBr=fumigated with MeBr; NF=not fumigated
[2]Values in the table are season averages. Beetles were sampled from 20 plants per treatment on six sample dates. Bacterial wilt incidence was determined by recording the percent of wilted vines on 64 plants in each treatment on a single sample date just before harvest. Fruit yield was determined by weighing all marketable fruit in each plot (four plots per treatment) on 10 sample dates.

TABLE 2. EFFECT OF MULTIPLE PGPR APPLICATIONS WITH AND WITHOUT MEBR[1] FUMIGATION ON PLANT GROWTH AND INCIDENCE OF BACTERIAL WILT, 1995

PGPR treatment	Average plant height (cm)[2]		% wilted vines/plant (AUDPC values)[3]	
	MeBr	NF	MeBr	NF
1. Soil drench at planting	13.4	10.0	9.5	8.9
2. (1) + soil drench 1 wk after planting	12.6	9.6	11.1	8.7
3. (2) + soil drench 2 wk after planting	15.0	10.1	12.1	5.5
4. (3) + soil drench 3 wk after planting	14.2	10.5	11.6	6.2
5. Non-treated control	10.1	6.9	15.3	10.3

[1]MeBr=fumigated with MeBr; NF=not fumigated
[2]Plant height was measured 21 days after planting.
[3]Mean percent wilted vines per plant recorded on five sample dates (50, 57, 64, 71, and 78 days after planting) on 16 plants per plot (64 plants per treatment) and area under disease progress curve (AUDPC) values were calculated to determine bacterial wilt disease progression.

Three levels of bacterial wilt control with or without fumigation were used. Straight 8 cucumber seeds were dipped into pelleted bacterial cells (PGPR treatment) or into distilled water (non-treated control) before planting. The numbers of cucumber beetles and wilted vines per plant in the treatment plots were recorded weekly, and the total harvested fruit weight per plot was determined. The 1995 experiment evaluated PGPR treatments, with and without fumigation, for stimulation of early plant growth and for protection against bacterial wilt disease. Five levels of PGPR treatment (which included multiple applications of PGPR) with and without fumigation were used as described above. Plant height was measured following emergence and the incidence of bacterial wilt symptoms was recorded weekly.

In 1994, PGPR treatment was as effective as weekly insecticide applications for control of cucumber beetles (Table 1). PGPR-induced resistance occurred in both fumigated and non-fumigated soils. However, greater disease protection occurred in non-fumigated soils indicating that fumigation has a negative

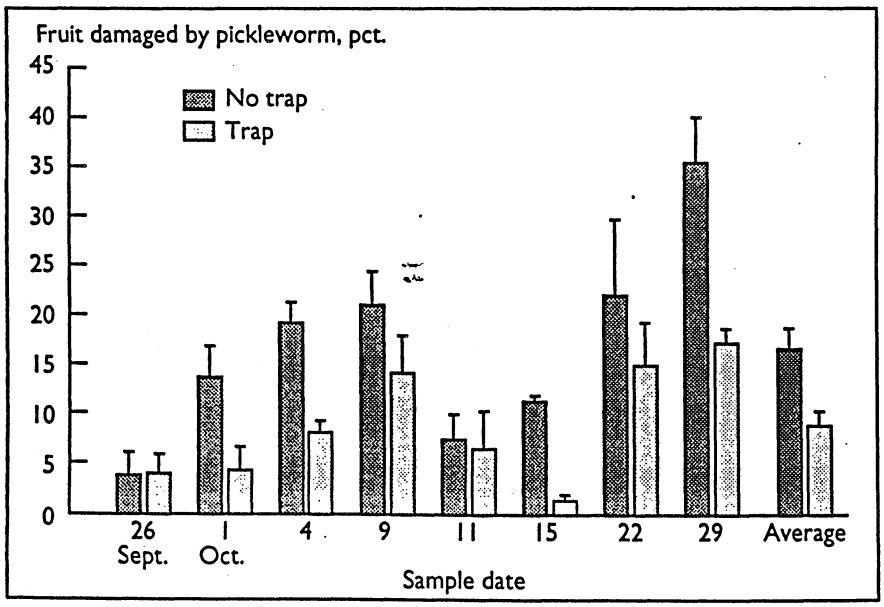
effect on PGPR-induced resistance to bacterial wilt. The 1995 results indicated that the at-planting and "booster" applications of PGPR resulted in increased plant growth in both fumigated and non-fumigated plots, compared with the non-bacterized control (Table 2). However, in non-fumigated soils, multiple PGPR applications resulted in greater disease protection than the single, at-planting application. The poorer early plant growth in non-fumigated plots, compared to fumigated, was overcome by PGPR. Plant growth in the non-fumigated PGPR treatments was equivalent to the fumigated, non-bacterized treatments; evidence that PGPR is an effective alternative to methyl bromide fumigation for early plant protection against damping off disease. As in 1994, the percentage of wilted vines was lower in the PGPR, non-fumigated plots than in the PGPR, fumigated plots (Table 2). Therefore, PGPR-induced protection against bacterial wilt appears to be inhibited by fumigation, while growth promotion by PGPR is enhanced by fumigation.

