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PR-603

UNIVERSITY OF KENTUCKY
College of Agriculture

2009 Fruit and Vegetable Research Report

UKAg RESEARCH

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2009 Fruit and Vegetable Crops Research Report

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Acknowledgments

Grants from the Agricultural Development Board through the Kentucky Horticulture Council have allowed an expansion of the field research and demonstration program to meet the informational and educational needs of our growing vegetable and fruit industries.

Important note to readers:
The majority of research reports in this volume do not include treatments with experimental pesticides. It should be understood that any experimental pesticide must first be labeled for the crop in question before it can be used by growers, regardless of how it might have been used in research trials. The most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information. Contact your county's Cooperative Extension office if you need assistance in interpreting pesticide labels.

This is a progress report and may not reflect exactly the final outcome of ongoing projects. Please do not reproduce project reports for distribution without permission of the authors.

Contents

The 2009 Fruit and Vegetable Crops Research and Demonstration Program

Timothy Coolong, Department of Horticulture

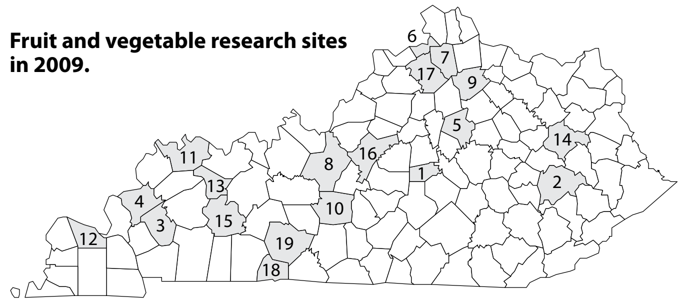
Fruit and vegetable production in Kentucky continues to grow. The explosive growth of farmers' markets in the state (there are now 120) has helped spur growth in the fruit and vegetable industries. The farmers supporting this ever-growing industry require up-to-date information to help them improve production as much as possible. The *2009 Fruit and Vegetable Crops Research Report* includes results for more than 45 field research and demonstration trials that were conducted in 19 counties in Kentucky (see map below). Research was conducted by faculty and staff from several departments within the University of Kentucky College of Agriculture including Horticulture, Biosystems and Agricultural Engineering, and Plant Pathology. This report also includes collaborative research projects conducted with faculty and staff at Kentucky State University. Many of these reports include data on varietal performance as well as different production methods in an effort to provide growers with better tools that they can use to improve fruit and vegetable production in Kentucky.

Variety trials included in this year's publication include fresh-market tomatoes, pumpkins, beets, cucumbers, sweet corn, blueberries, raspberries, blackberries, apples, peaches, and grapes. New varieties are continually being released, and variety trials provide us with much of the information necessary to update our recommendations in our *Vegetable Production Guide for Commercial Growers* (ID-36). However, when making decisions about what varieties to include in ID-36, we factor in performance of varieties at multiple locations in Kentucky over multiple years. We may also collaborate with researchers in surrounding states to discuss results of variety trials they have conducted. In addition, we consider such things as seed availability, which is often of particular concern for organic growers. Only then, after much research and analysis, will we make variety recommendations for Kentucky. The results presented in this publication often reflect a single year of data at a limited number of locations. Although some varieties perform well across Kentucky year after year, others may not. The following are some helpful guidelines for interpreting the results of fruit and vegetable variety trials.

Our Yields vs. Your Yields

Yields reported in variety trial results are extrapolated from small plots. Depending on the crop, individual plots range from 8 to 200 plants. Our yields are calculated by multiplying the yields in these small plots by correction factors to estimate per acre yield. For example, if you can plant 4,200 tomato plants per acre (assuming 18-inch within-row spacing) and our trials only have 10 plants per plot, we must multiply our average plot yields by a factor of 420 to calculate per acre yields. Thus, small errors can be greatly amplified. Furthermore, because we do not include factors such as drive rows in our calculations, our per acre yields are typically much higher than what is found on an average farm. Due to the availability of labor, research plots may be harvested more often than would be economically possible. Keep this in mind when reviewing the research papers in this publication

Fruit and vegetable research sites in 2009.



1. *Boyle*
2. *Breathitt*
3. *Caldwell*
4. *Crittenden*
5. *Fayette*
6. *Gallatin*
7. *Grant*
8. *Hardin*
9. *Harrison*
10. *Hart*
11. *Henderson*
12. *McCracken*
13. *McLean*
14. *Morgan*
15. *Muhlenberg*
16. *Nelson*
17. *Owen*
18. *Simpson*
19. *Warren*

Statistics

Often, yield or quality data will be presented in tables followed by a series of letters (a, ab, bc, etc.). These letters indicate whether the yields of the varieties are statistically different. Two varieties may have average yields that appear to be quite different. For example, if tomato variety 1 has an average yield of 2,000 boxes per acre and variety 2 yields 2,300 boxes per acre, one would assume that variety 2 had a greater yield. However, just because the two varieties had different average yields does not mean that they are *statistically* or *significantly* different. In the tomato example, variety 1 may have consisted of four plots with yields of 1,800, 1,900, 2,200, and 2,100 boxes per acre. The average yield would then be 2,000 boxes per acre. Tomato variety 2 may have had four plots with yields of 1,700, 2,500, 2,800, and 2,200 boxes per acre. The four plots together would average 2,300 boxes per acre. The tomato varieties have plots with yield averages that overlap and therefore would not be considered statistically different, even though the average per acre yields for the two varieties appear to be quite different. This example also demonstrates variability. Good varieties are those that not only yield well but also have little variation. Tomato variety 2 may have had yields similar to those of variety 1, but it also had much greater variation. Therefore, all other things being equal, tomato variety 1 may be a better choice due to less variation in the field.

Statistical significance is shown in tables by the letters that follow a given number. For example, when two varieties have yields followed by completely different letters, then they are significantly different; however, if they share even one letter, then statistically they are no different. Thus, a variety with a yield that is followed by the letters "bcd" would be no different from a variety followed by the letters "cdef" because the letters "c" and "d" are shared by the two varieties. Yield data followed by the letters "abc" would be different yield data from those followed by "efg."

Lastly, when determining statistical significance, we typically use a "*P*" value of 0.05. In this case, *P* stands for probability, and the 0.05 means that we have a 5% chance that our results are due to chance or error. Put another way, if two varieties are said to be different at $P<0.05$, then at least 95% of the time those varieties will be different. If the *P* value is 0.01, then 99% of the time those varieties will be different. Different *P* values can be used, but typically $P < 0.05$ is considered standard practice.

Without statistics, our results would not be useful. Using statistics ensures that we can make more accurate recommendations for farmers in Kentucky.

On-Farm Commercial Vegetable Demonstrations—Central Kentucky

Dave Spalding and Timothy Coolong, Department of Horticulture

Introduction

Fifteen on-farm commercial demonstrations were conducted in central and northern Kentucky in 2009. Grower/cooperators were from Boyle, Gallatin, Grant, Harrison, Nelson, and Owen counties. The grower/cooperators in Boyle, Harrison, and Nelson counties grew mixed vegetables for farmers' markets and on-farm markets. The grower/cooperators in Gallatin, Grant, and Owen counties grew Roma-type tomatoes for a KHI Foods Inc. paste tomato pilot project.

Materials and Methods

As in previous years, grower/cooperators were provided with black plastic mulch and drip irrigation lines for up to 1 acre and the use of the Horticulture Department's equipment for raised bed preparation and transplanting. The cooperators supplied all other inputs, including labor and management of the crop. In addition to identifying and working closely with the cooperators, county Cooperative Extension agents took soil samples from each plot and scheduled, promoted, and coordinated field days at each site. An Extension associate made regular weekly visits to each plot to scout the crop and make appropriate recommendations.

The grower/cooperators growing for local farmers' markets and on-farm markets grew a mix of vegetables (tomatoes, peppers, squash, green beans, melons, and sweet corn), while growers for the paste tomato pilot project grew only Roma-type tomatoes. The plots were planted into 6-inch-high beds covered with black plastic mulch and drip lines under the plastic in the center of the beds. The beds were planted at the appropriate spacing for the type of vegetable being grown (i.e., tomatoes were planted in a single row 18 inches apart, beans were planted in double rows 12 inches apart, etc.). Plots were sprayed with the appropriate fungicides and insecticides on an as-needed basis, and cooperators were asked to follow the fertigation schedules provided.

Results and Discussion

The 2009 growing season was one of the wettest and coolest in recent memory and produced numerous challenges for all vegetable growers in the state. Most transplanted crops were planted on time and grew fairly well early in the season. Seeded crops such as green beans, sweet corn, squash, and melons fared poorly as many of the seeds rotted due to the cool and wet conditions and had to be replanted. As the growing season progressed, the wet, cool conditions of midsummer slowed growth and maturity for many crops, with the tomato crop being particularly hard hit.

Table 1. Costs and returns of Owen County Roma tomato grower/cooperators.

	Growers				
	One	Two	Three	Four	Five
Inputs	(0.25 acre)			(1.0 acre)	
Gross receipts	$5,338	$2,737	$3,311	$8,443	$26,240
Out-of-pocket expenses	3,516	748	2,353	4,512	13,752
Return to land, labor, and mgt. after cash costs	1,822	1,989	958	3,931	12,488
Variable expenses 2-, 3-, and 5-year depreciation	2,080	748	2,043	3,861	11,927
Return to land, labor, and mgt. after variable expenses	3,758	1,989	1,268	4,582	14,313
Value of non-hired labor @ $10.00/hour	1,360	810	670	3,850	350
Return to land and management	1,898	1,179	598	732	13,963
Total yield (lb)	61,008	28,992	37,384	24,127	74,972
Gross receipts	$21,352	$10,948	$13,244	$ 8,443	$26,240
Return to land, labor, and mgt. after cash costs	7,288	7,956	3,832	3,931	12,488
Return to land, labor, and mgt. after variable costs	13,032	7,956	5,072	4,582	14,313
Return to management	7,592	4,716	2,392	732	13,963

Table 2. Cost and returns of mixed vegetable grower/cooperators.

Inputs	Boyle County (1.0 acre)	Nelson County (0.3 acre)	Nelson County (1.0 acre)
Plants and seeds	$ 150.00	$ 140.00	$800.00
Fertilizer	75.00	45.00	200.00
Black plastic	130.00	45.00	130.00
Drip lines	180.00	60.00	180.00
Fertilizer injector	50.00*	50.00*	50.00*
Herbicide	--------	------	60.00
Insecticide	20.00	20.00	100.00
Fungicide	--------	40.00	300.00
Water	212.00 (65,000 gal)	90.00 (48,000 gal)	200.00 (240,000 gal)
Labor	120.00 (488.0 hr)	120.00** (240.0 hr)	7,800.00** (830.0 hr)
Machine	78.00 (8.0 hr)	56.90 (6.4 hr)	160.00 (20.0 hr)
Marketing	75.00	350.00	950.00
Total expenses	1,090.00	1,016.00	10,930.00
Income	9,975.00	2,240.00	13,200.00
Net income	8,885.00	1,223.20	2,270.00
Net income/acre	8,885.00	4,077.33	2,270.00
Dollar return/Dollar input	9.2	2.2	1.2

* Cost amortized over three years.
** Does not include unpaid family labor.

Despite the adverse weather conditions and being a little late in getting their project started, the group of growers in northern Kentucky who were growing Roma tomatoes for the pilot project had a mostly positive outcome. The late start forced growers to transplant in less-than-ideal conditions, and a large number of plants died of excessive heat from the black plastic. Most of the dead plants were replaced, but wet weather hampered growing conditions most of the remaining growing season. Disease problems, particularly early blight, bacterial spot, and bacterial speck, were evident early and required a vigorous spray program. Later in the growing season, weeds became a big problem for many of the growers, but most had fairly good yields and made a profit (Table 1).

The grower/cooperators who were growing for the farmers' markets and on-farm markets had a much wider variety of produce and did not seem to be affected as adversely as the Roma tomato growers. Still, these growers had disease and weed problems to overcome, due primarily to the cool and wet conditions that persisted all season. Considering the difficult growing conditions, crop yields were good, and prices remained strong for most items, resulting in good returns to those growers. These growers intend to continue and expand for the next season (Table 2).

On-Farm Commercial Vegetable Demonstrations in South-Central Kentucky

Nathan Howell, Department of Horticulture

Introduction

Five on-farm commercial vegetable demonstrations were conducted in south-central Kentucky. Grower/cooperators for the demonstrations were located in Hardin, Hart, Simpson, and Warren counties. The cooperator in Hardin County had a demonstration plot of approximately 0.05 acre consisting of heirloom and hybrid tomatoes produced within a high tunnel production system. The cooperator marketed his produce to local stores and restaurants within the Elizabethtown marketing region. The Hart County demonstration plot of mixed vegetables was approximately 1 acre, and the produce was marketed at regional farmers' markets, roadside stands, and an area produce auction.

Two on-farm demonstrations were located in Warren County. One demonstration plot was approximately 0.35 acre consisting of mixed vegetables and was marketed at regional farmers' markets and restaurants within the Bowling Green marketing area. The second demonstration was 0.25 acre of field tomatoes. This cooperator operated a roadside market where he sold much of his crop. The fifth plot was located in Simpson County and was part of an educational program with the FFA chapter within that county. The plot consisted of 0.14 acres of field tomatoes, which were marketed at the high school and to local restaurants and stores near Franklin, Kentucky. Funds for this program were made possible from a grant from the Kentucky Horticulture Council from the Agricultural Development Board.

Materials and Methods

Grower/cooperators for the demonstration plots were provided with production supplies such as black plastic mulch, drip irrigation lines, blue lay-flat tubing, and fertilizer injectors. Grower/cooperators were also able to use the Horticulture Department's equipment for raised-bed preparation and transplanting. Field preparation was followed by fertilizer applications according to soil test results and recommendations provided by the University of Kentucky. Plastic for the demonstrations was laid in March and May. The plots used the standard black plastic mulch. The plastic cover and tunnel frame were provided in addition to the plastic mulch and drip irrigation for the Hardin County high tunnel demonstration plot. Three of the demonstration plots used a municipal water source, while two plots, including the Hardin County plot and the Warren County tomato plot, used surface waters, all with irrigation runs no longer than 300 feet. All plots used a Mazzei type injection system for fertilizer applications.

The Hardin County grower/cooperator produced his transplants, while the other grower/cooperators had local greenhouse managers produce their transplants. Demonstrations were planted from the last week of April through the end of June. The mixed vegetable demonstrations used 18-inch in-row spacing for their tomatoes and watermelon and 24-inch spacing for cantaloupes. Pepper plants were planted on 12-inch in-row spacing with two rows on each raised plastic bed. The remaining demonstration plots used 18-inch in-row spacing for their tomatoes. All the demonstration plots had bed rows 6 to 7 feet on center.

After plants were established, insecticides were applied to prevent damage from cucumber beetles and other insects. Imidacloprid (Admire), endosulfan, and permethrin were used for insect control. Imidacloprid was used as a soil drench and was effective for three weeks. Insect control for the remainder of the season was achieved by alternating insecticides on a weekly basis until harvest. Three weeks after transplanting, the grower cooperators began making preventative fungicide applications. Bravo Weather Stick, Mancozeb, and Quadris were used. These fungicides were applied on the demonstration plots on an alternating weekly schedule for disease control. The University of Kentucky's recommendations from *Vegetable Production Guide for Commercial Growers* (ID-36) were used for insecticides and fungicides. Fixed coppers were also used in the tomato demonstrations for control of bacterial problems throughout the year. The demonstration plots were irrigated with at least 1 acre-inch of water per week and fertigated weekly with greenhouse-grade calcium or potassium nitrate following the University of Kentucky's recommendations in *Vegetable Production Guide for Commercial Growers* (ID-36). Harvest for the demonstration plots began in July and was completed by late October.

Results and Discussion

The 2009 season started off with above-average temperatures in June; however, temperatures later in the production season were below average. This growing season was also one of the wettest on record. The wet weather contributed to the disease issues that were abundant in the south-central Kentucky growing region. This season the use of raised beds and plastic mulch proved profitable; both methods reduced disease pressure by increasing airflow and moving water away from the plant and roots.

Late blight was the leading pathogen recorded among the plots and accounted for much of the losses in each of the plots that had tomato production. The Simpson County tomato plot was hit with pythium shortly after transplanting to the field, and nearly half the field plot had to be replanted with a treatment of Ridomil Gold. The high tunnel, which was somewhat protected from the extreme wet weather, produced the most disease-free tomatoes; however, some plants did collapse due to southern blight.

There were some marketing issues this year as well. The Simpson County plot overproduced for its market and thus had some product that went unsold. The Hart County producer used many forms of marketing; in doing this, he saw a broad range in pricing from high retail prices to low prices in the wholesale market such as those at the regional produce auctions. The Warren County demonstrations used established markets and saw high prices throughout the season.

Overall, it was a productive and profitable year for demonstrators. Grower/cooperators learned the importance of critical timing and the need to follow recommendations in a timely manner. In addition, the grower/cooperators learned the importance of locating markets before harvest time. All the cooperators from 2009 are planning on using the plasticulture system in 2010. The high tunnel demonstrator is planning on earlier first crop planting so he can add a second crop of tomatoes in the fall.

The cooperators' cost and returns are listed in Table 1.

Table 1. Costs and returns from on-farm demonstrations of mixed vegetable, tomato, and high tunnel crops in Hart, Hardin, Simpson and Warren counties in 2009.

Inputs	Hart Co. Mixed Vegetables (1 acre)	Hardin Co. High Tunnel (0.05 acre)	Simpson Co. Tomato (0.14 acre)	Warren Co. Tomato (0.25 acre)	Warren Co. Mixed Vegetables (0.35 acre)
Plants/Seeds	468	71	205	400	410
Fertilizer/Lime	512	25	55	75	245
Black plastic	180	10	18	45	63
Drip line	144	8	14	36	50
Tomato stakes, pea fence, high tunnel, etc.[1]	35	225	65	12	30
Herbicides	0	5	15	75	52
Insecticides	175	10	25	100	75
Fungicides	300	15	49	110	102
Pollination	0	0	0	0	free
Machine[2]	25	25	25	25	25
Irrigation/Water[3]	200	12	80	50	210
Labor[4]	0	115	0	80	0
Market fees	125	0	0	0	175
Total expenses	2164	521	551	1008	1437
Income—retail	6700	1400	860	3000	11,811
Net income	4536	679	309	1992	10374
Dollar return/Dollar input	3.10	2.69	1.56	2.98	8.22

1 Five-year amortization on high tunnel and three-year amortization on tomato stakes.
2 Machine rental, fuel and lube, repairs, and depreciation.
3 Three-year amortization of irrigation system plus city water cost where applied.
4 Does not include unpaid family labor.