In summary, these results demonstrate that PGPR-induced resistance against bacterial wilt disease occurred in both fumigated and non-fumigated soils, although greater disease protection occurred in non-fumigated soils. This suggests that soil fumigation has a negative effect on PGPR. In addition, the results demonstrated that PGPR treatment compensated for poor early plant growth in non-fumigated soil, evidence that PGPR may be an effective alternative to methyl bromide fumigation in cucumber production for control of damping off disease. Although it is not likely that PGPR could be used as a single replacement for methyl bromide fumigation, PGPR can be used as an IPM component in vegetable production to protect against pests and disease.

Summer Squash as a Trap Crop to Reduce Pickleworm Damage in Cucumber

GEOFF ZEHNDER, TERI BRIGGS, DANE WILLIAMSON, AND JIM BANNON

Pickleworm is a serious, late-season pest of cucurbits in Alabama. Pickleworm is not believed to overwinter north of Florida, and adult moths migrate northward into Alabama during the growing season. Depending on location, pickleworm infestations in Alabama may begin as early as July, but do not become severe until late August or September. The moths are active in the evening and lay eggs on foliage. Upon hatching, the small, greenish larvae seek protected areas in the developing leaf or flower buds or inside plant stems. However, the most severe damage results from feeding and development inside fruit. They may enter fruit directly from attached flowers, or they may simply crawl from foliage or flowers onto the fruit and enter from the outside. Once inside the plant, pickleworms begin feeding and push out yellow-brown "frass" or excrement, which is visible outside the entry hole.



Pickleworm damage in cucumber with and without a squash trap crop border, 1996, E.V. Smith Research Station, Shorter.

In previous field studies with side-by-side plantings of squash and cucumber, we unexpectedly found that pickleworm infestations were much more severe in summer squash than in cucumber. Although we did not know the specific factors involved, we hypothesized that, if given a choice, pickleworm moths prefer to lay eggs on summer squash than on cucumber. If this is the case, summer squash might be used as a trap crop by cucumber producers to attract pickleworm where they could be controlled to reduce their potential for infesting cucumber. Late-season (early August planting) field experiments were conducted at the E.V. Smith Research Center in 1996 to test this theory. We evaluated two treatments; cucumber (Vlas-Pik) plantings (six

rows by 30 feet) with and without one border row of summer squash (Dixie) planted on either side. In plots with the squash borders, squash was planted two weeks before cucumber. The summer squash plants were examined weekly for presence of pickleworm larvae. If pickleworm were detected, both summer squash border rows were sprayed with Lannate LV insecticide at the rate of two pints per acre, on a weekly basis until the last cucumber harvest. Cucumber plots were not sprayed.

The figure shows the percentage of pickleworm-damaged cucumber fruit on each harvest date. Pickleworm infestation began on Sept. 28, with peak damage occurring on the last two harvest dates. Pickleworm damage was greater in the cucumber plantings without summer squash borders than in cucumber plantings with the summer squash borders on all but the first sample date. Averaging over all sample dates, pickleworm damage in cucumber without the summer squash borders was almost twice as great (16.5%) as in the cucumber plots with summer squash borders (8.7%). These results indicate that the planting of summer squash border rows adjacent to the main cucumber planting may be an effective method to attract pickleworm away from the main cucumber planting. The summer squash borders can be monitored regularly, and if pickleworm are detected, sprayed with a recommended insecticide to prevent movement into cucumber. Future studies will be done to examine the relationship between summer squash border planting size and effectiveness as a pickleworm trap crop in cucumber production.

Evaluation of Actigard (CGA 245704) and Biological Agents for Control of Bacterial Speck of Tomato

LEE CAMPBELL AND MARK WILSON

Field tests were conducted to determine the effect of biological agents and a new compound, Actigard [CGA-245704 (Novartis Crop Protection)], for controlling bacterial speck on tomato caused by *Pseudomonas syringae* pv. *tomato*. Spring weather conditions were conducive to the development of bacterial speck and a high incidence of the disease allowed for excellent evaluations of the products.