On-Farm Vegetable Demonstrations in Northwestern Kentucky

Nathan Howard, Department of Horticulture

Introduction

Four on-farm commercial demonstration plots were conducted in northwestern Kentucky in 2009. Grower/cooperators were located in McLean and Henderson counties. None of the grower/cooperators had ever used the plasticulture system for commercial production before. Funds for this program were made possible from a grant from the Kentucky Horticulture Council from the Agricultural Development Board.

Materials and Methods

Each grower/cooperator was provided up to an acre of black plastic mulch and drip irrigation lines for production. Grower/cooperators also used the Horticulture Department's plastic mulch layer, waterwheel setter, and plastic mulch lifter. All grower/cooperators took soil tests and fertilized according to University of Kentucky recommendations. Fungicides and insecticides were applied according to recommendations in *Vegetable Production Guide for Commercial Growers* (ID-36). The commercial vegetable crops associate working with the grower/cooperators made regular visits and assisted with production information throughout the season.

Results and Discussion

The 2009 growing season was a major challenge for many producers. For the second consecutive year, growers had to deal with very wet weather in April and May. The late start to the crops caused many producers to delay planting by as much as four weeks. Those growers who were able to lay plastic in a short three-day window in April were able to stay on schedule. Summer and fall brought mild and wet conditions that led to serious disease issues throughout the region. Disease management proved to be one of the biggest challenges growers dealt with.

The grower/cooperator in McLean County laid the plastic and drip irrigation in the fall of 2008 in his high tunnel. The grower wanted to make sure everything was in place to set early tomatoes the next March. The 30 x 96 tunnel was filled with tomatoes on March 30 and, although a wind storm tore the plastic off in the middle of April, most of the plants were saved. This delayed production a couple of weeks, but the grower/cooperator's crop was still ahead of field-planted tomatoes by two weeks. This grower/cooperator sold from a roadside stand, farmers' market, and wholesale venues and was able to make a profit from the tunnel (Table 1).

Table 1. Costs and returns of four vegetable demonstration plots in northwestern Kentucky in 2009.

Inputs	McLean Co. 30x96 High Tunnel Tomatoes	Henderson Co. 0.6 ac Mixed Veg.	Henderson Co. 1 acre Mixed Veg.	Henderson Co. 0.4 acre Pumpkins
Plants/Seed	$140	$350	$450	$138
Fertilizer/Lime	90	497	275	75
Plastic	10	140	178	71
Drip lines	7	87	145	58
Herbicide	0	10	100	50
Insecticide	0	70	250	100
Fungicide	75	108	225	80
Irrigation/Water[1]	67	483	150	60
Field labor[2]	0	2582	0	200
Machinery	65	55	100	110
Marketing	0	100	200	0
Total expenses	454	4482	2073	942
Income	8400	6089	3350	1400
Net income	7946	1607	1277	458
Net income/A	7492	2678	1277	1145
Dollar return/ Dollar input[3]	18.5	1.36	1.62	1.49

[1] Includes the cost of fuel and five-year amortization on irrigation system.
[2] Includes paid labor for field work; does not include unpaid family labor.
[3] Dollar return/Dollar input = Income/Total expenses.

The other three grower/cooperators were in Henderson County. A family grower/cooperator did this project for their children to learn about production and marketing of horticultural products. They raised 0.6 acre of mixed vegetables including tomatoes, squash, peppers, green beans, and sweet corn. The produce was sold from a roadside stand and from the Henderson Farmers' Market. The family paid the children on an hourly basis, and this is reflected in the field labor expense line in Table 1. The production for the season was outstanding, and a profit was made from the plot.

The next demonstration plot was to teach the grower/cooperator's grandchildren about production. The grower/cooperator was an established small-fruit producer who wanted to branch out into vegetables. The grower/cooperator raised 1 acre of mixed vegetables including sweet corn, tomatoes, cabbage, peppers, green beans, potatoes, squash, and watermelons. All produce was marketed from a roadside market along with the other fruit crops. A net profit was made from the plot.

The third grower/cooperator in the county was an experienced pumpkin producer. The grower/cooperator wanted to use plastic and drip irrigation to try to increase production. White plastic was used in this plot to keep the transplants from being damaged from the heat of the black plastic in June. The grower/cooperator raised 0.4 acre of jack-o'-lanterns for roadside stand sales on a heavily traveled road in the county. Pumpkins were harvested starting Sept. 15, and sales continued through Oct. 31. The grower/cooperator was able to make a profit from the plot but will probably not use plastic next season.

All four grower/cooperators were pleased with their production this season. They all plan to continue to raise produce again in 2010, with minor changes being made in the operations in both production and marketing.

On-Farm Vegetable Demonstration in Western Kentucky

Vaden Fenton, Department of Horticulture

Introduction

Three on-farm commercial vegetable demonstration plots were conducted in western Kentucky in 2009. Grower/cooperators were located in Crittenden, McCracken, and Muhlenberg counties. None of the growers had used the plasticulture system for commercial production before. Two mixed vegetable and one onion plot were planted. Each plot was 0.25 acre. Production using black and white plastic was compared on the onion plot.

Material and Methods

Each grower was provided up to 0.25 acres of plastic mulch and drip lines for the production season. The University of Kentucky Horticulture Department provided plastic mulch and a drip layer and a waterwheel setter to establish the plantings. All the growers were asked to conduct a soil test and make any soil amendments according to University of Kentucky recommendations. Regular visits were made to each grower. When fungicides and insecticides were utilized, they were applied in accordance with recommendations in the University of Kentucky's *Vegetable Production Guide for Commercial Growers* (ID-36).

Results and Discussion

The grower in McCracken County produced 0.25 acres of mixed vegetables. Some of the transplants were bought from a local greenhouse, and the others were grown by the producer. A wet spring caused planting to be delayed until May 22. This grower had indicated a willingness to concentrate on organic production or at least reduce chemical use for mixed vegetable production. Neem was applied three times for the control of aphids on tomatoes. This grower was successful, marketing most of her crop to a local health food store and some directly to a local restaurant. This grower indicated that the yield produced by using the plasticulture was approximately triple the yield obtained the previous year on the same size plot using bare-ground production.

The grower in Crittenden County produced 0.25 acres of onions. Walla Walla and Candy onions were planted on 31 March and 1 April 2009. Approximately 5,000 Candy and 1,000 Walla Walla onions were grown on white plastic, yielding 2,660 and 405 pounds of marketable onions, respectively. The grower also planted 4,000 Candy and about 600 Walla Walla onions on the black plastic with yields of 1,680 and 210 pounds, respectively. Onions were harvested from June until mid-July. Based on observations, the onions grown on white plastic were large and had better yields than those grown on the black plastic mulch.

The grower in Muhlenberg County had 0.25 acres of mixed vegetables. Although weed pressure was high, the use of black plastic ensured that parts of the planting yielded enough to be successfully marketed locally.

Table 1. Cost and returns of three commercial vegetable demonstration plots in western Kentucky.

Inputs	McCracken Co.	Crittenden Co.	Muhlenberg Co.
Plants/Seeds	$234	$288	$100
Fertilizer	164	95	100
Plastic	42	42	42
Drip lines	37	37	37
Herbicides	0	0	0
Insecticides	20	0	30
Irrigation	100	0	450
Field labor	0	0	0
Machinery	0	0	0
Total expense	597	462	759
Income	865	2500	1000
Net income	268	2038	241
Net income /acre	1072	8152	964
Dollar return/Dollar input	1.4	5.4	1.3

Peach Variety Demonstration

Dwight Wolfe, June Johnston, and Ginny Travis, Department of Horticulture

Introduction

One of the initial and most important decisions every fruit grower makes is cultivar choice. Although important for growers, evaluating cultivar performance requires significant resources due to the time required for trees to bear fruit. It is also expensive due to the large number of cultivars available. One way of reducing this cost is to conduct a variety trial of the most recent cultivars with the potential to perform well in Kentucky.

Materials and Methods

In 2004, a block of 37 peach cultivars was planted in the orchard of the University of Kentucky Research and Education Center (UKREC) at Princeton, Kentucky (1). This planting consisted of two trees per variety spaced 6 feet apart within rows 18 feet apart. The phenology (timing of flowering, etc.) of each cultivar was recorded in 2005 (1), in 2006 (2), and again in 2007 and 2008 (3). In the spring of 2009, one tree per variety was removed in order to allow adequate spacing for future growth. Yield, fruit size (average weight of 25 fruits), and Brix readings of three fruits were recorded at harvest in 2006, 2008, and 2009. No fruit was harvested in 2007 due to a series of freezes from April 5 through April 10, 2007, that affected all fruit crops in Kentucky. In July 2009, trees were rated on the degree to which they showed signs of bacterial spot infection, based on a scale from 1 to 5, with 1 representing negligible number of leaves with signs of infection and 5 representing half or more of the leaves showing signs of infection.

Table 1. Results of the 2009 harvest from the 2004 peach cultivar trial at Princeton, Ky.

Cultivar	Date of Harvest 2008	Date of Harvest 2009	Cumulative Yield[1] (lb/tree)	Yield (lb/tree) 2008	Yield (lb/tree) 2009	Fruit Wt. (oz) 2008	Fruit Wt. (oz) 2009	Brix (%) 2008	Brix (%) 2009	Bacterial Spot[2]
Allstar	August 4	July 27	196.3	111.1	29.9	5.1	6.8	12.3	9.9	1.0
Blushingstar	August 7	July 30	181.3	55.9	78.3	4.8	7.1	12.4	9.2	1.0
Contender	August 4	July 26	212.0	119.2	45.3	4.5	6.8	12.0	10.6	1.0
Coralstar	August 1	July 21	155.2	89.9	28.8	5.4	9.6	14.8	11.3	2.0
Cresthaven	August 18	August 7	122.8	48.8	40.0	7.1	7.6	12.0	11.9	1.5
Crimson Rocket	July 30	July 30	17.6	8.1	7.0	3.7	.	14.8	12.3	1.0
Encore	August 26	August 17	156.9	80.0	25.5	6.9	7.1	12.7	13.0	1.0
Ernie's Choice	July 30	July 24	11.4	2.6	8.4	3.4	5.1	16.8	10.9	2.0
Flat Wonderful	July 14	June 20	34.1*	17.4	16.7	3.8	3.4	12.0	13.5	2.0
Galaxy	August 21	July27	73.0*	71.9	1.1	4.9	.	13.8	18.0	3.0
Glowingstar	August 7	July 30	255.9	112.2	75.2	5.6	6.2	10.9	11.6	1.0
John Boy	July 28	July 22	205.6	46.6	105.2	6.0	6.1	13.7	11.9	1.5
John Boy II	August 1	July 27	84.4	73.5	22.0	4.8	5.4	12.5	9.3	1.5
Klondike White	July 30	July 24	128.1	107.3	3.1	4.7	5.6	16.0	12.8	1.0
Laurol	August 28	August 28	189.9	87.3	46.2	6.2	7.9	12.7	12.9	2.0
PF 1	June 29	June 24	131.4	56.5	49.3	3.4	5.2	8.2	.	1.5
PF 15A	July 28	July 2	122.8	75.0	10.8	3.5	4.9	8.0	10.9	2.0
PF 17	August 4	July 28	193.5	75.6	75.2	5.4	5.9	10.7	10.7	2.0
PF 20-007	August 1	July 20	175.3	86.7	31.7	6.5	9.6	10.1	10.4	2.0
PF 24C	August 11	August 5	125.0	41.8	57.6	6.2	4.5	11.1	.	1.0
PF 25	August 21	August 7	128.1	79.5	28.6	4.9	8.0	13.2	12.6	1.0
PF 27 A	August 15	August 7	73.7	58.3	2.2	4.5	.	12.3	.	1.0
PF 35-007	August 15	August 13	116.2	36.9	55.4	5.1	10.2	13.8	12.7	2.0
PF 5B	June 29	June 10	102.8	59.8	17.6	3.4	4.4	10.0	9.8	2.0
PF 7	July 11	June 30	94.1	51.3	33.0	3.8	5.6	10.2	8.3	2.0
PF Lucky 13	July 21	July 2	130.9	86.0	7.9	3.1	4.2	11.0	11.5	2.0
PF Lucky 21	August 4	July 4	172.5	84.0	58.1	6.5	5.6	11.8	10.3	2.0
Redhaven	July 22	July 15	129.5	80.6	7.9	3.7	4.9	11.5	11.7	2.0
RedStar	July 22	July 16	91.1	49.2	14.1	4.0	5.4	12.1	9.7	2.0
Reliance	July 14	July 14	35.4*	27.5	7.9	4.2	4.8	11.0	11.9	3.0
Snow Brite	July 14	no harvest	99.0	26.2	0.0	2.5	.	10.6	.	3.0
Snow Giant	August 25	August 25	82.7	81.8	55.0	7.9	7.9	13.3	10.5	3.0
Spring Snow	June 27	June 5	13.0*	5.1	7.9	3.1	3.8	9.6	13.1	2.5
Sugar Giant	August 15	July 27	19.8	16.7	1.3	5.4	.	11.3	10.9	4.0
Sugar May	July 8	June 5	24.9*	21.3	3.5	2.5	4.4	9.2	11.9	3.0
Summer Breeze	July 25	July 18	122.4	70.0	27.7	5.0	5.4	10.8	9.9	2.0
Sweet-N-Up	August 7	July 30	45.4	29.5	15.8	7.3	8.5	14.7	11.8	1.0
White Lady	August 7	July 20	124.8	76.6	8.8	3.1	5.6	10.1	11.7	2.0

[1] 2006, 2008, and 2009. There was no harvest in 2007 due to the spring freeze. * indicates first harvested in 2008.
[2] Bacterial spot rating is based on a scale from 1 to 5, with 1 representing negligible number of leaves with signs of infection to 5 representing half or more of the leaves showing signs of infection.

Results and Discussion

The date of harvest averaged about 11 days earlier in 2009 than it did in 2008 (Table 1). Glowingstar, Contender, and John Boy all have the highest cumulative yields to date. Allstar, Coralstar, Glowingstar, and Klondike averaged the highest yields per tree in 2008, while John Boy, Blushingstar, Glowingstar, and PF 17 were the highest in 2009. Yield in 2009 averaged about 63 percent of the yield in 2008. This 37 percent reduction in yield was probably due to cooler-than-normal weather in 2009. The lighter crop along with the above-normal rainfall resulted in fruit size being slightly larger in 2009 than it was in 2008. Fruit averaged about 6.2 ounces per fruit in 2009 versus 4.8 ounces in 2008. Brix readings averaged 11.4 in 2009 versus 11.9 in 2008. The cloudy, rainy weather resulted in both a decrease in production and a slight dilution of sugars during fruit development. Even though bacterial spot was also more of a problem than in previous years as a result of the wet, rainy growing season in 2009, the majority of the varieties grown at UKREC appear to be fairly resistant to bacterial spot (Table 1).

All peach cultivars in this trial generally have good flavor. Flat Wonderful and Galaxy are peento (flat-shaped) peach cultivars. Crimson Rocket has a pillar or columnar growth habit, while Sweet-N-Up has an upright growth habit. Blushingstar, Galaxy, Flat Wonderful, Klondike White, Snowbrite, Snow Giant, Spring Snow, Sugar Giant, Sugar May, and White Lady are white-fleshed cultivars. Numbered cultivars beginning with PF are Paul Friday selections.

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Rootstock Effects on Apple and Peach Tree Growth and Yield

Dwight Wolfe, Doug Archbold, June Johnston, and Ginny Travis, Department of Horticulture

Introduction

Apple and peach are the principal tree fruits grown in Kentucky, although the hot and humid summers and heavy clay soils make apple and peach production more difficult in Kentucky than in some neighboring tree-fruit-producing regions. Despite these challenges, productive orchards offer high per acre income and are suitable for rolling hills and upland soils. Furthermore, orchards on these sites have less potential for soil erosion.

Kentucky imports more apples and peaches than it produces. Identification of improved rootstocks and cultivars is fundamental for advancing the Kentucky tree fruit industry. For this reason, Kentucky cooperates with 39 other states and three Canadian provinces in the Cooperative Regional NC-140 Project titled "Improving Economic and Environmental Sustainability in Tree Fruit Production through Changes in Rootstock Use." The NC-140 trials are critical to Kentucky growers, allowing them to gain access to and test new rootstocks from around the world. The detailed and objective evaluations allow growers to select the most appropriate rootstocks for Kentucky.

The NC-140 orchard trials are research trials that also serve as demonstration plots for visiting fruit growers, extension personnel, and researchers. The data collected from these trials help establish baseline production and economic records for the various orchard system/rootstock combinations that can be used by Kentucky fruit growers.

Table 1. Blackheart injury to xylem and winter injury to scion and rootstock bark in the 1999 NC-140 dwarf and semi-dwarf apple rootstock trial, UKREC, Princeton, Ky.

Rootstock	Blackheart Injury of Xylem (%)	Winter Injury of Rootstock Bark (%)	Winter Injury of Scion Bark (%)
Dwarf			
Supporter 1	13.0	0.0	0.5
Supporter 2	19.2	4.2	1.3
M.26 EMLA	11.9	2.0	2.0
CG.5179	11.4	2.0	1.0
G.16T	7.0	0.0	1.8
Supporter 3	12.4	0.0	0.0
M.9 NAKBT337	18.7	20.0	0.5
G.16N	11.1	1.3	3.3
CG.4013	20.0	0.0	1.0
CG.202	9.1	0.0	3.3
CG.41	7.2	0.0	0.0
Mean	13.4	2.2	1.4
LSD (5%)	NS	11.2	NS
Semi-Dwarf			
M.7 EMLA	12.8	7.5	1.8
M.26 EMLA	10.1	2.5	3.0
CG.4814	6.9	0.0	1.3
CG.7707	15.9	0.0	0.0
CG.30 N	11.9	0.0	2.5
Supporter 4	20.0	50.0	0.0
Mean	11.8	5.3	1.7
LSD (5%)	NS	12.6	NS

Materials and Methods

Grafts of known cultivars on the various rootstocks were produced by nurseries and distributed to cooperators. The University of Kentucky terminated one trial planted in 1999 and has three current NC-140 rootstock plantings at the University of Kentucky Research and Education Center (UKREC) at Princeton:

1. The 1999 dwarf and semi-dwarf apple rootstock trials were terminated at the end of the 2008 growing season. Yield and performance data were published in the *2008 Fruit and Vegetable Report* (3). In 2009, samples were collected for determining the degree of blackheart in the xylem tissue of the trunks of these trees 6 inches above the graft union. The degree of winter injury on the bark of the Fuji scions and various rootstocks was also assessed.
2. The 2002 apple rootstock trial compares nine rootstocks: three clones of M.9, two clones each of B.9 and M.26, and one clone each of Supporter 4 and of P.14. All have Buckeye Gala as the scion. Seven replications of each rootstock were planted in a randomized complete block design. The planting has seven rows with a pollenizer tree at the end of each row. A trellis was constructed and trickle irrigation installed a month after planting. Trees were planted on 8-foot x 15-foot spacing.
3. The 2003 apple rootstock trial compares 11 rootstocks with Golden Delicious as the scion. Two trees of each rootstock were planted in a randomized complete block design with four replications (blocks). Trees were planted on 8-foot x 15-foot spacing.
4. The 2009 peach rootstock trial compares 14 rootstocks with Redhaven as the scion cultivar. Eight trees of each rootstock were planted in a randomized complete block design with eight replications (blocks). Trees were planted on 16-foot x 20-foot spacing.

Table 2. 2009 results from the 2002 NC-140 apple rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (no. trees planted)	Cumulative Yield, 2004-09 (lb/tree)	Yield (lb/tree)	Fruit Wt. (oz)	Trunk Cross-Sectional Area (sq. in.)	Cumulative Yield Efficiency (lb/sq. in.)
P.14	43 (7)	716	334	5.7	20.3	35.8
M.9 Burgmer 756	29 (7)	525	225	5.2	13.4	39.4
M.9 NAKB T337	43 (7)	478	248	6.1	11.4	41.8
M.26 NAKB	57 (7)	420	172	5.8	10.8	39.1
M.9 Nic29	57 (7)	348	149	5.4	7.1	47.2
Supporter 4	43 (7)	333	112	6.2	6.7	49.4
M.26 EMLA	43 (7)	297	94	5.3	8.0	36.7
B.9 Treco	86 (7)	177	49	4.7	3.6	45.5
B.9 Europe	71 (7)	100	23	4.3	2.1	46.4
Mean	52	338	137	5.3	8.2	43.8
LSD (5%)	NS	174	80	0.9	3.9	NS

[1] Arranged in descending order of cumulative yield.

Table 3. 2009 results from the 2003 NC-140 apple rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (no. trees planted)	Cumulative Yield, 2005-09[2] (lb/tree)	Yield (kg/tree)	Fruit Wt. (oz)	Trunk Cross-Sectional Area (sq. in.)	Cumulative Yield Efficiency (lb/sq. in.)
PiAu56-83	100 (8)	480	108	7.7	28.7	16.7
PiAu51-4	100 (7)	429	69	7.2	25.7	16.8
CG.5935	50 (8)	398	67	7.5	9.5	41.3
M.9 Pajam2	88 (8)	370	35	7.2	14.0	26.6
Bud.62-396	100 (8)	359	86	6.9	10.0	36.9
J-TE-H	100 (8)	356	5	-	12.2	29.4
CG.3041	88 (8)	307	36	7.1	9.5	32.4
G.16	50 (8)	289	30	7.3	10.9	26.6
M.26	75 (8)	280	43	7.6	12.1	23.5
M.9 NAKBT337	88 (8)	274	21	7.5	10.7	41.7
B.9	50 (8)	106	24	6.7	2.6	41.7
Mean	80	344	49	7.3	14.2	28.0
LSD (5%)	33	106	63	NS	3.4	7.6

[1] Arranged in descending order of cumulative yield.
[2] There was no yield in 2007 due to a spring freeze and extensive bird damage during that season.

Orchard floor management consists of a 6.5-foot bare-ground herbicide-treated strip with mowed sod alleyways. Trees are fertilized and sprayed with pesticides according to local recommendations (1, 2). Yield and trunk circumference measurements are recorded for all the rootstock trials, and trunk cross-sectional area is calculated from the trunk circumference measurements taken 10 inches above the graft union for apple and 6 inches above the graft union for peach. Cumulative yield efficiency is the cumulative yield divided by the trunk cross-sectional area of the tree. It is an indicator of the proportion of nutrient resources a tree is putting into fruit production relative to vegetative growth. Tree height and canopy spread (the average of the within-row and across-row tree widths) are recorded at the end of the fifth and final (usually the tenth) seasons of each trial. Fruit size is calculated as the average weight (oz) of 50 fruits.

Results and Discussion

As reported in 2007 (3), all of our NC-140 apple plantings at UKREC sustained damage that severely reduced yield in that year due to a series of devastating freezes from April 5 through April 10, 2007, that affected all fruit crops in Kentucky. Also, Hurricane Ike blew through western and northern Kentucky on Sept. 14, 2008. At UKREC, some fruit was blown off trees, and some trees were broken at either the graft union or at their roots just below the soil line. Nevertheless, the heavy bloom in the spring of 2008 resulted in excellent yields.

The 2009 growing season in Kentucky had the second coolest and eighth wettest July and the 24th coolest August and 56th driest August in the past 115 years. Over the past 12 months, the temperature was on average only 0.4°F lower than normal.

Kentucky growers produced an apple crop that was about 60% of normal due to poor pollination caused by a cool, wet spring and the light cropping year in a biennial bearing situation. Fruit set in clusters randomly within trees for many varieties. Most growers decided not to thin their apples this season. Fruit size was often smaller than normal due to low seed numbers, while adequately pollinated fruit were large. Fruit color was outstanding at UKREC.

1. 1999 Apple Rootstock Trial

The 1999 dwarf and semi-dwarf apple rootstock trial was terminated at the end of the 2008 growing season. Three trees in the dwarf rootstock planting (one each on CG.41, CG.5179, and CG.202) and seven trees in the semi-dwarf planting (one each on CG.4814 and M.26, two on CG.7707, and three on Supporter 4) broke off at either the roots or graft union during the summer of 2002. In 2004, one tree on M.9 NAKBT337 and one tree on M.26 EMLA broke off at the graft union in the dwarf rootstock planting, and another tree on Supporter 4 died in the semi-dwarf planting. In 2005, one tree on M.26 EMLA and one tree on Supporter 4 were blown over and broken at their roots in the semi-dwarf planting. In 2008, due to Hurricane Ike, two trees on Supporter 3 and one tree on M.9 NAKBT337 were broken off at their roots just below the soil line; one tree on CG.202 was broken at its graft union.

There were no significant differences among either the dwarfing or semi-dwarf rootstocks with regard to either blackheart injury in the xylem or winter injury of scion bark. The percent winter injury on the bark of M.9 and Supporter 4 was significantly higher than that observed for the other dwarfing rootstocks and the semi-dwarfing rootstocks, respectively (Table 1).

2. 2002 Apple Rootstock Trial

Sixty-three trees of Buckeye Gala were planted in 2002. A few trees have been lost to fire blight and wind breakage, but significant differences in tree mortality have not been observed to date (Table 2). Significant differences were observed for cumulative yield, yield, fruit size, and trunk cross-sectional area, but no differences were observed in number of root suckers, cumulative yield efficiency, or tree mortality (Table 2). The cumulative yield was greatest for scions on P.14 and M.9 Burgmer 756. The P.14 and the two B.9 rootstock strains have produced the largest and smallest trees, respectively.

3. 2003 Apple Rootstock Trial

Mortality, cumulative yield, yield, trunk cross-sectional area, and cumulative yield efficiency varied significantly among the rootstocks in the 2003 apple rootstock trial (Table 3). Trees on B.9, G.16, and CG.5935 rootstocks have the highest mortality (50%) in this trial. The highest cumulative yield and highest yield for 2009 were observed for scions on Pi Au 56-83, which also had the largest fruit size and trunk cross-sectional area. Biennial bearing in this trial was evident in that yield in 2009 averaged only about one-fourth of the 2008 yield. Biennial bearing was the worst for scions on J-TE-H where a fruit sample size of at least 50 fruit per tree could not be obtained, and fruit size could not be calculated.

Table 4. 2009 NC-140 peach rootstock planting, Princeton, Ky.

Rootstock[1]	Tree Mortality (% lost)	Trunk Cross-Sectional Area (sq. in.)	Number of Root Suckers
Atlas	0	1.54	0
P. American	0	1.43	1.9
Guardian	0	1.29	0
Microbac	0	1.28	0
Viking	12.5	1.26	0
Krymsk 86	0	1.25	0
Bright's Hybrid	0	1.23	0.1
Lovell	0	1.05	0
Controller	0	1.03	0
HBOK 10	0	1.02	0
KV010-127	0	0.99	0
Krymsk 1	0	0.94	0.5
KV010-123	12.5	0.91	0
HBOK 32	0	0.87	0
Mean	1.8	1.15	0.2
LSD (5%)	NS	0.30	NS

[1] Arranged in descending order of trunk cross-sectional area for each rootstock.

4. 2009 Peach Rootstock Trial

Redhaven, on 14 different rootstocks with eight replications per rootstock, was planted in March 2009 in a randomized complete block design with four rows (two blocks per row) with a border tree at both ends of each row. Trickle irrigation was installed a month after planting.

No significant differences were observed for either mortality or number of root suckers, but trunk cross-sectional area did vary significantly among the 14 rootstocks in this trial (Table 4).

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Wine and Table Grape Cultivar Evaluation Trial

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Introduction

Over a six-year period, commercial grape acreage in Kentucky grew from 272 acres in 2002 to 436 acres in 2008, a 60% increase (Smigell et al., 2008). As new vineyards are planted, assessing viticultural and enological performance of economically important cultivars is extremely helpful for grape growers in Kentucky.

The continental climate and varying topography of vineyard sites in Kentucky greatly influence the production potential and fruit quality of cultivars planted. The primary types of grapes grown in Kentucky are American (*Vitis labrusca*), French-American hybrids (*Vitis labrusca x V. vinifera*), and European (*Vitis vinifera*). Although American and French-American varieties are more suited for the climate in Kentucky, European, i.e., *vinifera*, varieties often produce more desirable wines and potentially have the highest economic gain for grape growers and winemakers. However, *vinifera* varieties are more susceptible to winter injury and diseases, often resulting in a lower yield. A cultivar trial consisting of table, hybrid, and European grape varieties was conducted to assess and improve fruit and wine quality through cultural management, rootstock, and clone selection. The following research update is intended to provide growers with preliminary results of cultivar performance.

Table 1. Yield components for the 2009 American/hybrid wine grape cultivar trial, UK Horticulture Research Farm.

Cultivar / Rootstock	Harvest Date	Yield per Acre[1] (tons)	Yield per Vine (lb)	Clusters Harvested per Vine	Percent Culled Clusters Rot[2]	Percent Culled Clusters Bird[3]	Cluster Wt. (g)
White							
NY76.084	8/24	3.6	13.4	74	10	0	82.9
Cayuga White	8/27	3.4	12.4	34	11	0	177.5
Traminette	9/3	3.9	14.2	62	8	0	106.6
Traminette / 5C	9/3	4.6	16.8	49	12	0	161.2
Vignoles	9/4	3.3	12.2	73	33	0	74.7
Chardonel / C-3309	9/8	4.4	16.3	43	0	13	184.9
Chardonel	9/8	3.5	12.8	34	0	19	176.7
Vidal Blanc / 5C	9/8	5.3	19.4	47	7	0	187.6
Vidal Blanc	9/8	5.6	20.5	47	8	0	201.7
Villard Blanc	9/17	5.5	20.3	51	1	0	182.8
Red							
Foch	8/24	1.3	4.9	70	0	53	65.9
Frontenac	8/24	0.0	0.0	52	0	100	-
GR7	9/4	2.4	9.0	68	0	100	64.1
Chancellor	9/9	4.7	17.2	51	3	0	155.1
St. Vincent	9/16	4.6	17.0	46	1	0	170.2
Chambourcin / 101-14	10/5	2.9	10.6	41	2	0	119.3
Corot Noir	10/5	3.4	12.5	37	21	0	163.8
Noiret	10/7	2.4	8.9	30	10	3	140.2
Norton	10/8	2.9	10.8	70	8	0	71.2

1 Yield per acre calculated using 8 ft x 10 ft vine/row spacing, with 545 vines per acre.
2 Percentage of harvested clusters having ≥ 30% damage caused by cluster rot.
3 Percentage of harvested clusters having ≥ 30% damage caused by bird feeding.

Table 2. Yield components for the 2009 table grape cultivar trial, UK Horticulture Research Farm.

Cultivar	Harvest Date	Yield[1] per Acre (tons)	Yield[1] per Vine (lb)	Clusters Harvested per Vine	Percent Culled Clusters Rot[2]	Percent Culled Clusters Birds[3]	Cluster Wt. (g)
Reliance	7/31	4.4	16.3	32	0	4	242.1
Jupiter	8/12	2.9	10.7	32	16	2	169.1
Einset	8/17	2.0	7.4	33	0	13	111.7
Marquis	8/17	4.9	17.9	25	0	0	314.7
Neptune	9/10	2.6	9.5	16	7	0	264.4

1 Yield per acre calculated using 8 ft x 10 ft vine/row spacing, with 545 vines per acre.
2 Percentage of harvested clusters having ≥ 30% damage caused by cluster rot.
3 Percentage of harvested clusters having ≥ 30% damage caused by bird feeding.

Materials and Methods

Two research vineyards were planted in the spring of 2006 at the University of Kentucky Horticulture Research Farm in Lexington, Kentucky. Vineyard one consists of five table grape and 20 American/hybrid cultivars. Each cultivar in vineyard one had four replications with three vines per replication (12 vines total) in a randomized complete block design. All cultivars were planted at 545 vines/acre (8 feet between vines and 10 feet between rows) and trained to a 6-foot single high wire bilateral cordon. Vines were own-rooted with the exception of Chambourcin, Chardonel, Vidal Blanc, and Traminette that were planted on the rootstocks 101-14, 3309, and 5C (Vidal Blanc and Traminette), respectively. Vineyard two consists of 15 *vinifera* varieties and 21 different clones (refer to Table 3). Each cultivar and clone of a cultivar had four replications with four vines per replication (16 vines total) in a randomized complete block design. All vines were planted on the rootstock 101-14, spaced at 622 vines/acre (7 feet between vines and 10 feet between rows) and trained to vertically shoot positioned (VSP) bilateral cordons.

Standard commercial cultural management practices were implemented in both vineyards. Vines were spur-pruned in March 2008, and 30 lb/acre of N were applied as ammonium nitrate. Weed, disease, and insect control were in accordance with the *Midwest Commercial Small Fruit and Grape Spray Guide* (ID-94). Polyethylene bird netting was applied in mid-July and removed in late October. Crop and vine balance were achieved by shoot thinning to four to six shoots per foot of cordon length in mid-May and cluster thinning to appropriate crop loads post-fruit set (berries BB size). Vines on the VSP trellising system were manually hedged in late July before the onset of veraison. Fruit maturity and harvest dates were determined by taking 100-berry samples starting at veraison to monitor the progression of total soluble solids (TSS) (Atago Digital Refractometer), pH (Hannah 222 pH meter), and titratable acidity (TA) (end point titration of pH 8.2 using 0.10 N sodium hydroxide) until harvest. Each vine was harvested separately to determine the number of clusters and yield/vine. A final 100-berry sample was taken at harvest to determine fruit chemistry (TSS, pH, and TA) and berry weight.

Results and Discussion

In 2009, vines from vineyards one and two were vigorous enough to carry a full commercial crop. However, harvest data were greatly affected in 2009 due to cool, wet weather, resulting in reduced fruit set and increased incidence of powdery mildew, downy mildew, and bunch rot diseases that were especially severe in susceptible *vinifera* varieties. Yields in the American/hybrid vineyard were commercially acceptable despite the cool, wet weather late in the season (Table 1). Vignoles and Corot Noir had the highest percentage of cluster rot where 33 and 21% of the clusters were affected, respectively (Table 1). Frontenac, Foch, and GR7 had excessive bird damage, greatly reducing harvest data (Table 1). Own-rooted Vidal Blanc, Vidal Blanc/5C, Villard Blanc, Chancellor, St. Vincent, and Traminette/5C were the highest-yielding cultivars in tons/acre (Table 1). TSS and TA were within acceptable ranges for winemaking purposes. Titratable acidity was higher than normal in most cultivars due to the cool weather (Table 4).

The highest-yielding table grape cultivars were Marquis at 4.9 tons/acre and Reliance at 4.4 tons/acre (Table 2). Jupiter, Neptune, and Einset yielded less than 3.0 tons/acre. These yields are relatively low compared to previous cultivar trials; however, a yield standard for table grape production in Kentucky has not yet been established. Jupiter and Neptune had the highest incidences of bunch rot, Reliance and Einset were most affected by bird damage, and Marquis did not have any cluster damage. Fruit composition was appropriate for table grape production (Table 5). Jupiter and Marquis had TSS of less than 18 °Brix. Juice pH and TA were measured between 3.0 to 3.5 and 5.0 to 10.0 for all table grape cultivars, respectively (Table 5).

All *vinifera* cultivars yielded less than 2.0 tons/acre with the exception of Pinot Grigio/#146 and Pinot Grigio/#4 (Table 3). Additionally, all *vinifera* cultivars had > 20% cluster damage due to birds or rot except Pinot Grigio/#4, Chardonnay/#37, Chardonnay/#76, and Viognier (Table 3). Viognier had the highest TSS at 23.3, and Riesling/#9 had the lowest at 17.0 (Table

Table 3. Yield components for the 2009 vinifera wine grape cultivar trial, UK Horticulture Research Farm.

Cultivar / Clone #	Harvest Date	Yield per Acre[1] (tons)	Yield per Vine (lb)	Clusters Harvested per Vine	Percent Culled Clusters Rot[2]	Percent Culled Clusters Bird[3]	Cluster Wt. (g)
White							
Pinot Grigio / #146	8/27	3.0	13.0	57	37	0	81.8
Pinot Grigio / #152	8/27	1.7	7.3	37	47	0	71.8
Pinot Grigio / #4	8/27	2.7	11.6	48	13	0	82.0
Chardonnay / #15	9/1	0.9	3.8	25	20	0	59.5
Chardonnay / #37	9/1	1.3	5.7	28	6	0	69.1
Chardonnay / #4	9/1	1.5	6.3	25	40	15	136.7
Chardonnay / #43	9/1	1.0	4.2	23	30	10	85.7
Chardonnay / #76	9/1	1.1	4.7	23	10	0	73.5
Viognier	9/10	1.2	4.9	13	0	0	118.1
Riesling / #12	10/1	1.4	5.9	31	37	0	69.3
Riesling / #17	10/1	1.1	4.7	33	38	0	55.9
Riesling / #9	10/1	1.8	7.9	39	42	0	73.7
Red							
Limberger	10/5	1.2	5.1	32	12	33	89.8
Sangiovese / #12	10/6	1.8	7.7	22	57	20	204.1
Syrah / #383	10/8	0.0	0.2	4	100	0	-
Syrah / #470	10/8	0.3	1.2	9	80	0	83.6
Syrah / #5	10/8	0.6	2.8	13	67	0	94.4
Cabernet Franc / #1	10/20	1.0	4.5	27	26	1	64.6
Cabernet Franc / #214	10/20	0.9	3.8	29	66	4	38.0
Cabernet Franc / #312	10/20	1.5	6.6	32	26	1	82.5
Cabernet Franc / #4	10/20	0.9	3.9	34	53	0	51.7
Cabernet Franc / #5	10/20	2.0	8.5	46	32	1	68.7
Cabernet Sauvignon / #337	10/21	0.8	3.6	28	52	2	62.3

1 Yield per acre calculated using 7 ft x 10 ft vine/row spacing, with 622 vines per acre.
2 Percentage of harvested clusters having ≥ 30% damage caused by cluster rot.
3 Percentage of harvested clusters having ≥ 30% damage caused by bird feeding.