SUMMARY OF FIELD TESTS

Test 1	Disease severity				Test 2	Disease severity			
	Rating #1		Rating #2			Rating #1		Rating #2	
Treatment	Mean	Red.[1]	Mean	Red.	Treatment	Mean	Red.	Mean	Red.
		%		%			%		%
Untreated control	19.5	–	27.5	–	Untreated control	25.7	–	21.4	–
BlightBan	11.7	40.0	25.7	6.5	*P. syringae* Cit7	14.8	42.4	13.2	38.2
P. syringae TLP2	9.8	49.7	22.4	8.5	CGA-245704[2]	13.2	48.6	11.2	47.6
P. syringae Cit7	10.7	45.1	19.9	27.6	CGA-245704[3]	6.6	74.3	10.7	50.0
Kocide/Manex	4.9	74.8	8.7	68.4	CGA-245704[2] + *P. syringae* Cit7	6.2	75.8	8.5	60.2
CGA-245704[2]	2.9	85.1	6.3	77.1					

[1]Red. = reduction
[2]Applied at a rate of 0.0312 lb. ai/acre
[3]Applied at a rate of 0.0624 lb. ai/acre

Three bacterial biological agents, *Pseudomonas syringae* Cit7, P. *syringae* TLP2, and *P. fluorescens* A506 (BlightBan) were applied weekly as foliar treatments to tomato plants in 1997. CGA-245704, a new product that activates natural defense mechanisms within the plant, was applied to foliage at planting and weekly thereafter. Results were compared with those from weekly applications of Kocide plus Manex, a standard commercial control.

Once bacterial speck was established, it spread quickly through the field plots due to cool wet weather in spring. Thirty leaves from each of five replications were sampled on two occasions and lesions were counted to determine disease severity. The biological agents significantly reduced disease severity 16.7-23.6% but CGA-245704 reduced disease severity significantly better than the Kocide + Manex treatment (64% compared to 46.1%).

Bacterial speck is a problem only when the spring is cool and wet and only affects tomatoes planted early, but when fruit is infected they become unmarketable. CGA-245704 has shown promise as a new alternative to currently available bactericides in repeated field tests. Biological agents may never completely eliminate chemical pesticides but this test demonstrates that potential is there to reduce disease and further they may be used in combination with chemicals such as CGA-245704 to achieve synergistic levels of control.

Evaluation of Actigard (CGA 245704) and Biological Agents for Control of Bacterial Spot of Peach

LEE CAMPBELL AND MARK WILSON

Field tests were conducted to determine the efficacy of Actigard [CGA-245704 (Novartis Crop Protection)] on the control of bacterial spot of peach caused by *Xanthomonas campestris* pv. *pruni*. With the introduction of peach cultivars from outside the Southeast, bacterial spot has become a problem and there is currently no adequate means of control for this disease.

Actigard, a new product that activates natural defense mechanisms within the plant, was applied weekly at recommended rates (0.24 pound a.i. per acre) beginning at first leaf bud break and continuing to fruit harvest. Actigard has shown excellent results against bacterial diseases of field crops by reducing the incidence of disease on tomato and pepper. A biological agent (*Pseudomonas putida* B56) that has been effective against bacterial spot of tomato (*Xanthomonas campestris* pv. *vesicatoria*) was also tested alone and in combination with Actigard. Results were compared against the untreated control.

Once bacterial spot appeared on the foliage, ratings were made to determine the disease progress. Thirty leaves were sampled on three occasions and lesions were counted to determine disease severity. Actigard significantly reduced severity of bacterial spot alone and in combination with *P. putida* B56 while the biological agent had no significant reduction. Fruit was harvested and ratings were made based on the percentage of fruit surface covered by spot lesions. Actigard reduced disease severity with 29% of the fruit being rated 1 (<25% of surface covered) compared to the untreated control where only 4% of the fruit were rated 1. Hence, the use of Actigard resulted in 25% more marketable fruit than the untreated control.

Copper bactericides are phytotoxic to peaches therefore they are ineffective against bacterial spot and also oxytetraclycline has proven to be ineffective. Actigard offers hope that this disease may be controllable allowing the introduction of new California varieties that are susceptible to bacterial spot.

TABLE 1. INCIDENCE AND SEVERITY OF BACTERIAL SPOT ON FRUIT

Treatment	Disease rating[1]	Reduction	Infected fruit[2]	Reduction
		%	%	%
Untreated control	2.56	–	97.2	–
P. putida B56	2.54	<1	93.6	3.7
Actigard	1.98	23.0	74.4	24.2
Actigard + B56	2.11	17.6	82.6	15.0

[1]Ratings were made from 25 fruit per replicate (250 fruit) and based on a 1 (<25% surface covered); 2 (26-50%); 3 (51-75%); 4 (>75%).
[2]Represents the number of fruit on which lesions appeared.