Table 4. Fruit composition for the 2009 American/hybrid wine grape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar / Rootstock	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
White				
NY76.084	2.9	18.2	3.3	8.5
Cayuga White	3.5	21.0	3.3	6.6
Traminette	1.9	21.1	3.4	6.9
Traminette / 5C	1.8	21.7	3.5	7.1
Vignoles	1.5	24.2	3.3	11.2
Chardonel / C-3309	2.6	21.5	3.2	10.1
Chardonel	2.7	21.9	3.2	10.9
Vidal Blanc / 5C	2.2	23.0	3.4	8.2
Vidal Blanc	2.0	22.3	3.3	8.5
Villard Blanc	3.1	21.4	3.2	8.7
Red				
Foch	1.4	21.2	3.5	7.2
Frontenac	1.2	21.2	3.2	12.8
GR7	1.7	22.1	3.5	9.1
Chancellor	2.1	21.4	3.4	7.5
St. Vincent	4.6	20.1	3.3	9.5
Chambourcin / 101-14	2.6	22.7	3.5	8.9
Corot Noir	2.7	19.2	3.6	5.0
Noiret	2.2	18.6	3.4	5.7
Norton	1.4	22.4	3.5	10.0

1 Fruit samples were collected and analyzed on harvest dates listed in Table 1.
2 TSS = Total soluble solids measured as °Brix in juice.
3 TA = Titratable acidity measured as grams of tartaric acid per liter of juice.

6). Juice pH and TA were generally in acceptable ranges for all cultivars except for all clones of Cabernet Franc, which were slightly imbalanced with high pH and low acids (Table 6).

Conclusions

In general, bird damage was higher in early-ripening varieties. Late-season bunch rot disease pressure greatly affected *vinifera* varieties. TSS were lower in late-ripening varieties due to excessive late-season rains. These varieties were therefore allowed to hang longer than usual to accumulate higher TSS; as a result, pH values were higher and TA values lower. Vines in both research vineyards are coming into full production, and all data presented in Tables 1 through 6 are preliminary. More years of data are needed before cultivar recommendations can be made from this trial. Cultivars that are not yet in full production and will be reported in successive years include five hybrid cultivars, own-rooted Chambourcin, Seyval Blanc, St. Croix, Valvin Muscat, and Frontenac Gris; seven *vinifera* cultivars, Cabernet Sauvignon/#8, Malbec, Petit Verdot, Pinot Noir, Rkatsiteli, Tinto Cao, and Touriga Nacional; and one table grape cultivar, Vanessa.

Table 5. Fruit composition for the 2009 table grape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
Reliance	2.8	18.6	3.1	9.7
Jupiter	4.8	17.4	3.4	7.9
Einset	2.5	20.7	3.2	6.5
Marquis	5.7	17.5	3.5	5.1
Neptune	4.1	20.2	3.2	8.8

[1] Fruit samples were collected and analyzed on harvest dates listed in Table 2.
[2] TSS = Total soluble solids measured as °Brix in juice.
[3] TA = Titratable acidity measured as grams of tartaric acid per liter of juice.

Literature Cited

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Table 6. Fruit composition for the 2009 white vinifera wine grape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar / Clone #	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
White				
Pinot Grigio / #146	1.4	19.1	3.7	6.3
Pinot Grigio / #152	1.4	19.4	3.8	5.9
Pinot Grigio / #4	1.4	19.1	3.6	6.0
Chardonnay / #15	1.6	20.5	3.6	6.3
Chardonnay / #37	1.6	20.9	3.7	6.5
Chardonnay / #4	1.7	20.9	3.6	6.6
Chardonnay / #43	1.6	20.8	3.7	6.8
Chardonnay / #76	1.6	20.5	3.7	6.5
Viognier	1.6	23.3	3.5	6.6
Riesling / #12	1.8	16.8	3.3	6.5
Riesling / #17	1.8	16.9	3.3	6.4
Riesling / #9	1.8	17.0	3.3	6.4
Red				
Limberger	2.0	20.6	3.3	7.8
Sangiovese / #12	2.7	20.7	3.4	6.0
Syrah / #383	1.6	19.9	3.5	5.8
Syrah / #470	2.3	19.8	3.5	5.6
Syrah / #5	2.0	19.4	3.4	5.7
Cabernet Franc / #1	1.6	18.8	3.6	6.2
Cabernet Franc / #214	1.6	17.3	3.5	4.8
Cabernet Franc / #312	1.9	20.2	3.9	4.1
Cabernet Franc / #4	1.6	21.2	3.7	4.2
Cabernet Franc / #5	1.8	21.5	3.9	4.1
Cabernet Sauvignon / #337	1.6	18.9	3.6	6.0

[1] Fruit samples were collected and analyzed on harvest dates listed in Table 3.
[2] TSS = Total soluble solids measured as °Brix in juice.
[3] TA = Titratable acidity measured as grams of tartaric acid per liter of juice.

Preemergent Herbicide Weed Control on Eden Shale Soil

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Introduction

Oryzalin (Surflan) and flumioxazin (Chateau) are preemergent herbicides labeled for use in grape plantings. Both have been previously evaluated on silt loam soils in Princeton, Kentucky. This experiment was conducted to compare herbicide efficacies when applied in a vineyard planted on Eden Shale type soil.

Materials and Methods

The experiment was conducted in an eight-year-old vineyard at the University of Kentucky Eden Shale Research Farm in Owen County. The experiment was set up as a completely random design with eight replications. Paired treatment and control plots were 4 feet wide by 15 feet long (60 square feet) and within the 4-foot wide, sod-free areas under the vines. All herbicide treatments were applied on 23 April. Some weed seedlings had emerged by that date, so Roundup WeatherMax was applied to all plots, at the 24 oz/acre rate on 23 April, to kill weed seedlings. The treatments were Chateau 51 WDG applied at 6 oz/acre and Surflan AS applied at 3 qt/acre. Herbicides were applied using a hand-held, one-gallon pump sprayer. For each treatment, 1.0 liter of herbicide solution was evenly sprayed on a plot to provide consistent applications. The percentage of plot area not covered by weeds (weed-free area) and weed seedling counts were made on 21 May, 28 days after treatment (DAT). On 26 June, 65 DAT, the percent weed-free area and percentages of treated area covered by different weed species were visually estimated for all treatments.

Results and Discussion

A single one-half to one inch rainfall is necessary to activate Surflan. A half centimeter (roughly one-quarter inch) of rain is needed to activate Chateau. Rain was recorded by the Kentucky

Mesonet weather station, located within 400 feet of the plots, on 28 April (0.07 in.), 29 April (0.02 in.), 30 April (0.19 in.), and 5 May (0.53 in.). Thus, the Chateau was not likely activated until about a week after application, and the Surflan about 12 days after application.

By 28 DAT, 3.8 inches of rain had fallen. The amounts of area covered by weeds were similar for plots treated with Surflan and Chateau (Table 1) and were significantly less than in the control plots. This was primarily because fewer grass seedlings emerged in the treated plots. The most common weeds were dandelion, white clover, Queen Anne's lace, and a mixture of grass species. The number of Queen Anne's lace and white clover seedlings present in treated and control plots were not significantly different. Chateau-treated plots had more dandelion seedlings than either the Surflan-treated or the control plots.

By 65 DAT, about 10 inches of rain had fallen at the vineyard. By this time, the control plots were nearly completely covered by weeds, and the treatment plots were about 70% covered. Weed coverage was similar for the Chateau and Surflan treatments. However, coverage in both treatments was less than in the control (Table 2). Ground coverage by Queen Anne's lace and white clover was statistically similar for the treatments and the controls, consistent with the measurements at 28 DAT. Dandelion coverage was significantly less in the control plots than in plots treated with either herbicide, and dandelion coverage was significantly less in Chateau-treated plots than in the Surflan-treated plots. Non-grass weed coverage tended to be higher for the treated plots than in the control plots. This may have been due to the very high levels of grass emergence in the control plots. It is likely that heavy grass cover may have shaded out other weeds or made it more difficult to assess other weed species in the control plots. The amount of area covered by grass was similar for both herbicide treatments and significantly less compared to the control plots. The most common grass species were large crabgrass, goosegrass, and yellow foxtail.

Table 1. Percentage of weed-covered area and weed seedling counts, 28 days after treatment.

Treatment/Rate	Percent Covered Area[2]		Numbers of Weed Seedlings Counted: QAL[3]		White Clover		Dandelion		Mixed Grasses	
Surflan AS 3 qt/A	13.5	a	17.0	a	17.3	a	4.1	a	43.8	a
Chateau 51 WDG 6 oz/A	8.8	a	13.3	a	12.1	a	9.1	b	9.0	a
Control[1]	25.3	b	7.8	a	19.4	a	5.8	a	301	b

[1] Treatment and control plots were all sprayed with Roundup WeatherMax (24 oz/A) on day treatments were applied.
[2] Numbers followed by same letter are not significantly different (Duncan's multiple range test LSD P = 0.05).
[3] QAL = Queen Anne's lace.

Acknowledgments

The authors would like to thank the following for their hard work and assistance in this trial: Eugene Caldwell, Pat Colligan, Tom Colligan, David Spaeth, and Ricky Smith.

Table 2. Percentage of weed-covered area and percent area covered by weed species, 65 days after treatment.

Treatment/Rate	Percent Covered Area[2]		Percent of Treatment Area Covered by Weed Species: QAL[3]		White Clover		Dandelion		ASTH[3]		Mixed Grasses	
Surflan AS 3 qt/A	73.1	a	14.0	a	2.5	a	13.4	c	1.3	a	15.1	a
Chateau 51 WDG 6 oz/A	68.1	a	6.9	a	6.3	a	7.8	b	6.3	a	29.6	a
Control[1]	96.6	b	2.7	a	1.6	a	2.1	a	4.7	a	77.5	b

[1] Treatment and control plots were all sprayed with Roundup WeatherMax (24 oz/A) on day treatments were applied.
[2] Numbers followed by same letter are not significantly different (Duncan's multiple range test LSD P = 0.05).
[3] QAL = Queen Anne's lace; ASTH = annual sowthistle.

University of Arkansas Floricane-Fruiting Blackberry Trial in Kentucky

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Introduction

The University of Arkansas Blackberry Breeding Program has developed many excellent blackberry cultivars, including Apache, Arapaho, Cherokee, Comanche, Cheyenne, Chickasaw, Choctaw, Kiowa, Navaho, Ouachita, Shawnee, and recently the selection Natchez (Clark and Moore, 2008). The objective of this study was to compare yield and fruit quality of a number of floricane-fruiting advanced selections including Natchez, developed by the University of Arkansas, to the commonly grown selections Chickasaw and Triple Crown under Kentucky growing conditions.

Materials and Methods

In June 2006, a blackberry variety trial was established at Kentucky State University (KSU) Research and Demonstration Farm in Frankfort. The trial includes the commercially available cultivars Chickasaw (thorny erect) and Triple Crown (semi-erect, thornless) and the Arkansas (A) floricane-fruiting selections A-1937T, A-2215T, A-2241T, and A-2315T. The selection A-2241T was released in 2008 as Natchez after the start of the trial. All the advanced selections are thornless and erect in stature. The experiment was arranged in a completely randomized design with two replicate plots of each selection or cultivar. Plots were 10 feet long, with plants spaced 2 feet apart.

Five-foot spaces separated each plot. Each row was 70 feet in length, and rows were spaced 14 feet apart. This trial was managed with organic practices following the National Organic Program standards. Weed control was achieved by placing a 6- to 8-inch-deep layer of straw around plants, adding straw when necessary and hand-weeding. Plants were irrigated weekly with t-tape laid in the rows. In 2007, the 7 April freeze event destroyed the flower buds of the floricanes of all the plants. In 2008 and 2009, selections flowered in June, and fruit were harvested from plants each Monday and Thursday until August.

Table 1. Harvest data for 2008 and 2009 for three advanced floricane-fruiting selections from the University of Arkansas Blackberry Breeding Program and Natchez, Chickasaw, and Triple Crown, established at the Kentucky State University Research Farm in 2006.

	2008			2009			Harvest Period	
Selection	Yield (lb/A)[1]	Berry Wt. (g)		Yield (lb/A)	Berry Wt. (g)		2008	2009
A-1937T	10430	4.3	cd	1220	3.1	bc	6/30 – 8/3	7/2 – 7/30
A-2215T	8359	3.8	d	1515	2.9	c	7/3 – 8/11	6/25– 8/3
A-2315T	6526	5.5	b	1343	4.5	abc	7/3 – 8/3	7/2 – 8/3
Natchez	8924	6.8	a	3158	5.4	ab	6/26 – 8/3	6/25 – 8/3
Chickasaw	8259	5.4	bc	3750	4.9	abc	6/30 – 8/3	6/25 – 8/6
Triple Crown	6782	4.6	bcd	5541	5.9	a	7/17 – 8/14	7/2 – 8/13
Significance	ns	0.007		ns	0.05		-	-
LSD (5%)	-	1.2		-	2.3		-	-

[1] Numbers followed by the same letter are not significantly different (Duncan's multiple range test Least Significant Difference P = 0.05).

Results and Discussion

All cultivars and advanced selections had reduced yields in 2009 compared to 2008. There was not a significant difference in yield among the cultivars and advanced selections (Table 1). Although the planting was irrigated during the drought months of 2008, the drought likely still reduced the number of floricanes and yields in all selections in 2009. Anthracnose canker also damaged some canes and reduced yields. Berry weight was significantly larger for Natchez than any other cultivar in 2008, and it had the second largest berry in 2009. Triple Crown had the latest first harvest date. Natchez is the twelfth release in a series of erect-growing, high-quality, productive, floricane-fruiting blackberry cultivars developed by the University of Arkansas. Natchez has been reported to ripen early in Arkansas, ripening slightly before or with the cultivar Arapaho and a week before Ouachita in the Arkansas trials. Natchez has been released commercially and should be a popular new addition for blackberry production in Kentucky. The advanced selections in this trial are not commercially available. Year-to-year yield and fruit quality characteristics will need to be further evaluated for these advanced selections.

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Kentucky Primocane-Fruiting Blackberry Trial

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Introduction

Primocane-fruiting blackberries have the potential to be a niche-market crop for Kentucky growers from late summer until frost. They produce fruit on current-season canes (primocanes). The first commercially available varieties, Prime-Jim® and Prime-Jan®, were released by the University of Arkansas in 2004 (Clark et al., 2005). All previous blackberry varieties have been floricane-fruiting; thus, the canes must be overwintered for fruiting the second year. This new type of blackberry has the potential to produce more than one crop per year: a normal summer crop on the floricanes and a later crop on the current season primocanes. Primocane-fruiting blackberries flower and fruit from late summer until frost, depending on temperatures, plant health, and planting location. Primocane blackberries can be pruned by mowing the canes down in the late winter. This provides anthracnose, cane blight, and red-necked cane borer control without pesticides.

Fruit size and quality of Prime-Jim and Prime-Jan are affected by the environment. Summer temperatures above 85°F can greatly reduce fruit set, size, and quality on primocanes, resulting in substantial reductions in yield and fruit quality in areas with this temperature range in summer and fall (Clark et al., 2005; Stanton et al., 2007). The fruit of Prime-Jim and Prime-Jan also do not store well for shipping and are most suitable for home gardens and on-farm sales. Advanced selections are being developed that should have improved yield, berry size, and storage and shipping characteristics. The objective of this study was to determine if advanced selections developed by the University of Arkansas Blackberry Breeding Program were superior to Prime-Jim and Prime-Jan in terms of yield and fruit quality under Kentucky growing conditions.

Materials and Methods

The variety trial was established at the Kentucky State University (KSU) Research and Demonstration Farm in Frankfort in June 2006. Varieties included two commercially available primocane-fruiting cultivars Prime-Jim and Prime-Jan (both thorny erect) and the Arkansas primocane-fruiting (APF) selections APF-27, APF-40, APF-41, APF-42, APF-46, and APF-77 (all thorny erect) that are advanced selections from the University of Arkansas blackberry breeding program. Plants were arranged in a randomized complete block design with four blocks, each having five plants of each cultivar (total of 20 plants of each cultivar).

Each cultivar plot was 10 feet long, with 2 feet between each plant, and 5-foot spaces separated cultivar plots. Each row was 70 feet long. Rows were spaced 14 feet apart. This trial was managed with organic practices following the National Organic Program standards. Weed control was achieved by placing a 6- to 8-inch-deep layer of straw around plants, adding straw when necessary and hand-weeding. Plants were irrigated weekly with t-tape laid in the rows. Primocanes were tipped on all selections at 1 meter in early June and again in September to promote lateral branching and flowering.

Table 1. Yield and berry weight in 2009 for six advanced primocane-fruiting selections from the University of Arkansas Blackberry Breeding Program and the primocane-fruiting cultivars Prime-Jan® and Prime-Jim® established at the Kentucky State University Research Farm in 2006.

	Yield (lb/A)[1]				Average Fruit Wt. (g)				Harvest Dates (start to end)	
Selection	Floricane		Primocane		Floricane		Primocane		Floricane	Primocane
APF-27	-		3682	ab	-		5.3	abc	-	7/23 - 10/13
APF-40	-		3669	ab	-		5.9	ab	-	7/23 - 10/13
APF-41	580	a	3465	ab	5.1	a	6.3	a	7/2 - 8/10	8/13 - 10/13
APF-77	-		4189	a	-		5.9	ab	-	7/23 - 10/13
Prime Jan	31	b	2517	bc	1.7	b	4.9	bc	7/2 - 8/6	8/10 - 10/13
Prime Jim	5	b	1390	c	0.6	b	4.2	c	7/2 - 8/3	8/6 - 10/13

[1] Numbers followed by the same letter are not significantly different (Duncan's multiple range test Least Significant Difference P = 0.05.

Results and Discussion

Floricanes of some selections began producing fruit in early July 2009. Fruit were harvested from floricanes each Monday and Thursday until the beginning of August, when primocane fruit harvest began (Table 1). Primocane harvest ended in mid-October. The selections APF-42 and APF-46 have been dropped from this trial, and no harvest data were collected for these two selections.