TABLE 2. SUMMARY OF INCIDENCE OF BACTERIAL SPOT ON PEACH FOLIAGE

	Test 1- Chilton Area Horticulture Substation disease severity						Test 2- EV Smith Research Center disease severity					
	Rating #1		Rating #2		Rating #3		Rating #1		Rating #2		Rating #3	
Treatment	Mean[1]	Red.[2]	Mean	Red.	Mean	Red.	Mean	Red.	Mean	Red.	Mean	Red.
		%		%		%		%		%		%
Untreated	1.9	–	2.2	–	2.4	–	2.4	–	2.1	–	3.0	–
P. putida B56	1.7	13.0	1.9	16.7	2.3	4.2	2.1	17.9	2.4	–	2.7	10.4
Actigard	1.6	16.0	1.5	43.2	1.6	39.5	1.9	25.6	1.7	28.1	2.0	35.4
Actigard + B56	1.3	56.2	1.5	43.2	1.7	38.6	1.7	41.0	1.6	31.2	2.3	22.9

[1]Ratings were made from 25 fruit per replicate (250 fruit) and based on a 1 (<25% surface covered); 2 (26-50%); 3 (51-75%); 4 (>75%).
[2]Red. = reduction

Evaluation of a Recyclable Plastic Film for Plasticulture

ERIC SIMONNE, BOBBY BOOZER, AND JIM PITTS

The black plastic mulch used in plasticulture is usually a polyethylene material, of 1 to 3 mils thick and 48 to 60 inches wide, costing $0.6 to 0.9 per pound. An industrial clear polyester by-product was available in 1.5 mil thick, 56-inch-wide rolls, and at a cost of $0.20 per pound. The by-product has marked differences in rugosity. Because of its cost and availability, the potential for use of this recyclable plastic film was investigated under field conditions.

In May, raised beds were formed and mulch installed using a combination bedder/mulch layer. Selected films were the recyclable polyester plastic up-side-up, recyclable polyester plastic up-side- down, and a standard black polyethylene mulch. During installation, the recyclable material showed limited elasticity and a tendency to zip-crack. After minor adjustments to the bedder, acceptable beds were made using all selected mulches. On May 21 (days after treatment, DAT, =0), hole and paint treatments were applied. Selected punching devices were a burner, a stake, a spade, a three-inch PVC pipe cut at a 45-degree angle and sharpened, a bulb planter, and a water wheel. Exterior white latex paint was applied at three dilution rates [1 water:1 paint (v/v), 2:1, 3:1] and two application methods (paint roller and back-pack sprayer) were used. Sections were left unpunched and unpainted as controls. Ratings of plastic tear and paint coverage were made separately on 0 and 78 DAT. On 78 DAT, holes were punched by hand and the number of times the finger would go through the mulch was recorded. No weed control was used and no vegetable crop was established on the beds.

The burner, the stake, the PVC pipe, and the bulb planter punched clean holes with limited running tears (Table 1). The spade created some running tears. Due to the wheel weight and the lack of elasticity, the water wheel caused unacceptable tears. On Aug. 7, only the holes punched by the burner where still clearly delimited, suggesting that only holes punched with the burner could be used in production. Tear ratings for the black polyethylene plastic remained acceptable throughout the season. The thickness of the 2:1 and 3:1 dilution rates resulted in poor coverage, especially with the back-pack sprayer. The most uniform coverage was provided with the 1:1 dilution rate applied with the paint roller. Because the recyclable material is clear, uniform paint coverage is important to control the temperature in the root zone under the mulch.

On 78 DAT, the unpainted sections of the recyclable material had become brittle and easily damaged. Paint dilution and method of application influenced the mechanical resistance of the mulch (Table 2). For the recyclable material, the highest resistance was found for the up-side-up mulch painted with the 1:1 dilution and applied with the roller.

On 15 DAT, several grassy weeds had germinated and were actively growing under the recyclable material. By 25 DAT, however, these weeds were drying on the unpunched sections of the beds, suggesting that the temperature under the recyclable material was favorable for seed germination, but became too high for sustained weed growth. This clear material may be suited for soil solarization.

The recyclable polyester plastic had limited elasticity and became brittle after 78 days. Moreover, punching holes without damaging the mulch was possible only with the burner. This alternative is more labor intensive than the commonly used wheels installed on transplanters. Therefore, despite its lower cost, the potential for this product for use in vegetable production with plasticulture is unlikely.

TABLE 1. TEAR RATINGS AS AFFECTED BY PUNCHING DEVICE AND DATE OF RATING

Punching device	Tear rating[1]			
	May 21		Aug. 7	
	RM[2]	BP	RM	BP
Burner	5	5	4	5
Stake	5	5	3	5
Spade	3	5	3	5
3-in PVC pipe	4	5	3	5
Bulb planter	4	5	3	5
Wheel	2	5	1	5
Control	5	5	3	5

[1]Tears were rated as 1 = plastic destroyed; 2 = plastic badly torn; 3 = several tears; 4 = some cracks; and, 5 = intact plastic.
[2]RM = recyclable material; BP = black plastic