Only three primocane-fruiting selections had a limited floricane crop in 2009, with APF-41 producing the highest yields and the largest fruit (Table 1). The small floricane crop was likely the result of a combination of: 1) the drought conditions in 2008 reducing the number of canes for floricane production in 2009, 2) winter injury to canes in January and February (-2.7 ° F on 26 January 2009), and 3) anthracnose canker that damaged some canes. Primocane fruit production began in late July for most selections, although APF-41 and Prime-Jan did not ripen until early August. All the advanced selections and Prime-Jan had high primocane yields. Prime-Jim had statistically lower yields than any of the advanced selections. All the advanced selections and Prime-Jan had large fruit; Prime-Jim had smaller fruit than the other selections. Of the two selections that are currently commercially available, Prime-Jan can be recommended for limited grower trial; however, Prime-Jim cannot be recommended for grower trial in Kentucky. Year-to-year yields and fruit quality characteristics will need to be further evaluated. None of these advanced selections have yet been released for commercial production.

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Blackberry Cultivar Trial at Princeton, Kentucky

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Introduction

Blackberries are an important small fruit crop grown in Kentucky. Demand for this fruit at farmers' markets is strong and generally exceeds supply. Producers are looking for better cultivars that are productive and have berries with good size and flavor. Resistance to orange rust and rosette is also a consideration among growers. For this reason, a cultivar trial was initiated in the spring of 2006 at the University of Kentucky Research and Education Center (UKREC) in Princeton to evaluate five blackberry cultivars.

Materials and Methods

Twenty plants each of five cultivars were planted in the spring of 2006. Plants were spaced 2 feet apart within 10-foot long plots in rows spaced 20 feet between rows. Only one cultivar was allocated to each plot, and each row contained five plots. Cultivars were randomized in a randomized block design with each row being one block. Trickle irrigation was installed, and plants were maintained according to local recommendations (1, 2). Fruit was harvested twice weekly from mid-June through August 1. Fruit size was calculated as the average weight (oz) of 50 fruits.

Results and Discussion

Due to the cooler spring in 2009, pre-bloom occurred about a week earlier in 2009 than it did in 2008 (Table 1). Likewise, bloom occurred about 10 days earlier, and petal fall occurred about 21 days earlier in 2009 than it did in 2008. Anastasia was the first to reach petal fall stage in 2009 as it was in 2008. Consequently, peak harvest occurred again in June, ahead of the other blackberry cultivars (Table 2).

Yield, fruit size, and taste all differed significantly among cultivars. Chickasaw and Kiowa produced the most fruit in 2008 and 2009, respectively. Yields averaged nearly 16% more this year than last year. Kiowa and Chesapeake again had the largest berries in

2009 as they did in 2008, but berry size averaged about 27% smaller than last year for all cultivars, possibly due to a heavier crop load in 2009 than in 2008. Berry flavor lacked the sugars and was generally not as good this year as it was last year. Still, flavor was generally good except for the tayberry Anastasia, a cross between blackberry and raspberry. It has a sourer flavor than the other blackberry cultivars.

Table 1. 2008 and 2009 phenology of blackberry cultivars at UKREC, Princeton, Ky.

	1/4" Leaf		Pre-Bloom		Bloom		Petal Fall	
Cultivar	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Anastasia	April 7	April 6	May 1	April 24	May 8	April 27	May 28	May 5
Chesapeake	April 9	April 8	May 7	April 27	May 12	May 1	June 5	May 15
Chickasaw	April 1	March 31	May 1	April 24	May 8	April 27	June 1	May 8
Kiowa	April 9	April 8	May 1	April 24	May 8	April 27	June 5	May 8
OAL-W6	April 9	April 8	May 16	May 10	May 21	May 15	June 10	June 2

Table 2. 2008 and 2009 harvest results from the blackberry cultivar trial at UKREC, Princeton, Ky.

	Peak Harvest		Yield (lb/Acre[1])		Berry Size (oz/berry)		Taste Rating[2]	
Cultivar	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Anastasia	June 23	June 24	1,419	374	0.32	0.24	1.00	1.88
Chesapeake	July 8	July 4	4,360	4,949	0.43	0.30	4.63	3.87
Chickasaw	July 8	July 13	9,528	10,952	0.37	0.27	4.63	3.71
Kiowa	July 13	July 13	7,723	11,356	0.50	0.34	4.75	4.17
OAL-W6	July 10	July 8	8,844	9,269	0.33	0.23	4.63	3.83
Mean	NA	NA	6,375	7,382	0.37	0.27	3.93	3.49
LSD (0.05)[3]	NA	NA	2,450	4,438	.028	0.02	0.69	2.18

1 Based on a spacing of 20 feet between rows.
2 Based on a scale from 1 to 5 with 1= very poor, 2 = marginal, 3 = fair, 4 = good, and 5 = excellent.
3 LSD (0.05) = least significant difference at the 0.05 probability level.

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2008 Raspberry Cultivar Trial Results*

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Introduction

Raspberries are a potentially economically viable crop for Kentucky farms. Demand and prices are generally very good, and fall-bearing (also known as ever-bearing, or primocane-fruiting) raspberries can be harvested until the first hard freeze, allowing growers to get a premium price in fall farm markets. Additionally, raspberries require little pesticide spraying compared to many other fruit and vegetable crops. In the spring of 2006, a cultivar trial was established at the University of Kentucky Horticulture Research Farm in Lexington to compare survival, yields, and quality of five fall-bearing and two June-bearing raspberry cultivars.

Materials and Methods

The experimental design consisted of seven cultivars replicated five times, arranged in a randomized complete block design. Five fall-bearing cultivars were planted: Explorer, an experimental, black-fruited cultivar (P. Tallman, Nourse Farms), the red-fruited Caroline (Nourse Farms), Heritage (H. Schwartz, D. Stokes, OH), Jaclyn (Nourse Farms), and the yellow-fruited Anne (Nourse Farms). The two black June-bearing cultivars were Jewel and Mac Black (both from Nourse Farms). Rows were spaced 10 feet apart, and each cultivar was planted in a 10-foot long plot, with 10 feet of buffer space between cultivar plots. Explorer, Jewel, and Mac Black were spaced 3 feet apart within a 10-foot section, and the remaining varieties were spaced 2 feet apart. Sixty pounds of N per acre as ammonium nitrate were applied preplant and tilled into the soil. Explorer, Jewel, Mac Black, Caroline, and Heritage were planted in the spring of 2006. Jaclyn and Anne were planted in the spring of 2007. Insecticide, fungicide, and herbicide applications were made in accordance with the *Midwest Grape and Small Fruit Spray Guide* (ID-94). Plants were trickle-irrigated as needed.

A V-trellis system was installed in the spring of 2007. In May, all plants were sidedressed with 0.8 lb of calcium nitrate per 10 feet of row, and floricanes were removed from all cultivars except Jewel and Mac Black. All plots were mulched with 6 inches of mixed wood chips.

Harvesting began on 19 June and finished on 19 October. Berries were harvested once per week at the beginning and end of the harvest period and every two to three days during peak harvest. Yield and berry weight (weight of 15 berries per plot) data were collected at each harvest, and the per-acre yields and average berry weights were calculated. Yields per acre were extrapolated from the average yields per 10-foot plot. Firmness

*** Editor's note:** Data from the 2008 growing season are presented here because data collection was not complete when the *2008 Fruit and Vegetable Report* went to press.

and flavor ratings were made at each harvest. Firmness was determined by squeezing individual berries between thumb and finger and comparing firmness between cultivars. Flavor ratings were made by a single researcher the day of harvest. Harvest midpoint dates were the dates by which half of the total harvest was taken.

Table 1. Raspberry cultivar yields and berry characteristic measurements, 2008 harvest.

Variety[1]	Color	Yield (lb/A)[2]	Harvest Midpoint[3]	Berry Wt. (g)[4]	Firmness[4]	Flavor[5]
Jewel (June-bearing)	Black	5428 a	29 June c	2.2 a	2.7 d	3.7 d
Heritage (fall-bearing)	Red	5204 a	21 Sept a	1.6 c d	3.6 a	4.0 b c
Caroline (fall-bearing)	Red	4349 a	4 Sept b	2.0 b	3.0 c	4.1 b
Mac Black (June-bearing)	Black	1765 b	5 July c	1.7 c	3.6 a	3.9 b c d
Jaclyn (fall-bearing)	Red	1386 b	3 Sept b	2.4 a	3.4 a b	4.3 a
Anne (fall-bearing)	Yellow	875 b	21 Sept a	2.4 a	3.6 a	3.8 c d
Explorer (fall-bearing)	Black	515 b	5 Sept b	1.4 d	3.2 b c	3.1 e

1 Listed in decreasing order of yield.
2 Weights followed by the same number are not significantly different (Duncan Waller LSD P=0.05).
3 Date by which half of the total harvest was taken.
4 Based on average weight of 15 berries, measured at each harvest.
5 Flavor: 1 = poor, 5 = excellent.

Results and Discussion

In 2008, growing season temperatures were normal, and rainfall was above normal. As in 2007, rust pustules began to be observed in late September on the leaves and fruit of all cultivars. The species of rust could not be identified.

Jewel, Caroline, and Heritage were the highest-yielding cultivars (Table 1). Jewel yielded more than three times as much as Mac Black, the other June-bearing cultivar. Caroline and Heritage had significantly higher yields than the other fall-bearing cultivars and Mac Black.

The Jewel harvest began on 19 June, about a week ahead of that of Mac Black, and the Jewel harvest midpoint was a week earlier than that of Mac Black. The fall-bearing cultivars begin ripening about a month after the June-bearing ones begin. Caroline, Jaclyn, and Anne were all first harvested on 18 July, but the harvest midpoints for Caroline and Jaclyn (4 September and 3 September, respectively) were nearly three weeks earlier than the midpoint for Anne (21 September). The Explorer harvest began about a week later than these three cultivars, and the Heritage harvest did not begin until 12 August. Still, Heritage and Anne had the same harvest midpoint (21 September).

Jaclyn, Anne, and Jewel had significantly higher average berry weights than any other cultivars in 2007 and again in 2008. Jewel berries were about 30% heavier than Mac Black berries. As in 2007, the average berry weight for Explorer was significantly less than for any other cultivar except for Mac Black.

Heritage, Anne, Jaclyn, and Mac Black had the same average firmness ratings of 3.6. Jewel had a significantly lower firmness rating than the other cultivars, at 2.7.

Jaclyn and Caroline had the highest flavor ratings of all the cultivars in 2007 and 2008. In 2008, Jaclyn had significantly higher flavor ratings than all other cultivars. Mac Black and Jewel had similar taste ratings both years. The two standard red cultivars, Caroline and Heritage, had similar taste ratings in 2008. Explorer had significantly lower taste ratings than the other cultivars and had very hard seeds both years.

Comparing the red cultivars over two years of testing, Jaclyn tended to taste better and have a larger berry than the standards Caroline and Heritage. Jaclyn was significantly better tasting and larger than the other two in 2008. However, Caroline outyielded it by a factor of more than three, and Heritage outyielded it by a factor of four. Jaclyn was planted a year later than Caroline and Heritage. Another limitation to Jaclyn is that the berries tend to adhere to the fruit receptacles, making them difficult to harvest. In both years, Heritage had significantly smaller berries than Caroline and Jaclyn. Thus, Heritage could be expected to have greater picking costs.

Anne and Jaclyn are both fairly new fall-bearing cultivars. In both test years, they had statistically similar yields, berry weights, and firmness ratings. In both years, Jaclyn had significantly better taste ratings.

Comparing the black raspberries, Jewel yielded more than three times as much as Mac Black and had significantly larger berries than Mac Black. However, Mac Black had significantly firmer berries. Their flavor ratings were about the same and not as high as for the red cultivars.

Blueberry Variety Evaluations

John Strang, Amy Poston Lentz, Chris Smigell, John Snyder, and Darrell Slone, Department of Horticulture

Introduction

Blueberries are a profitable and rapidly expanding small fruit crop in Kentucky. Previous University of Kentucky trials have evaluated primarily highbush blueberries. Relatively recent releases of Southern highbush varieties that have higher chilling hour requirements have performed well at the Robinson Center for Appalachian Resource Sustainability near Jackson, Kentucky. Home plantings of the less hardy rabbiteye blueberries, which are planted commercially from Tennessee southward, have done well in the Princeton and Henderson areas of Kentucky. This trial was established to evaluate six highbush, 10 southern highbush, and seven rabbiteye blueberry varieties for performance in the central Kentucky area.

Materials and Methods

Plants were acquired from Fall Creek Nursery, Lowell, Oregon; Finch Nursery, Bailey, North Carolina; DeGrandchamp's Farm, South Haven, Michigan; and Dr. Jim Ballington at North Carolina State University in Raleigh. They ranged in age from rooted cuttings to two-year-old plants. This trial was established at the University of Kentucky Horticulture Research Farm in Lexington in the spring of 2004. Plants were set on raised beds of Maury silt loam soil into which peat and composted pine bark mulch had been incorporated and the soil pH had been adjusted from 5.6 to 4.6 by applying 653 pounds of sulfur per acre. Seventy pounds of phosphorus were applied per acre and incorporated into the field prior to bed shaping and planting. Five replications of individual plant plots were set in rows running east to west in a randomized block design. The southern highbush and highbush plants were randomized together at one end of the planting and spaced 4 feet apart in the row with 12 feet between rows. The rabbiteye blueberries were planted at the other end with 6 feet between plants and 12 feet between rows. All plants were mulched with a 3-foot wide, 6-inch layer of wood chips.

Plants showing iron chlorosis were fertilized with Peters Professional Acid fertilizer (24-12-12) and iron chelate the first year. Plants have been fertilized yearly with Osmocote Plus 5-6 Month controlled release (15-9-12) fertilizer that contains six trace elements and magnesium at the rate of 1 oz per plant in March, April, May, June, and July.

Insecticide applications included Sevin, Malathion, and Esteem. Fungicide applications included lime sulfur, Pristine, Cabrio, Elevate, and Captan. Herbicides for weed control included Surflan, Princep, Roundup, Gramoxone, and Poast.

Plots were drip irrigated using point source emitters (1 gph/plant), and netting was used over the planting for bird control. Flowers were removed annually in the spring from plants less than 3 feet tall. Larger plants were allowed to fruit for the first time in 2006.

The 2009 season was frost free. Rainfall was above normal in January, April, and May, and below normal in February and March. Temperatures from March to July were above normal, while June and August temperatures were below normal. Fruit were harvested once a week. Twenty-five berries from each plant were weighed to determine average berry size at each harvest, and fruit were rated for taste and appearance several times during the season.

Table 1. Highbush and southern highbush blueberry yield, fruit size, taste and appearance ratings, and harvest dates, Lexington, Ky., 2009.

Variety	Type[1]	Yield (lb/A)[2]		Berry Wt. (oz/25 berries)		Berry Taste (1-5)[3]	Berry Appearance (1-5)[4]	First Harvest (date)	Harvest Midpoint[5] (date)
Chandler	HB	10905	a	1.7	a	4.3	4.2	25 June	9 July
Pamlico	SH	9139	ab	0.6	e	4.3	3.5	25 June	1 July
Echota	HB	7870	abc	0.9	cde	3.0	4.0	25 June	4 July
Ozarkblue	SH	7014	bcd	1.6	ab	3.8	4.0	25 June	12 July
Bluecrop	HB	6408	bcde	1.0	cd	3.0	3.2	25 June	3 July
Arlen	SH	5238	cdef	1.3	bc	4.0	4.0	25 June	5 July
NC-2927	SH	4539	cdef	0.6	e	3.8	3.9	25 June	26 June
Misty	SH	4344	cdefg	0.9	cde	3.3	4.0	25 June	5 July
Lenore	SH	3951	defg	0.8	de	4.2	3.8	25 June	1 July
Aurora	HB	3903	defg	1.5	ab	3.5	4.2	8 July	22 July
NC-3129	HB	3229	efg	0.7	de	3.4	2.8	27 June	1 July
Spartan	HB	2195	fg	0.9	cde	-	-	25 June	3 July
Star	SH	1999	fg	0.8	de	4.3	3.4	25 June	27 June
NC-1871	HB	859	g	0.8	de	4.0	3.8	25 June	27 June
Sampson	SH	838	g	1.4	ab	4.3	3.7	25 June	28 June

[1] Type: HB = highbush; SH = southern highbush.
[2] Numbers followed by the same letter are not significantly different (Waller-Duncan multiple range test LSD P = 0.05).
[3] Berry taste: 1 = poor; 5 = excellent. Spartan data were not taken.
[4] Berry appearance: 1 = poor; 5 = excellent. Spartan data were not taken.
[5] Date at which half of the berries were harvested, based on total season yield.

Results and Discussion

At planting, most of the varieties were two-year-old, 18- to 30-inch plants. Columbus, Ira, Lenore, Pamlico, Powderblue, NC-3129, NC-1871, NC-2927, and NC-1827 were greenhouse-forced, rooted, hardwood cuttings. This yield analysis has not been adjusted to account for these plant differences. Essentially, all fruit were lost in 2007 due to a severe late spring freeze, resulting in a heavy flower set for 2008. Harvest and fruit size data for the highbush and southern highbush varieties are shown in Table 1. All of the Duplin and Legacy southern highbush plants in the plot have died. The Chandler (highbush) and Pamlico (southern highbush) varieties had the highest yields in 2009 as well as in 2008. Chandler, Sampson, and Ozarkblue tended to have the largest berries as was also noted in 2008. NC-2927 and Pamlico produced some of the smallest berries. There were no significant differences in berry taste or appearance for the highbush and southern highbush varieties. Most of the varieties were first harvested on 25 June, and Aurora had the latest first harvest date. Harvest dates were only a day or two earlier than those in 2008, but the harvest period was considerably shorter in 2009 due to warmer July temperatures. NC-2927, Star, NC-1871, and Sampson had the earliest harvest midpoints, while Ozarkblue and Aurora had the latest.

Yields for the rabbiteye blueberries (Table 2) were considerably lower than those of the highbush blueberries because these plants have generally not grown as fast as the highbush blueberries. NC-1827, Powderblue, and Climax produced some of the higher rabbiteye blueberry yields. Columbus and Onslow had the largest berry weights, while Powderblue, Columbus, and Tifblue had some of the best-tasting berries. Powderblue and Columbus tended to have the most attractive berries.

Rabbiteye blueberries are less sensitive to variations in soil pH, and the fruit generally mature later in the season than those of highbush and southern highbush varieties. Thus, rabbiteye blueberries could extend the Kentucky blueberry harvest season. NC-1827 was the first rabbiteye to be harvested. Powderblue had the latest first harvest date and midpoint of any cultivar in the trial. Its harvest midpoint is almost two weeks later than that of the latest highbush cultivar, Aurora.

This trial was initiated to evaluate rabbiteye and southern highbush blueberry variety adaptation to central Kentucky growing conditions. These blueberry varieties typically have shorter chilling requirements than highbush blueberries, and once the chilling requirements are satisfied, buds begin to develop when exposed to warm weather. Consequently, these buds may begin developing earlier and have a more rapid development rate. Table 3 shows that in 2009 there was not a clear separation among southern highbush, rabbiteye, and highbush blueberry types in the rate of floral bud development. All three types were found to be present in the earliest and latest floral development regions. Echota (highbush), Pamlico (southern highbush), and Powderblue (rabbiteye) all had some of the faster developmental rates and were in the earliest floral developmental group. Chandler (highbush), Sampson (southern highbush), and Columbus (rabbiteye) all had lower rates and were slower to develop. Blueberry varieties found in the latest developmental group bloom later and would be expected to sustain less flower loss from late spring frosts.

Table 2. Rabbiteye blueberry yield, fruit size, taste and appearance ratings, and harvest dates, Lexington, Ky., 2009.

Variety	Yield (lb/A)[1]		Berry Wt. (oz/25 berries)		Berry Taste (1-5)[2]		Berry Appearance (1-5)[3]		First Harvest (date)	Harvest Midpoint[4] (date)
NC-1827	4146	a	0.7	d	3.0	bc	3.6	abc	25 June	11 July
Powderblue	2418	ab	1.2	b	4.5	a	4.8	a	16 July	3 Aug
Climax	2363	ab	0.9	c	2.5	c	2.5	c	30 June	9 July
Onslow	1602	b	1.6	a	3.8	ab	4.0	ab	10 July	31 July
Columbus	1287	b	1.6	a	4.5	a	4.3	ab	8 July	29 July
Tifblue	1072	b	1.1	b	4.2	a	2.6	c	15 July	27 July
Ira	591	b	1.2	b	3.8	ab	3.3	bc	6 July	21 July

1 Numbers followed by the same letter are not significantly different (Duncan's multiple range test LSD P = 0.05).
2 Berry taste: 1 = poor; 5 = excellent.
3 Berry appearance: 1 = poor; 5 = excellent.
4 Date at which half of the berries were harvested, based on total season yield.

Table 3. Rate of flower bud development for blueberry varieties and types.

Variety[1]	Type[2]	Floral Development Rate ± CI (95%)[3]
Echota	HB	0.21 ± 0.34
Pamlico	SH	0.20 ± 0.03
Lenore	SH	0.19 ± 0.04
Star	SH	0.16 ± 0.04
Powderblue	R	0.16 ± 0.05
Climax	R	0.16 ± 0.06
Onslow	R	0.15 ± 0.06
Arlen	SH	0.15 ± 0.41
NC-1871	HB	0.15 ± 0.04
NC-3129	HB	0.15 ± 0.05
Misty	SH	0.14 ± 0.05
NC-2927	SH	0.13 ± 0.03
Bluecrop	HB	0.13 ± 0.04
Ozarkblue	SH	0.13 ± 0.04
Tifblue	R	0.13 ± 0.04
Spartan	HB	0.12 ± 0.03
Ira	R	0.11 ± 0.11
Aurora	HB	0.10 ± 0.03
Columbus	R	0.09 ± 0.03
NC-1827	R	0.09 ± 0.03
Sampson	SH	0.08 ± 0.10
Chandler	HB	0.05 ± 0.02

1 Listed in order of floral developmental rate.
2 Type: HB = highbush; SH = southern highbush; R = rabbiteye.
3 Regression slope for floral stage (1 = dormant; 2 = bud scales cracked; 3 = buds swelling; 4 = buds beginning to open; 5 = flowers separating; 6 = flowers extending) on three dates March 6, March 9 and March 20, 2009.

Acknowledgments

The authors would like to thank the following persons for their hard work and assistance in the successful completion of this trial: David Abell, Matthew Anderson, Travis Baney, Sean Bessin, Jessica Cole, Jessica Dye, Ethan Glidewell, Thomas Iorio, Keith Kral, Ellen Meyer, Dave Lowry, Julie Pfeiffer, Kirk Ranta, Kiefer Shuler, Chie Togami, Joseph Tucker, Bonka Vaneva, William Waun, David Wayne, and Sarah Yates.

Beet Variety Evaluation

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Introduction

Twenty-three beet varieties were evaluated in a replicated trial for their performance under Kentucky conditions. These included red, golden, and one white beet variety.

Materials and Methods

Varieties were seeded in the field on 29 May at the University of Kentucky Horticulture Research Farm in Lexington. One hundred seeds (beet balls) were planted in each 20-foot-long plot. Rows were 22 inches apart. Each treatment was replicated four times in a randomized complete block design. Fifty pounds of nitrogen per acre as ammonium nitrate were applied to the plot. No fungicides, insecticides, or herbicides were used in this trial. Ten beets from each replication were evaluated for uniformity of size and shape and exterior appearance. One beet from each replication was evaluated for soluble solids content and for flavor (raw) by two evaluators. Soluble solids were measured with a refractometer on a quarter-inch diameter core taken with a cork borer horizontally through the midsection of the beet. Juice was extracted using a garlic press. Raw beet flavor was determined from a slice at the center of each beet. Foliage disease evaluations were made on 19 August.

Cooking Process—Roots. Beet roots were roasted for 45 minutes in a 400°F convection oven. Cooled beets were peeled and sliced for sampling. Attempts were made to select beet roots that were similar in size. Beet roots were evaluated by four to five evaluators for appearance and flavor.

Cooking Process—Greens. Beet greens (leaves from each beet) were sautéed in one-half teaspoon of canola oil over medium heat until wilted. One-half cup of water was added to the greens and covered. Greens were simmered until tender. The leaves of the beets varied in volume of greens produced, leaf texture, and stalk size. Because of the variations, cooking time varied for each variety. The greens with larger stalks would have been more appealing if prepared as Swiss chard (dice stalks and sauté before adding leaves). Beet greens were evaluated while warm. Two evaluators rated the cooked greens for appearance and flavor. Those greens receiving a score of "2" were considered bitter. The rating was not based on the texture of the stem.

Table 1. Beet variety ranking, germination, disease rating, and root characteristics.

Cultivar	Days Maturity	Seed Source	Ranking[1]	Germination (1-200)[2,4]		Cercospora Disease Rating (0-10)[3,4]		Uniformity of Size (1-5)[5]	Uniformity of Shape (1-10)[6]	Exterior Appearance (1-5)[5]	Soluble Solids (%)[4]		Taste Raw (1-5)[5]
Solo	49	SW	47.5	76.8	defghi	2.6	cdefg	4.1	7.0	3.7	10.2	abcde	4.3
Excalibur	60	SI	46.6	155	a	3.4	ab	3.1	7.3	3.8	10.7	abc	4.3
Merlin	55	RU	46.5	79.5	cdefgh	2.5	defg	3.6	7.3	4	10.4	abcd	4
Red Ace	53	RU	45.6	93.3	bcd	2.6	cdefg	3.5	6.3	3.6	9.7	bcdefg	4.1
Taunus	65	SW	45.4	65.8	ghij	2	ghi	3.4	8.8	4.5	8.1	ghi	3.3
Kestrel	53	RU	45.2	80.8	cdefg	2.9	bcde	3.1	7.3	4	9.7	bcdefg	4.6
Red Titan	52-54	SI	44.4	158.5	a	3.6	a	3.5	6.8	4.1	11.5	a	4.1
Red Cloud	53	SW	44.4	100.8	bc	2.8	bcdef	3.8	6.5	3.9	11.2	ab	4.2
Ruby Queen	60	RU	42.5	77.3	defghi	2.6	cdefg	3.3	7.0	3.5	9.7	abcdef	3.9
Eagle	54	ST	42.1	71.8	efghi	2.3	efgh	3.4	5.5	3.3	9.3	cdefgh	3.9
Touchstone Gold	60	SW	41.9	58.8	hij	0.4	k	3.3	6.3	3.8	7.6	hi	3
Detroit Supreme	59	ST	40.8	70.3	fghi	1.6	hig	4.0	4.0	2.5	8.5	efghi	2.6
Cylindra	60	BU	39.4	90.3	bcdef	2	ghi	3.0	6.8	3.3	8.3	ghi	3.6
Warrior	57	CF	39.3	82.8	bcdefg	3.1	abcd	4.1	6.8	3.3	10.1	abcde	3.3
Blankoma	55	JS	39.3	92.8	bcde	0.4	k	3.4	5.8	3.2	10.1	abcde	3.6
Bull's Blood	60	RU	38.8	57i	j	1	jk	2.5	5.5	2.8	7.7	hi	2.1
Chioggia	60	RU	38.6	76.8	defghi	1.5	ij	3.8	7.0	3.5	10.9	abc	2.9
Detroit Dk Red	59	BU	38.4	97.3	bcd	2.6	cdefg	4.0	6.3	3.1	8.8	defghi	2.8
Early Wonder	52	RU	37.5	66.8	ghi	2	ghi	3.5	6.8	2.6	9.2	cdefgh	2.6
Burpee Golden	60	RU	36.4	30.8	k	0.5	k	2.8	6.5	3.7	7.3	i	2.6
Moneta	60	SW	36.3	30.3	k	2.1	fghi	3.9	5.3	2.9	7.8	hi	2.7
Red Heart	58	BU	35.9	102.	b	3.3	abc	3.4	3.8	2.6	9.4	bcdefgh	3.6
Golden Beet	65	SI	34.9	45.3	jk	0.4	k	2.9	3.7	2.6	7.7	hi	2.9

1 Ranking based on summation of Tables 1 and 2 data. The Cercospora disease rating is subtracted from the total ranking, and the germination number is not included.
2 Germination based on planting 100 beet balls, each normally containing more than one seed. Solo and Moneta are monogerm and contain one seed.
3 Cercospora disease rating: 0 = no disease; 10 = complete blighting.
4 Numbers followed by the same letter are not significantly different (Waller-Duncan multiple range test LSD P = 0.05).
5 Rating: 1 = poor; 5 = excellent.
6 Rating based on number of beets out of 10 with a uniform shape.

Table 2. Beet appearance and cooked beet and greens evaluations.

Variety	Appearance: Whole Uncooked Beets and Greens (1-5)[1]	Appearance: Sliced Roasted (1-5)[1]	Flavor Roasted (1-5)[1]	Greens: Appearance Cooked (1-5)[1]	Greens: Flavor Cooked (1-5)[1]	Comments[2]
Solo	5	4.5	3.3	4	4	Very dark interior, not bitter, early maturing, monogerm, excellent cooked greens, globe shape
Excalibur	5	4.5	4.3	3.5	3.5	OP, very firm, sweet, dark interior, uniform shape, excellent cooked, not bitter
Merlin	3	4	4.2	4	4.5	Very firm dark interior, not bitter, smaller size, uniform shape, excellent cooked beets and greens
Red Ace	5	4.4	3.6	4	4	Very dark interior, not bitter, excellent cooked greens, globe shape
Taunus	5	4.3	3.5	3.5	3	OP, very dark red interior, not bitter, cylindrical shape, smooth skin
Kestrel	3	4.4	4	4	4	Very sweet, dark interior, excellent roasted, not bitter, globe shape
Red Titan	4	4.5	4	3	2.5	Very attractive dark interior, very sweet raw and cooked, slightly bitter, globe shape
Red Cloud	4	3.8	2.8	3.5	3.5	Very dark attractive interior, round shape, not bitter
Ruby Queen	4	4.4	2.8	3.5	3	Very dark interior, uniform shape, slight bitterness
Eagle	5	4	4	3	3	Very dark interior, irregular shape, small size, not bitter, excellent roasted
Touchstone Gold	2	4.3	3.5	4	4.5	OP, overall best golden beet, excellent cooked greens, not bitter, round shape
Detroit Supreme	4	4.3	4.5	4	4	OP, very dark interior, irregular shape, excellent cooked beets and greens
Cylindra	2	3.8	3.6	3	4	OP, dark interior, cylindrical shape, variable size, not bitter, excellent cooked greens
Warrior	2	3.6	3.2	3	3	Very firm dark interior, not bitter, maroon tops, globe shape
Blankoma	1	3.8	2.8	3	3	OP, white beet, slightly bitter, dark spots on skin, round to slightly conical
Bull's Blood	5	4	3.2	4	3	OP, dark maroon greens, flattened globe shape
Chioggia	1	3.8	2.2	3	2	OP, attractive purple and white interior zoning, some bitterness, globe shape
Detroit Dark Red	2	4	4	3	3	OP, industry standard, very dark interior, excellent flavor roasted, slight bitterness
Early Wonder	4	3.8	3	2	2	OP, some bitterness, flattened globe shape
Burpee Golden	3	3.2	2.8	3	2	OP, not bitter, round shape
Moneta	3	4	2.8	3	3	OP, very dark interior, monogerm, not bitter, round shape
Red Heart	3	3.4	3	3.5	3.5	Very dark interior, not bitter, elongated globe shape
Golden Beet	2	4	3.5	3	3	OP, irregular shape, not bitter, round shape

1 Appearance and flavor: 1 = poor; 5 = excellent. Roots were rated by four to five evaluators, and greens were rated by two evaluators for consumer appeal. Cooked greens with a rating of 2 or less were bitter.
2 Comments on bitterness refer to the raw taste evaluation in Table 1. OP refers to open pollinated varieties; all others are hybrid.

Results and Discussion

The 2009 growing season was cool and abnormally wet. Beets were harvested at diameters of 1.5 to 3 inches. Harvest and evaluation data for the replicated trial are in Table 1, and data for whole plant appearance and cooked beets and greens are in Table 2. Merlin, Red Ace, Kestrel, and Detroit Supreme had high rankings and were the best red beets in terms of cooked appearance and flavor for both roots and greens. Excalibur and Red Titan were notable for beet root roasted flavor. Solo, the highest-ranked variety in the trial, and Touchstone Gold had high ratings for appearance and flavor of the cooked greens. Solo, Excalibur, Merlin, Red Ace, Kestrel, and Red Cloud had some of the best raw taste evaluations (Table 1). Raw beets are used in salads and should not be bitter. Taunus was the best cylindrical-shaped beet. The cylindrical beets were noted to cook more evenly than globe-shaped beets and provided a uniform size and shape when sliced. Uniformity is desirable in beets that are sliced for canning. Touchstone Gold was the best golden beet. Golden beets are notable for having poor germination percentages, and Touchstone Gold tended to have a higher germination rating than the other two golden varieties. Chioggia is an older variety that is notable for its red and white zoning, and Blankoma was the one white beet in the trial.

The wet season contributed to the development of the Cercospora foliage disease (Table 1). The golden beets, Blankoma, Bulls Blood, Chioggia, Detroit Supreme, Taunus, Cylindra, and Early Wonder, had some of the lowest Cercospora ratings. However, the white, golden beets, Chioggia, Taunus, and Moneta all were observed to have higher levels of Pseudomonas bacterial leaf spot, which is not shown in the tables.

Acknowledgments

The authors would like to thank the following persons for their hard work and assistance in the successful completion of this trial: David Abell, Matthew Anderson, Travis Baney, Sean Bessin, Jessica Cole, Jessica Dye, Ethan Glidewell, Thomas Iorio, Keith Kral, Ellen Meyer, Dave Lowry, Julie Pfeiffer, Kirk Ranta, Kiefer Shuler, Chie Togami, Joseph Tucker, Bonka Vaneva, William Waun, David Wayne, and Sarah Yates.

Slicing Cucumber Cultivar Trial

Dave Spalding and Timothy Coolong, Department of Horticulture

Introduction

Slicing cucumbers have been widely grown in Kentucky for many years and are a primary crop for one of the vegetable marketing cooperatives in the state. This cultivar trial looked at some of the newer cultivars that are being grown in this area and two varieties that have been grown for some time to determine if the newer cultivars represent improvements.

Materials and Methods

The trial was conducted at the University of Kentucky Horticulture Research Farm in Lexington. Seed of 10 slicing cucumber cultivars were seeded in the greenhouse in 72-cell size trays on 3 April. Plants were transplanted to the field on 5 May, in a randomized complete block design with four replications. Plants were transplanted into raised beds with black plastic mulch and trickle irrigation. Each cultivar in each replication had 10 plants with 12 inches between plants within the rows. The plot received a pre-plant application of 50 lb/A of N, and P and K were applied pre-plant as indicated by soil samples. An additional 50 lb/A was applied through the trickle irrigation during the growing season. The plot was scouted regularly for disease and insects, and sprays were applied accordingly. Harvest began on 16 June and continued as needed about every two to three days until 24 July. The cucumbers were graded (Super Select, Select, Small, and Culls) counted, and weighed by grade.

Results and Discussion

Results of the trial were broken into two categories: the first two weeks of harvest and yields for the whole season. For the first two weeks, yields for the top six cultivars were substantially higher than the bottom four but were not statistically different due to a high degree of variability within the plot. The two cultivars with the lowest yields in the first two weeks of harvest (Lider and Rockingham, Table 1) had the highest yields for the whole season (Table 2). Although the yields are not statistically different due to the variability, there is a large difference between the highest- and lowest-yielding varieties for the first two weeks of harvest and the full growing season.

Table 1. Slicing cucumber yields by weight of super select, select, small, and culls for the first two weeks of harvest.

Cultivar	Super Select (lb/A)	Select (lb/A)	Small (lb/A)	Cull (lb/A)
Indy	21,280 A[1]	1,728 A	3,028 A	3,195 A
Talladega	20,518 A	2,117 A	3,499 A	3,712 A
Speedway	19,656 A	965 A	4,162 A	2,344 A
Intimidator	19,424 A	1,541 A	2,817 A	2,434 A
Cobra	19,415 A	989 A	3,031 A	3,827 A
General Lee	19,057 A	1,310 A	2,729 A	3,827 A
Stonewall	17,599 A	715 A	2,819 A	3,650 A
Dasher II	17,464 A	1,055 A	2,058 A	3,249 A
Rockingham	17,311 A	1,469 A	3,312 A	2,918 A
Lider	14,794 A	810 A	1,256 A	1,917 A

[1] Numbers within the same column followed by the same letter are not significantly different at $P < 0.05$ according to Duncan's multiple range test.

Table 2. Slicing cucumber yields by weight of super select, select, small, and culls for the full season.

Cultivar	Super Select (lb/A)	Select (lb/A)	Small (lb/A)	Cull (lb/A)
Lider	50,935 A[1]	1,878 A	4,155 A	16,656 A
Rockingham	48,427 A	4,128 A	5,515 A	15,986 A
General Lee	46,536 A	2,844 A	5,810 A	14,832 A
Indy	44,017 A	2,588 A	4,803 A	14,105 A
Cobra	43,403 A	2,448 A	6,215 A	14,544 A
Speedway	42,820 A	3,382 A	6,109 A	13,433 A
Intimidator	41,247 A	2,394 A	4,664 A	14,509 A
Dasher II	40,104 A	2,862 A	5,670 A	13,504 A
Stonewall	39,465 A	2,851 A	4,396 A	15,469 A
Talladega	37,806 A	3,399 A	4,270 A	13,576 A

[1] Numbers within the same column followed by the same letter are not significantly different at $P < 0.05$ according to Duncan's multiple range test.