TABLE 2. NUMBER OF HOLES OUT OF 10 ATTEMPTS

Mulch	Paint dilution		
	1:1	2:1	3:1
Sprayer			
Up-side-up	10	8	10
Up-side-down	9	10	10
BP	1	0	0
Paint roll			
Up-side-up	2	6	8
Up-side-down	10	9	10
BP	0	1	1

Consumer Preferences for Color, Price, and Vitamin C Content in Bell Peppers

CHRIS FRANK, ERIC SIMONNE, BRIDGET BEHE, ROBERT NELSON, AND AMY SIMONNE

Nontraditional colored bell peppers such as orange, yellow, red, and brown have been identified as a potentially lucrative product for Alabama growers. Alabama has a suitable climate for their production, and colored bell peppers generally sell for two to three times the wholesale price of traditional green bell peppers. This is an expanding market with per capita consumption increasing steadily from 2.5 pounds a year in 1973 to 7.1 pounds a year in 1996 with a domestic consumption of 1.875 billion pounds. Approximately 20% of this consumption consists of colored bell peppers.

In the Southeast, the major suppliers of colored bell peppers are Florida in the spring through midsummer and imported hothouse peppers from midsummer through winter from Holland. Several issues need to be resolved before a determination can be made on the competitiveness of Alabama growers in this potential market. As a first step, the objective of this study was to evaluate consumer preferences for certain key attributes of bell peppers, specifically color, price, and vitamin C (Vit. C) as a percentage of U.S. recommended daily allowance. Attributes are the features of a product that consumers use to evaluate a product. Moreover, each attribute consists of at least two levels that reflect market ranges. For example, green and red are two levels of the attribute "color."

The practical purpose of this objective is to enable horticulturists, growers, and retailers to make production decisions that result in maximum consumer satisfaction through an understanding of relative importance and part-worths. Relative importance is the percentage that each attribute contributes to the consumer's overall decision to purchase. Part-worth is the relative satisfaction that each level provides to the consumer. Levels of part-worths with positive values are preferred to those with negative values. Larger values are preferred to lower values.

Results in this study are based on an overall sample of 436 respondents interviewed at two stores of a large retail grocery chain in Alabama. Results indicate that there is not a homogenous market based on consumer preferences (see table). Rather, five separate segments were identified based on the similarity of their preference functions. Results from the five segments are as follows:

Segment 1: Prefers orange and yellow; price sensitive, and prefers high Vit. C.

Segment 2: Prefers green; relatively indifferent to price and Vit. C.

Segment. 3: Prefers green and orange; relatively indifferent to price, and prefers high Vit. C.

Segment 4: Prefers green and red; price sensitive, and prefers low Vit. C.

Segment 5: Prefers red and yellow; most sensitive to price, and prefers low Vit. C.

The overall results indicate that higher Vit. C content in bell peppers would significantly increase consumer satisfaction for segments one and three (27% of the market). Also, sales of colored bell peppers in segments one and five (36% of the market) could potentially benefit from price promotions. Last of all, there are no identifiable segments that have a preference for brown.

RELATIVE IMPORTANCE AND PART-WORTHS BY MARKET

Attributes and levels	Segment 1 (16%) part-worth	Segment 2 (36%) part-worth	Segment 3 (11%) part-worth	Segment 4 (17%) part-worth	Segment 5 (20%) part-worth
Color:					
green	1.881	1.757	1.035	0.987	20.470
brown	1.620	-1.357	1.269	1.250	1.925
red	2.046	1.922	1.994	0.231	0.243
yellow	0.279	1.850	2.031	1.766	0.051
orange	0.318	1.972	0.305	1.910	1.887
Relative importance	20.55%	91.08%	60.82%	50.41%	22.06%
Price:					
$0.69	1.877	1.992	2.025	1.866	1.804
$1.69	1.630	1.910	1.992	1.602	1.451
$2.69	19.815	20.260	1.959	19.770	203.850
$3.69	1.136	1.747	1.926	19.505	-1.303
Relative importance	47.59%	7.16%	2.61%	22.39%	57.84%
Vitamin C:					
75%	0.744	0.091	2.078	19.035	1.495
100%	0.992	0.121	2.771	-1.926	1.311
125%	1.240	0.151	3.463	-2.408	1.127
Relative importance	31.86%	1.75%	36.56%	27.20%	20.10%

Potential for Organic Products to Control Deer Damage to Vegetable Crops

ERIC SIMONNE AND JOHN OWEN

The deer population in Alabama is large. For farmers and vegetable producers deer can be a threat to their crops. Presently, fencing is the most efficient method to restrict deer access to small fields. However, fencing is costly, and deer can adapt to physical obstacles. This study evaluated the possibility of reducing damage to vegetable crops by rendering vegetable plants non-palatable to deer by application of organic materials.

TABLE 1. EFFECT OF SELECTED SPRAYS ON DEER DAMAGE TO SOME VEGETABLE CROPS

	Corn[1,2]	Squash[1,2]	Sweetpotato[2]			Southernpea[2]			
			7/25	8/17	9/15	7/25 to 8/28	9/02	9/10	9/15
1. Garlic around	0	0	2.5	2.3	2.7	0	0.2	0.2	0.6
2. Garlic on	0	0	1.5	1.7	2.3	0	0.2	0.2	0.8
3. Deer stopper	0	0	1.2	1.7	1.8	0	0.3	0.5	0.2
4. Control	0	0	2.7	3.5	3.5	0	0.5	0.7	0.5

[1]For all rating dates between June 24 and Sept.15
[2]The 0-to-4 rating scale was: 0 = no damage (0%); 1 = some damage (25%); 2 = half of above-ground part eaten (50%); 3 = most of above ground-part eaten (75%); and 4 = all plant eaten (100%).

Deer stopper (an unlabeled product of known efficacy for deer control) and Garlic Barrier (a garlic and fish oil based spray) were evaluated on Beauregard sweetpotato, Snow Belle sweet corn, Coronet southernpea, and Condor zucchini squash. Both materials were applied as foliar sprays on the plants; the garlic spray was also sprayed to the ground around the plots. The garlic spray was applied at a rate of 10 times the manufacturer-recommended rate. All treatments were applied once weekly, or as needed after a heavy rain. Control plots received no sprays. A one-acre field was planted in soybeans mid May to attract deer. When soybeans were four to six inches tall, vegetable plots were established along the branches of an eight-branch stars. Three vegetable plots consisting of four-foot sections of sweetpotato-sweet corn-zucchini-southernpea (all in the same order) were established on each branch. The star-shape design allowed a similar exposure of all the treatments regardless of the point of entrance into the test.

All crops were direct seeded, but slips were used for sweetpotato. Severe soybean grazing and deer tracks were visible at the date of vegetable planting (June 18). Between June 24 and Sept. 15, damage ratings were made three to five times per week. Stage of plant development at damage was noted.

Overall, individual damage ratings ranged between 0 to 3.5. Because of the presence of tracks, clear-cut damage, damage pattern, and observation of deer feces in the field, the damage was attributed to deer. The first damage occurred on sweetpotato five days after planting. Sweetpotato slips were replaced two weeks later. No damage was noticed on southernpeas until 50% bloom (Aug. 28). No damage was observed on any date on sweet corn or zucchini.

Garlic Barrier (Treatment 1) sprayed around the plots and the control (Treatment 4) resulted in higher damage than Deer Stopper Treatment 2 and Garlic Barrier on the plants (Treatment 3) for the sweetpotato and the southernpea (Table 1). However, on Sept. 15 damage on treatments 2 and 3 corresponded to approximately 60 and 45% damage to sweetpotato.

Damage ratings of southern pea was lower than expected and occurred mainly after bloom. Although the amount of plant removed was relatively low (between 5 and 20% on Sept. 15), the loss affected the growing tips and the developing pods. This study suggests that both organic materials provided some control of deer damage to sweetpotato and southernpeas, however, the protection was not complete.

Benefits and Limits of Garlic Sprays on Lettuce

ERIC SIMONNE, JOHN OWEN, AND MARVIN RUF

With the increasing concern over pesticide residues in foods and the reduction in crop protectants labeled for minor crops, alternative pest control methods such as integrated pest management and 'natural' spray materials have received increased attention. Garlic extracts have been attributed nematicidal, miticidal, insecticidal, fungicidal, and growth promoting properties through various unpublished reports or isolated testimonies. The beneficial effects of garlic-based products have been attributed to the compound diallyl disulfide. The effect of the Garlic Barrier (GRAB-IT Enterprises) was investigated with lettuce.

Plots were established in 1996 at the Piedmont Substation in Camphill and in 1997 at the Sand Mountain Substation in Crossville. Sierra lettuce in 1996 and Salinas 88 Supreme lettuce in 1997 were transplanted on May 30 and May 6, respectively, on raised beds with white plastic mulch and drip irrigation. Several treatments were used and modified following first-year results (Table 1). Following the product's label, the garlic spray was prepared by mixing one gallon of Garlic Barrier and one gallon of sticker-spreader into 98 gallons of water applied at a rate of 10 gallons per acre. This rate corresponded to the point of product runoff from the leaves. Treatments were applied in the morning on a weekly schedule for eight weeks beginning on June 3 in 1996 and June 12 in 1997. The drench treatment in 1997 consisted of a 200-ml soil application of Garlic Barrier solution at transplanting. Plots were rated for foliar damage on a 0 to 5 scale (0 = 0%; 1 = 5%; 2 = 10%; 3 = 15%; 4 = 20%; 5 = 30% of the plants showing foliar damage). Lettuce heads were harvested on July 2, 1996, and July 12, 1997.