Sweetpotato Variety Trial and Response to Irrigation in Central Kentucky

Timothy Coolong, Department of Horticulture

Introduction

Sweetpotatoes are growing in popularity in Kentucky. They represent a profitable and low-input crop that can be easily grown in many parts of the state. As more growers are looking to sweetpotatoes as a new crop, there is a need for a review of production practices as they pertain to Kentucky. Important questions for growers include which varieties to grow and whether to irrigate. There are large differences in the productivity of sweetpotato varieties. Therefore, we chose to test three common varieties in Lexington, Kentucky, to determine the yield potential of each. In addition, we tested the effect of drip irrigation on the productivity of the variety Beauregard during the summer of 2009.

Table 1. Total yields, yields of USDA No. 1 and No. 2, percent No. 1, percent culls, and yields of extra large sweetpotatoes for three varieties, irrigated and non-irrigated sweetpotatoes grown in Lexington, Ky., in the summer of 2009.

Variety	USDA No. 1 (bu/A)[1]		USDA No. 2 (bu/A)		Marketable Yield (bu/A)		Percent No. 1		Percent Culls[2]		Extra Large[3] (bu/A)	
Beauregard	409	a*	84	a	493	a	83%	a	29%	a	53	a
O'Henry	218	b	78	a	295	b	74%	a	33%	a	0	b
Covington	179	b	71	a	251	b	72%	a	33%	a	0	b
Irrigation												
(Beauregard)												
Irrigated	437	a	70	a	507	a	86	a	31%	a	67	a
Non-irrigated	380	a	99	a	478	a	80	a	27%	a	39	a

1 Yields are calculated assuming 44-inch row spacing and a 40-pound bushel weight.
2 Culls are calculated as a percentage of the root weight of culls (including extra large) divided by total harvested weight.
3 "Extra large" is not an official USDA designation but commonly refers to roots that are too large to be considered No. 1 or No. 2 according to USDA standards.
* Means in the same column followed by different letters were significantly different at P>0.05 as determined by Duncan's multiple range test.

Materials and Methods

Sweetpotato cuttings of three varieties were obtained from Jones' Farms in Bailey, North Carolina. The varieties tested were O'Henry, a white-fleshed sweetpotato, and two orange-fleshed varieties, Beauregard and Covington. Cuttings were planted on 2 June 2009 at the University of Kentucky Horticulture Research Farm in Lexington. Cuttings were planted on rows spaced 44 inches apart using a tobacco setter with 10-inch in-row spacing. A starter fertilizer was used when planting the cuttings. Cuttings were planted into flat beds on bare ground. Each bed was approximately 275 feet in length. Fifty pounds of N were applied as a broadcast using 19-19-19 prior to planting. All cuttings were irrigated immediately after planting to ensure a uniform plant stand. Areas between and within rows were hand-cultivated for weed control. No fungicide or insecticide sprays were made during the season.

The effectiveness of drip irrigation was evaluated on the variety Beauregard. Those rows receiving supplemental drip irrigation were irrigated when tensiometers, buried at a depth of 12 inches in each row, read 60 to 70 cbar. Three replications of each irrigation treatment were tested. Plants were typically irrigated for six to eight hours, or until tensiometers in the irrigated rows read 10 cbar or less. This resulted in six irrigation events during the 2009 growing season. Sweetpotatoes were harvested 14 September 2009 using a sweetpotato flip plow. Fifty-foot sections of each row were graded and weighed according to USDA standards.

Results and Discussion

Beauregard had the highest total marketable yields and yields of USDA No. 1 sweetpotatoes (Table 1). Beauregard produced yields of 409 bushels/acre of USDA No. 1 sweetpotatoes, while O'Henry and Covington had yields of 218 and 179 bushels/acre, respectively. There were no differences in yields of USDA No. 2 sweetpotatoes. Beauregard had the highest percentage of No. 1 sweetpotatoes at 83%. This is somewhat surprising as this variety typically has a large number of No. 2 sweetpotatoes. The percent culls ranged between 29 to 33% and were not affected by variety. Beauregard had yields of 53 bushels/acre of "extra large" sweetpotatoes, while O'Henry and Covington did not have any. Although "extra large" is not an official USDA designation, many growers use the term to describe sweetpotatoes that are larger than the USDA designations for No. 1 and No. 2 sweetpotatoes. Typically, extra large sweetpotatoes are difficult to market.

Irrigation did not significantly affect yield of Beauregard sweetpotatoes (Table 1). The summer of 2009 was unusually wet, however. Further research is required before we can determine if there is an economic benefit to irrigating sweetpotatoes in Kentucky.

Acknowledgments

This research is funded from a S. Region SARE On-Farm Research Grant. The author also would like to thank the Morgan County Cooperative Extension office and ANR Agent Sarah Fannin for providing the sweetpotato plow for harvest.

Supersweet Corn Evaluations in Northwestern Kentucky

Nathan Howard and Timothy Coolong, Department of Horticulture

Introduction

Sweet corn is the number one vegetable crop in terms of acreage planted in Kentucky. Locally grown sweet corn is generally in high demand in retail and wholesale markets. This trial was designed to evaluate supersweet corn varieties in northwestern Kentucky.

Materials and Methods

Eleven supersweet corn varieties were planted by hand on 20 May. The plot was planted on a grower/cooperator's farm in McLean County. Plots consisted of a 20-foot-long row of each cultivar and were replicated four times in a randomized complete block design. Rows were spaced 30 inches apart, and 100 seeds were planted in each 20-foot row. After evaluating plant stands for each treatment, plants were then thinned to a distance of 8 inches apart.

Prior to planting, 100 lb of actual nitrogen and 120 lb of potassium as 0-0-60 were applied according to soil test results. Drip irrigation was placed on top of the ground, and plants were sidedressed with 50 lb of actual N per acre with 28% liquid nitrogen. Prowl herbicide was applied at 3 pt/acre immediately after planting as a preemergent control of grasses and annual broadleaves. Asana and Pounce were used on a weekly basis after pollination for insect control.

Table 1. Plant characteristics and yield of supersweet corn varieties, McLean County, Ky, 2009.

Cultivar	Days to Maturity	Plant Stand (%)[1]	Height to First Harvested Ear (in.)	Ear Length (in.)	Ear Width (in.)	Tip Fill[2]	Yield (dozens of ears/A)	
Mirai 308 BC	70	78	25.25	7.82	1.83	10.0	1853	a[3]
Obsession	78	76	28	7.76	1.83	10.0	1796	ab
BSS 0977	78	67	26.5	6.91	1.65	9.75	1777	ab
Xtra Tender 275 A	75	71	28.31	7.63	1.90	9.75	1561	abc
Awesome	74	70	23.94	7.32	1.83	9.75	1544	abc
Triumph	74	69	16.06	7.53	1.81	9.75	1490	abc
BSS 0982	81	66	25.75	7.44	1.89	10.0	1455	abc
Vision	75	72	18.5	7.74	1.91	9.75	1383	bc
Xtra Tender 2170	70	68	18.31	7.86	2.08	10.0	1307	c
Xtra Tender 277 A	77	67	23.5	7.09	2.58	9.75	1307	c
XTH 2171	71	67	20.18	8.13	1.83	10.0	1250	c

1 Plant stand is percentage emergence of 100 seeds planted.
2 Number of ears out of 10 that had good tip fill.
3 Numbers in the same column followed by different letters are significantly different at $P < 0.05$ according to Duncan's multiple range test.

Results and Discussion

With the late planting date, we were expecting to evaluate these varieties under hot and dry pollination conditions. The month of July turned out to be ideal for pollination and ear fill with high moisture levels and mild temperatures throughout. The plot was harvested on 5-6 August, and varieties were evaluated (Table 1). All varieties tested were bicolor except for Vision, which was a yellow variety. Mirai 308 BC was the best-performing variety in this trial. It yielded significantly more ears per acre than the other varieties. It also had the highest level of germination in the spring. Obsession and BSS 0977 were the next two highest-yielding varieties. Obsession had an above-average ear length, excellent plant stand, and tip fill. Xtra Tender 275A was also a good performer, with above-average ear length, width, and yield. Two *Bt* varieties were tested, BSS 0977 and BSS 0982. Although BSS 0977 was a good-yielding variety, it had the shortest average ear length and width of the varieties tested. Awesome and BSS 0982 yielded nicely but were slightly below average on ear length and width.

As stated earlier, these varieties were evaluated under ideal growing conditions the entire season. When selecting sweet corn varieties, it is important to take into consideration performance under all growing conditions.

Sugar-Enhanced/Synergistic Sweet Corn Cultivar Evaluations in Eastern Kentucky, 2009

Crystal Sparks, Terry Jones, and Ryan Hays, Department of Horticulture

Introduction

Sweet corn remains a very popular item at roadside and farmers' markets. Sweet corn is Kentucky's most commonly planted vegetable crop. This research was undertaken to evaluate supersweet sweet corn varieties that might be suitable for production in eastern Kentucky.

Methods and Materials

Eighteen sugar-enhanced/synergistic sweet corn cultivars were planted by hand on 15 June 2009. Plots consisted of 20-foot-long rows of each cultivar replicated four times in a randomized complete block design. Rows were spaced 3 feet apart, and 100 seeds were planted in each plot. One day after planting, 2.1 qt/A of Bicep Magnum II were applied preemergence to control weeds. Soil test results (Table 1) showed that additional phosphorus and potassium were needed. Therefore, 50 lb N, 120 lb P_2O_5, and 100 lb K_2O (all rates per acre) were applied prior to planting. The plots were sidedressed (50 lb N) when plants were approximately 14 inches tall and again when plants were 30 inches tall. Supplemental overhead irrigation was not needed. Capture 2EC or Endosulfan 3EC (pyrethrum insecticides) were applied every 7 days during silking to reduce corn earworm damage. However, control was less than expected, likely due to earworm resistance to the pyrethrum sprays.

In evaluating and ranking cultivars, points were awarded based on plant stand, husk coverage, tip fill, yield, and disease tolerance (northern corn leaf blight). Disease tolerance was very important in 2009 because northern corn leaf blight reduced yields and tip fill in many susceptible cultivars.

Table 1. 2009 sweet corn cultivar trial soil test results.

pH	Buffer pH	P	K	Ca	Mg	Zn
6.76	7.02	60	292	3401	289	6.2

Table 2. 2009 sugar-enhanced sweet corn plant characteristics and yield components, Robinson Center, Quicksand, Ky.

Cultivar Name[1]	Seed Source	Plant Stand[2]	Husk Coverage[3,6]	Tip Fill[4,6]	Disease Rating[5]	Dozen Ears/A	Cultivar Points[7]	Rank Based on Points
Charisma (BC)	SW	97.8	10	10	0.875	1921	3082	1
Synergy (BC)	ST	92.8	10	9.8	1.125	2072	2997	2
Revelation (BC)	HR	94	10	8.6	0.875	1361	2851	3
Whiteout (W)	SW	97.5	10	9.3	2.5	1346	2785	4
Shasta (W)	SW	80.8	9.8	9.8	1.875	2027	2773	5
Kristine (BC)	ST	87	10	8.6	0.875	771	2722	6
Silver King (W)	SW	79.3	10	9.8	2.625	1679	2673	7
Absolute (BC)	SW	86.8	10	8.1	1.875	1664	2659	8
Temptation (BC)	ST	89.8	10	8.4	2.25	1422	2652	9
Providence (BC)	HR	93.8	10	9.0	3.625	1497	2625	10
Chippewa (BC)	HR	60.8	10	9.4	0.875	1210	2579	11
Montauk (BC)	ST	88.0	10	7.5	2.25	1573	2562	12
Celestial (W)	SW	51.3	10	9	0.75	1513	2489	13
Cameo (BC)	ST,SW	43.3	10	8.4	1.75	1271	2222	14
Reflection (BC)	HR	69.8	7.5	7	0.625	1074	2192	15
Honey Select (Y)	SW	96	10	6.3	5.25	1240	2184	16
Kandy Korn (Y)	SW	91.5	9.5	5.3	4.125	1210	2099	17
HMX6358 (BC)	HR	78	9.8	7.0	7.4	681	1786	18

1 BC = bicolor, W = white, Y = yellow.
2 Plant stand is percent emergence of 100 seeds.
3 Husk coverage: 1 = poor, 10 = excellent.
4 Number of ears out of 10 that had good tip fill.
5 Disease rating (made at time of harvest): 0 = no disease; 1 = 10% or less mild; 2 = 20% slight-moderate (infected to just below ear level); 3 = 30% moderate (infected above ear level; 4 = 40-50% moderate-severe (infected to flag leaf); 10 = severe (all plant leaf and husk tissue dead).
6 Based on 10 ears of corn.
7 Points obtained (rank) = (10 x stand) + (100 x husk coverage) + (100 x tip fill) + (100 x commercial acceptability) + (yield/10) - (disease rating x 100).

Results and Discussion

This was a good year to evaluate sweet corn cultivars for pollination and ear fill under cool, wet weather conditions. A very wet May delayed planting until mid-June. We experienced cooler- and wetter-than-normal weather during most of the 2009 growing season. Quicksand, Kentucky, received 13.9 inches of rain between June 15 and Aug. 26. At planting time, the soils were very moist with a 6.4 inches surplus between May 1 and June 15. The average monthly temperatures for June and August were near normal, while July averaged 4.4 degrees below normal. No irrigation was required during the growing season. Harvest for these cultivars occurred from Aug. 19 until Aug. 26. Because of the cool, wet conditions, northern corn leaf blight (NCLB) was the major disease present, so we were able to determine which cultivars had good NCLB tolerance and thus were better suited for late-season production in a disease-prone area.

Charisma, Synergy, and Revelation were rated as the three top-yielding, best-quality, and bicolor sweet corn cultivars (Table 2). They had some resistance to NCLB as well.

Whiteout and Shasta were the best white cultivars, ranking fourth and fifth in points out of the 18 cultivars studied in this trial (Table 2). Honey Select and Kandy Korn were the only yellow supersweet sweet corn cultivars studied (Table 2). Both were very susceptible to NCLB. Infections were significant resulting in poor tip fill in both cultivars. The HMX6358 early maturity bicolor corn was very susceptible to NCLB and should not be planted late when disease problems are worse. The bicolor cultivar Kristine had a lot of blank stalks which resulted in a low yield.

Sweet corn cultivar selection should take into consideration the cultivar's ability to produce over an extended planting season where site location, weather, and changes in disease pressure may drastically change performance.

Attracting Beneficial Insects Using Methyl Salicylate-Based PredaLure® Lures

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Introduction

Exploiting chemical ecology in conservation biological control incorporates practices that attract insect predators and parasitoids into crop systems (Khan et al., 2008). Strengthening the natural enemy community by increasing density and species diversity to suppress pests is the goal. Exploitation of beneficial insect attractants (semiochemicals) in pest management is a small but growing field of conservation biological control.

In field experiments conducted in hops and grapes, synthetic methyl salicylate was attractive to the lygaeid, *Geocoris pallens;* syrphid flies; the coccinellid, *Stethorus punctum picipes;* the green lacewing, *Chrysopa nigricornis* (James 2003a, b; James and Price 2004), and the seven-spotted lady beetle, *Coccinella* *septempunctata* (Zhu and Park 2005). Based on these studies, AgBio Inc. recently patented and marketed the methyl salicylate-based PredaLure® lure for use in a variety of agricultural commodities. Therefore, the objective of this study was to determine the effects of PredaLure insect attractant on populations of beneficial insects in conventionally grown sweet corn.

Table 1. Average number of the most abundant beneficial insects captured per trap by sampling date in PredaLure® baited and non-baited sweet corn plots, Horticulture Research Farm, Fayette County, Ky.

Date	Species	Predalure		No Predalure		P-value	Significance
08/13/09	Pink lady beetle	0.21	a[1]	0.46	a	0.1191	NS[2]
	Asian lady beetle	4.58	a	3.08	b	0.0314	SIG
	Green lacewing	1.04	a	0.04	a	0.0001	SIG
08/19/09	Pink lady beetle	4.33	a	1.58	b	0.0002	SIG
	Asian lady beetle	0.33	a	0.33	a	1.0000	NS
	Big-eyed bug	0.75	a	0.00	b	0.0015	SIG
08/26/09	Pink lady beetle	4.92	a	5.63	a	0.4552	NS
	Asian lady beetle	0.04	a	0.13	a	0.3115	NS
	Big-eyed bug	0.71	a	0.29	a	0.1208	NS

[1] Numbers within the same column not followed by the same letter are significantly different at P<0.05.
[2] NS and SIG represent nonsignificant and significant, respectively.

Materials and Methods

Experimental plots were located on the University of Kentucky Horticulture Research Farm. Four plots, each 40 x 100 feet were planted with the sweet corn variety Garrison. Plots were separated by a minimum of 165 feet. Sweet corn was planted in double rows on raised beds with 36-inch row and 8-inch plant spacing, respectively. Standard agricultural practices were used. For statistical analysis, a randomized complete block design with four replicates was used.

Yellow sticky traps were used to capture insects and examine efficacy of PredaLure attractancy within the plots. Six lures were deployed in each plot on Aug. 1, with two placed in the center of each plot and one in the center of each quadrat of each plot. One sticky trap was deployed at the same location as each lure. Traps were changed weekly through anthesis. When collected, sticky traps were wrapped individually in clear plastic wrap, labeled, and transported to the laboratory for insect identification and enumeration. Data are presented for the Aug. 13, 19, and 26 sampling dates. Data were analyzed using analysis of variance (ANOVA) in SAS (SAS, 2008).

Results and Discussion

Nine species of lady beetles, one species of big-eyed bug, the green lacewing, and the brown lacewing were caught in this study. Species captured were the pink lady beetle, *Coleomegilla maculata*; Asian lady beetle, *Harmonia axyridis*; seven-spotted lady beetle, *Coccinella septempunctata*; spotless lady beetle, *Cycloneda munda*; parenthesis lady beetle, *Hippodamia parenthesis*; large parenthesis lady beetle, *Hippodamia glacialis*; convergent lady beetle, *Hippodamia convergens*; variegated lady beetle, *Hippodamia variegata*; mildew-eating lady beetle, *Psyllobora vigintimaculata*; big-eyed bug, *Geocoris punctipes*; green lacewing, *Chrysoperla carnea*; and the brown lacewing, *Hemerobius* spp. The pink lady beetle and Asian lady beetle were the two most abundant predators caught, representing 56 and 28%, respectively, of the total number caught. Big-eyed bug, green lacewing, and seven-spotted lady beetle accounted for only 6, 4, and 3%, respectively, of the total number caught. The remaining seven species combined for only 3% of the total. Significantly greater numbers of pink lady beetles, Asian lady beetles, green lacewings, and big-eyed bugs were found in PredaLure-baited plots (Table 1).