Warm and dry weather conditions in 1996 resulted in no disease or insect damage. No spray applications were necessary and all plots were rated 0. In 1997, damage was visible. Mean ratings for treatments 1 (chemical control), 2, 3, and 4 (water control) were 1.0, 1.75, 0.75, and 3.25, respectively. Feeding damage was observed mainly on wrapper leaves not reducing marketability of lettuce heads. In 1996, lettuce receiving the garlic spray (Treatment 2) had significantly higher yield than the other treatments (Table 2). However, since the differences in stand at harvest were not significant, higher yields in plots receiving Treatment 2 were attributed to an increase in individual head size. In 1997, differences in head size and yield were not significant.

Weekly applications of Garlic Barrier did not consistently affect lettuce growth. Since the fertilization program followed current recommendations for Alabama and crops exhibited no signs of nutritional imbalances or deficiencies, it was unlikely that the positive effect of an application of the Garlic Barrier once a week in 1996 was due to the addition of nutrients. After proper dilution, the contribution of the Garlic Barrier to the fertilization program was less than 0.1 pound per acre for all minerals.

These results suggest that when the Garlic Barrier is applied at the manufacturer's recommended rate, no adverse

TABLE 1. SUMMARY OF TREATMENTS USED ON LETTUCE IN 1996 AND 1997

Treatment	1996	1997
1	Recommended foliar spray as needed (control)	Recommended foliar spray as needed(control)
2	Foliar garlic spray on Monday only	Foliar garlic spray on Monday only
3	Foliar garlic spray on Monday and Thursday	Drench application of garlic at transplanting and foliar garlic spray on Monday only
4	Foliar water spray on Monday and Thursday	Foliar water spray on Monday

TABLE 2. RESPONSE OF LETTUCE MARKETABLE WEIGHT AND STAND AT HARVEST TO SELECTED SPRAY TREATMENT

Treatment	Marketable weight	Stand at harvest
	(lb./acre)	%
1996		
Chemical control	22,822	86
M garlic[1]	28,640	86
M-T garlic	17,473	73
M-T water control	22,623	82
1997		
Chemical control	20,354	100
M garlic (no drench)	21,358	96
M garlic (drench[2])	18,078	100
M water control	20,735	96

[1]M = Monday; T = Thursday
[2]Add 200 ml at transplanting

TABLE 3. ADVANTAGES AND DISADVANTAGES OF GARLIC BARRIER COMPARED TO LABELED SYNTHETIC PRODUCTS

Factor	Garlic Barrier	Labeled synthetic product
Registered by EPA	yes[1]	yes
Toxic to humans	no	yes, in most cases
Toxic to animals	no	yes, in most cases
Restrictions on handling	none	some
Proven efficacy	no	yes
Scope of activity	broad	specific
Product cost	low[2]	high

[1] Registration No. 66352-1
[2] Approximately $10/acre/application for material

effects on lettuce occurs. Spray application at the manufacturer's recommended rate did not result in a persistent odor or flavor on harvestable parts. Since feeding damage was restricted to the wrapper leaves, the product showed an acceptable level of control for foliage feeding insects in 1997. Until additional results are reported for other crops, growers should not rely solely on this product to control pests of vegetables without taking uncontrolled risks (Table 3). Additional research is needed to scientifically establish its efficacy on the main vegetable crops grown in Alabama.

Bell Pepper Yield Grown with Plasticulture Respond to Nitrogen Rates

ERIC SIMONNE, JIM BANNON, JOSEPH KEMBLE , AND PASCAL LIENHARD

Current fertilization recommendation for bell pepper is 120 pounds of nitrogen (N) per acre and was developed for bare ground, single-row bell pepper production (approximately 8,700 plants per acre). Typically, one half to one third of the total amount of recommended N (40 to 60 pounds of N) is applied preplant. The rest of N is sidedressed.

Bell pepper production with plasticulture is different than on bare ground. Water and nutrients are supplied as needed through the drip system. Also, bell peppers grown on plastic are planted in double rows. When beds are four feet wide, one foot apart, this results in a plant population of approximately 17,400 plants per acre, which is twice as high as that of a single-row, bare ground planting.

Because of differences in plant population and because expected fertilizer efficiency is higher with plasticulture, it is possible that the current recommendation for bell pepper on bare ground is inadequate for plasticulture.

Enterprise bell peppers were planted at the Horticulture Unit at the E.V. Smith Research Center on black plastic with drip irrigation. Within-row spacing was 12 inches creating a stand of 17,400 plants per acre. The entire field received a preplant application of 450 pounds per acre of 0-20-20 and 387 pounds per acre of 15.5-0-0 (calcium nitrate). Other cultural practices followed current recommendations. Beginning one week after transplanting, fertilizer was injected twice weekly (Monday and Thursday). Treatments consisted of injections of five and seven pounds N twice per week, for the low and high N rate, respectively, and alternatively from a liquid calcium nitrate solution (9-0-0-11) and 100% soluble 20-10-20 (Table 1). Bell pepper were harvested 10 weeks after transplanting and graded.

Fertilizer rate significantly affected plant height 57 DAT (Aug. 10), bell pepper yield, and grade distribution of the first harvest (Table 2). The high-N treatment resulted in taller and bushier plants. Plants with abundant foliage better protect pepper fruit from sun scar and sun burn. Mean fruit size for both N treatment for Fancy and US#1 grade pepper were similar, suggesting that the increase in yield was primarily due to an increase in fruit number rather than individual fruit weight.

The results of this one-year study suggest that yields of bell pepper grown on plasticulture respond to N application in the 160 to 200 pounds. N per acre range. This results are in agreement with findings of previous AAES studies. Whether yields would continue to increase at higher N rates was not determined by this study.

TABLE 1. FERTILIZER SCHEDULE USED FOR BELL PEPPER

	Low N	High N
Preplant	60 lb	60 lb
Injected	10 lb/week	14 lb/week
Duration	10 week	10 week
Total injected	100 lb	140 lb
Total N applied	160 lb	200 lb

TABLE 2. EFFECT OF FERTILIZER SCHEDULE ON GROWTH AND YIELD OF BELL PEPPERS

N rate	Plant ht.	Marketable		Fancy		US# 1	
		wt.	#	wt.	#	wt.	#
lb./acre	*in.*						
160	43	10,071	96,368	1,227	7,359	4,215	34,785
200	47	14,100	139,914	2,007	12,732	5,739	44,156

Alabama's Agricultural Experiment Station System
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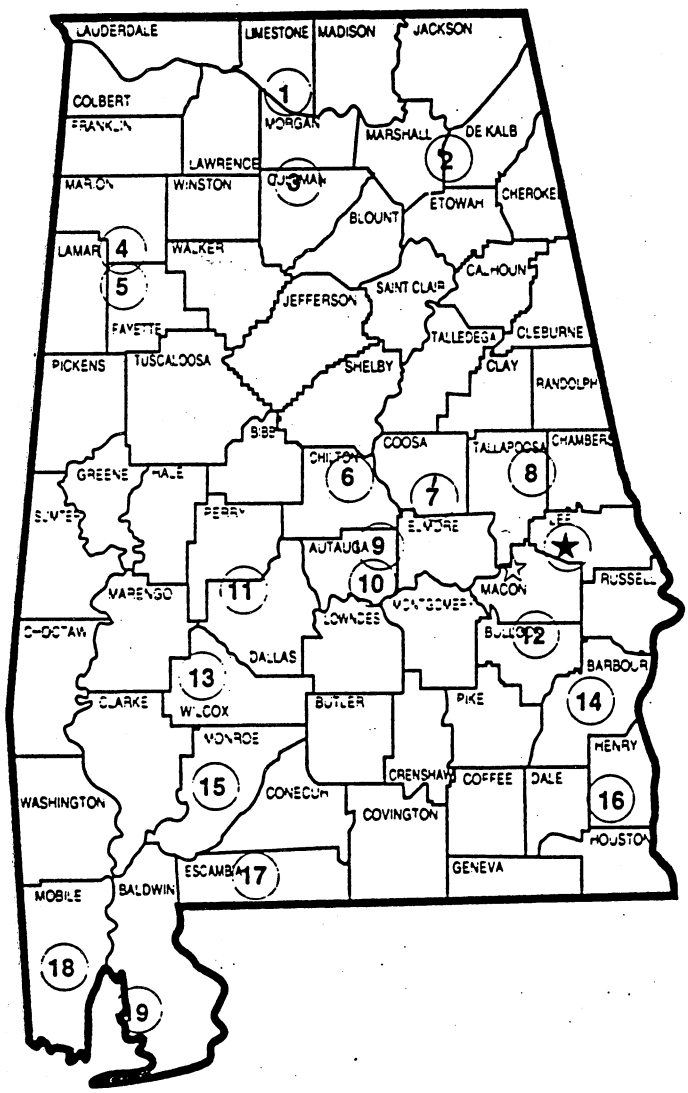

- ★ Main Agricultural Experiment Station, Auburn.
- ☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Forestry Unit, Autauga County.
10. Prattville Experiment Field, Prattville.
11. Black Belt Substation, Marion Junction.
12. The Turnipseed-Ikenberry Place, Union Springs.
13. Lower Coastal Plain Substation, Camden.
14. Forestry Unit, Barbour County.
15. Monroeville Experiment Field, Monroeville.
16. Wiregrass Substation, Headland.
17. Brewton Experiment Field, Brewton.
18. Ornamental Horticulture Substation, Spring Hill.
19. Gulf Coast Substation, Fairhope.