In a previous study using PredaLure in organically grown sweet corn, there was a tendency toward higher numbers of Asian lady beetles, spotless lady beetles, and green lacewings in plots where PredaLure had been deployed (Sedlacek, unpublished data). However, there were no significant differences in abundance of any of the predatory insects found between PredaLure-baited and non-baited plots. Vertical placement of lures in the crop and significant weed growth may impact lure attractiveness. In the current study, lures were kept at crop canopy height, whereas they were mounted at ear height in the organic sweet corn experiment. Mounting the lures at ear height may have limited the movement of methyl salicylate plumes, thus making detection by insects more difficult. In addition, the organic sweet corn plots had high levels of pigweed which may have concealed the scent of the PredaLure.

Results of the current study demonstrate that deployment of the Predalure increased the abundance of several important predators of sweet corn pests. Ear damage needs to be investigated to determine if higher populations of beneficial insects reduce damage to corn ears. These experiments need to be repeated with lures deployed at crop canopy height and with better weed management in organic plots. The lures also should be examined for efficacy in other vegetable and fruit crops.

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Sumagic Sprays for Height Control of Greenhouse-Grown Tomato and Pepper Transplants

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Introduction

For years, there have been no plant growth regulators (PGRs) labeled for use on vegetable transplants. Recently, a supplemental label for Sumagic (uniconazole; Valent Biosciences, Libertyville, IL) has been released allowing foliar sprays on some vegetable transplants (tomato, pepper, eggplant, tomatillo, ground cherry, and pepino). The new label is rather restrictive, however. The maximum total allowed application is 10 mg·L^{-1} at 2 L per 100 m^2. This means one 10 mg·L^{-1} spray, two 5 mg·L^{-1}, or four 2.5 mg·L^{-1} sprays, and so on are allowed. The last spray must be no later than two weeks after the 2- 4 leaf stage (approximately four weeks after sowing). PGRs like Sumagic are gibberellin biosynthesis inhibitors that suppress plant height by inhibiting internode elongation. There are other means of controlling heights of transplants that have been successfully used including negative DIF (difference between day and night temperatures), brushing, and light quality manipulation (Duman and Duzyaman, 2003; Garner and Bjorkman, 1997; Li et al., 2000; Rideout and Overstreet, 2003). However, these techniques require specialized equipment and/or manual labor that can significantly add to production costs. PGR sprays can be applied with any standard sprayer and require little time to execute. Sumagic is a particularly active PGR, so very small concentrations are needed for efficacy. Sumagic and other PRGs have been shown to effectively control height of both pepper (*Capsicum annuum*) and tomato (*Lycopersicon esculentum*) seedlings when applied as sprays, drenches, or seed soaks (Brigard et al., 2006; Davis et al., 1990; Latimer, 1992; Pasian and Bennett, 2001). The current study was designed to elucidate the size control efficacy that can be achieved with Sumagic sprays on pepper and tomato transplants using procedures allowed by the new label.

Materials and Methods

Seeds of three tomato and pepper varieties were sown on 29 May 2009 in Sunshine LA4 peat-lite substrate (Sun Gro Horticulture, Vancouver, B.C., Canada). Tomato Early Girl, Big Boy, and Champion II are indeterminate varieties typically produced for retail sales to home gardeners. Pepper Hungarian Yellow Wax, Big Bertha, and Better Belle are also typically produced for the home garden. The seeds were sown directly into 36-count cells. This "6-pack" size is common for retail pepper and tomato transplants. Plants were grown in a fan- and pad-cooled greenhouse in Lexington, Kentucky. Plants received plain water for the first week after sowing and then constant liquid feed at 50 mg·L^{-1} 15-5-15 CalMag (The Scotts Company, LLC, Maryville, OH) for one week, then 100 mg·L^{-1} 15-5-15 CalMag for the remainder of the experiment. Sumagic sprays were applied at concentrations of 0, 2.5, 5, or 10 mg·L^{-1} Sumagic at 14, 21, and/or 28 days after sowing. Plant heights were recorded when the transplants were at a market-ready stage six weeks after sowing (10 July). Market readiness was defined as 50% of plants having seven to eight true leaves expanded.

Results and Discussion

Sumagic is highly effective for height suppression of both pepper and tomato seedlings. All plants that received a Sumagic spray were shorter than their untreated controls at the market-ready stage (Table 1). Tomato plants were 18 to 52% shorter than their untreated controls. Pepper seedlings treated with Sumagic ranged from 6 to 71% shorter than their untreated control plants. In the ornamental plant market, 25 to 35% height suppression is considered ideal to produce plants with aesthetically pleasing form that will likely resume normal growth in a timely manner (Hamrick, 2003). Plants more than 35% shorter than untreated plants may appear stunted, and it may take a considerable amount of time for normal internode elongation to resume.

Tomatoes. The three tomato cultivars showed very similar responses to Sumagic. Each concentration of Sumagic produced plants of similar size at the market-ready stage. Champion II seedlings sprayed with 2.5, 5, and 10 mg·L^{-1} Sumagic 14 days after sowing were 20, 19, and 20 cm tall, respectively, compared to the control plants at 33 cm tall, approximately 40% shorter than the control plants. However, those treated with the higher concentrations would probably take longer to resume normal growth. In the interest of chemical use efficiency and prevention of post-planting complications, it would be best for growers to use the lowest effective Sumagic concentration. Additional applications can be made one to three weeks after the initial spray if additional height control is needed. For example, Big Boy tomato seedlings sprayed with 2.5 mg·L^{-1} Sumagic 14 days after sowing were 33% shorter than the untreated control compared to 35 and 42% shorter when additional sprays of 2.5 mg·L^{-1} Sumagic were applied 21 days or 21 and 28 days after sowing, respectively. Sumagic has not been tested on enough tomato varieties to be sure that they will all react similarly. As with any new PGR program, on-site testing of small portions of the crop is recommended before full-scale implementation.

Peppers. The three pepper cultivars were all highly responsive to Sumagic applications (Table 1). With a single Sumagic application at 2.5 mg·L^{-1} applied 21 days after sowing, Hungarian Yellow Wax, Big Bertha, and Better Belle pepper plants were 41, 41, and 29% shorter than their respective untreated controls. Higher spray rates caused stunting. Hungarian Yellow Wax, Big Bertha, and Better Belle plants sprayed with 10 mg·L^{-1} Sumagic at any time averaged 48, 52, and 48% shorter than their respective untreated control plants. For Better Belle peppers following sprays of 0, 2.5, 5, or 10 mg·L^{-1} Sumagic 14 days after sowing, those treated with 10 mg·L^{-1} Sumagic were severely stunted (58% shorter than the control plants) and would not be marketable. Given this high sensitivity, growers will need to use extreme caution when applying Sumagic to pepper seedlings. In most cases, negative DIF or other non-chemical height control measures should be sufficient to produce marketable pepper transplants (Hamrick, 2003; Li et al., 2000).

Post-transplant concerns. There is clearly a risk of undesirable side effects of PGR application to fruiting crops, namely delayed fruit set, reduced fruit size, or yield, in addition to PGR residue in the fruits. Maginitsky et al. (2003) found that there was no detectable Sumagic in tomato or cucumber fruits following seed soak applications. Wang and Gregg (1990) found that uniconazole applications two weeks after sowing led to a reduction in fruit number but an increase in fruit size. Zandstra et al. (2003) reported no reduction in yield or fruit size following Sumagic sprays on tomato transplants. In fact, this study reported a reduction in time from planting to fruit set. Clearly, more research is needed to further elucidate the effect of PGR applications on field performance of tomato and pepper transplants.

Table 1. Average heights of tomato Early Girl, Big Boy, and Champion II and pepper Hungarian yellow wax, Big Bertha, and Better Belle at the market-ready stage (7-8 expanded leaves) following foliar sprays of Sumagic (uniconazole) at 0, 2.5, 5, or 10 mg·L^{-1} applied 14, 21, and/or 28 days after sowing.

Sumagic Concentration (mg·L^{-1})	Spray Day(s) (days after sowing)	Height (cm) at Market-Ready Stage (42 days after sowing)					
		Tomato			Pepper		
		Early Girl	Big Boy	Champion II	Hungarian Yellow Wax	Big Bertha	Better Belle
0	14	29.4 a[z]	33.8 a	32.6 a	22.2 a	21.4 a	19.2 a
2.5	14	20.7 def	22.8 cdef	20.0 ef	20.9 a	16.5 b	14.3 b
2.5	21	20.0 defg	21.7 efgh	22.6 d	13.0 bcd	12.7 de	13.7 bc
2.5	28	24.1 bc	27.4 b	26.5 b	14.8 b	16.8 b	13.5 bc
2.5	14, 21	17.9 g	21.8 efgh	17.4 gh	14.0 bc	10.3 fgh	9.8 ef
2.5	14, 28	18.8 fg	22.1 defg	17.9 fgh	11.2 cde	14.2 cd	12.8 bc
2.5	21, 28	21.4 de	19.6 gh	21.7 de	10.6 de	11.5 ef	11.2 de
2.5	14, 21, 28	19.4 efg	16.3 i	16.9 h	9.5 ef	8.3 ij	11.2 de
5	14	20.2 defg	21.7 efgh	19.4 efg	15.8 b	11.2 efg	12.2 cd
5	21	21.9 cde	23.4 cde	23.7 cd	15.3 b	13.5 d	13.6 bc
5	28	22.0 cd	24.6 cd	22.8 d	15.0 b	15.5 bc	10.6 de
5	14, 21	18.8 fg	20.8 efgh	16.9 h	9.9 e	7.1 jk	9.9 ef
5	14, 28	18.9 fg	19.3 h	25.4 bc	7.0 f	8.0 j	8.6 fg
5	21, 28	21.9 cd	20.0 fgh	18.4 fgh	10.3 de	9.6 hi	9.8 ef
10	14	18.4 fg	20.0 fgh	20.0 ef	9.9 e	6.1 k	8.1 g
10	21	19.6 defg	22.6 cdef	23.4 cd	11.7 cde	9.7 ghi	10.5 e
10	28	25.8 b	25.2 bc	26.1 b	13.3 bcd	15.3 bc	11.2 de
Significance		***	***	***	***	***	***

[z] Within-column means followed by different letters are significantly different by Waller-Duncan K-ratio t-test at $P \leq 0.05$.
*** Significant at $P \leq 0.001$.

Conclusions

Sumagic is a viable tool to control excessive stem elongation in pepper and tomato transplants. Sumagic can be applied without special equipment and with minimal labor, making this an economical choice for growers. In addition, the product is not expensive, and the effective concentrations are very low, which will keep chemical costs to a minimum as well. However, growers must be very cautious in implementing a Sumagic height-control program. With these low concentrations, growers must have the ability to accurately calculate and precisely measure the volume of chemical required for the spray solution. With proper attention to detail, Sumagic will help growers produce highly marketable, top-quality tomato and pepper transplants.

Acknowledgments

The author would like to acknowledge the Scotts Company LLC for donations of potting media and fertilizer, the Ball Horticultural Company for donation of the seed used in this study, and Kirk Ranta and Patrick Mooney for technical assistance.

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Yield and Income of Fall Staked Tomato Cultivars in Eastern Kentucky

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Introduction

Kentucky growers produce approximately 1,200 acres of staked, vine-ripe tomatoes for local and national sales. Kentucky tomatoes have an excellent reputation for quality among produce buyers. This trial evaluated new and existing cultivars to identify those that might produce well as a late-season (fall) tomato with heat tolerance and resistance to various disease problems. Cultivars were evaluated for yield, appearance, and potential return to growers. We wanted to see which tomato cultivars would produce good yields of attractive fruit, acceptable to the industry.

Materials and Methods

Twenty fresh-market tomato cultivars were evaluated at Quicksand, Kentucky (Table 1). In accordance with soil test results (Table 2), the plot received 100 lb K_2O/A, preplant and 50 lb N/A through the drip line the day after planting. An additional 75 lb of N/A were applied through the drip irrigation lines on a weekly basis during the growing season. Pest control was based on recommendations in the University of Kentucky's *Vegetable Production Guide for Commercial Growers* (ID-36). Fungicides were applied weekly and insecticides as needed.

Trays were seeded in the greenhouse at Quicksand on 28 May. Wet weather delayed plastic laying and planting by about seven days. White on black plastic mulch and drip tape were laid on 7 July, and tomatoes were transplanted the next day. Cultivars were replicated four times with six plants per replication. Plants were spaced 18 inches within rows. Rows (bed centers) were 8 feet apart to allow the sprayer to be driven between beds.

Six harvests were made during this trial starting on 9 September and ending 12 October. The tomato cultivars were harvested when the fruit was at the breaker stage. Data collected included grade, weight, and count for jumbo and extra-large (>3.5 in.), large (>2.5, <3.5 in.), No. 2, mediums (<2.5, >2.0 in), and cull tomatoes. Reasons for culling included catfacing, concentric or radial cracks, disease, scars, and blotchy ripening. Incomes were calculated based on the prices received by growers for staked tomatoes at the Lincoln County Produce Auction in 2009 (Table 3).

Table 1. Tomato cultivars, descriptions, and reported disease resistance, grown at Quicksand, Ky., 2009.

Variety Name (Company)[1]	Comments/Description[2]
Rocky Top (SW, RUPP)	Large to extra-large fruit with exceptional quality, is well adapted to North USA & Canada. Resistance to FW1, 2, 3.
Nico (HM)	Determinate, mid-maturity, dark red fruit. Resistance to VD, FW1, 2; ASC, Nt, TSWV.
Red Defender [HMX 5825] (HM)	Determinate, mid-maturity, dark red fruit. Resistance to VD, FW1, 2; ASC, TSWV.
Mt. Fresh Plus (HM)	Determinate, red, 78 days. Resistance to FW1, 2; Nt, VD.
Bella Rosa (SW)	Sets well in heat. Large attractive fruit, meaty & firm, large & a sturdy shipping tomato.
Crista [NC 0256] (HM)	Determinate, red, 75 days. Resistance to FW1, 2, 3; VD, TSWV, Nt.
Amelia VR (HM)	Determinate, red, 80 days. Resistance to FW1, 2; TSWV, Nt, VD, ST.
Solar Fire (SW, HM)	Heat set, 73 day determinate, compact plant, red fruit. Resistance to FW1, 2, 3; VW1, ST.
Mt. Glory [NC 0392] (ST)	Determinate large red fruited Mt. Spring type. Resistance to FW1, 2; VW1, 2, 3 ST, TSWV (tol.).
Finishline [RFT 4974] (ST)	Determinate for extra lg. green harvest. Resistance to FW1, 2, 3; VW; ST; TSWV.
Redline (ST)	Determinate, L-XL red fruit. Resistance to TSWV, FW1, 2, 3.
Fletcher (SW)	Very productive, resistant to TSWV, good firm fruit with good yields. In Mt. Spring class.
RFT 6153 (SW)	Offers good eating quality, fancy in appearance & firm, large is a sturdy shipping tomato.
Primo Red (HM)	Extra-large smooth fruit, very early maturity, nice red color. Resistance to FW, TSWV, VW.
BHN 871 (RUPP)	Gold to tangerine color, globe shape, nice firm smooth fruit. Resistance to BW, VW.
BHN 962 (RUPP)	Has good heat set ability for fruit, uniform green shoulders. Resistance to FW3.
BHN 876 (RUPP)	Orange to red color, globe-shaped fruit has a good flavor & texture. Resistance to BW, VW.
BHN 669 (RUPP)	Designed for production areas with bacterial wilt pressure. Resistance to BW, VW.
BHN 964 (RUPP)	Has good heat set ability for fruit, uniform green shoulders. Resistance to moderate tolerance to early blight.
BHN 963 (RUPP)	Has good heat set ability, flat globe with uniform green shoulders. Resistance to VW, FW.

1 See Appendix A for seed sources.
2 ASC = Alternaria Stem Canker Tolerant; BSR = Bacterial speck resistant; BW = Bacterial Wilt; ED-Early Blight Tolerant; FW1 = Fusarium Wilt R1; FW2 = Fusarium Wilt R2; FW3 = Fusarium Wilt R3; GLS = Gray Leaf Spot; Nt = Nematode tolerant; ST = Stemphylium Tolerant; TSWV = Tomato Spotted Wilt Virus; VD = *Verticillium dahliae*; VW = Verticillium Wilt 1, 2, 3.

Table 2. Results from soil test at Quicksand, Ky., 2009.

pH	Buffer pH	P	K	Ca	Mg	Zn
6.36	6.84	77	312	3052	288	7

Table 3. Prices used to calculate incomes—average farm gate prices paid at the Lincoln County Produce Auction in 2009.[1]

Week	Price/20 lb Box
Sept 9	9.10
Sept 16	8.46
Sept 23	10.94
Sept 30	7.79
Oct 7	10.46
Oct 12	9.59

[1] Yields for extra-large and jumbo grades were multiplied by these average prices for the appropriate harvest dates to calculate "income per acre" for each cultivar.

Table 4. 2009 fall fresh-market tomato yields at Quicksand, Ky., 2009. Data are means of four replications.

Cultivar	Jumbo & XL (boxes/A)[3]		Jumbo & XL (%)[3]		Total Marketable Yield (lb)[1,3]		Income ($)		Pounds No. 2 Tomatoes[3]		Percent Culls[2,3]	
Rocky Top	918	a	94	ab	24494	a	11139	a	1215	cde	2.3	ef
BHN 963	851	a	92	ab	23240	a	11619	a	2857	abc	7.5	abcd
Nico	822	a	89	ab	23153	a	10639	a	2091	abcde	3.8	def
Red Defender	821	a	94	a	21712	a	9751	a	1271	bcde	1.3	f
BHN 669	780	a	90	ab	22458	a	10898	a	2983	ab	9.4	abc
BHN 871	773	a	89	ab	21701	a	8875	a	2044	abcde	10	ab
BHN 964	742	a	93	ab	19831	a	9949	a	2723	abcd	4.5	def
Solar Fire	732	a	86	b	21243	a	9625	a	671	e	2.6	def
BHN 876	732	a	88	ab	20722	a	8471	a	1034	de	5.2	cdef
Mt. Glory	730	a	92	ab	19799	a	8429	a	592	e	2.3	ef
Primo Red	705	a	88	ab	20036	a	7598	a	1484	abcde	11.4	a
Fletcher	695	a	91	ab	19128	a	8637	a	1428	bcde	3.1	def
BHN 962	688	a	89	ab	19286	a	9962	a	3196	a	11.4	a
Amelia	683	a	90	ab	19097	a	8588	a	1926	abcde	4.2	def
Crista	657	a	88	ab	18592	a	8045	a	1286	bcde	3.5	def
Redline	644	a	92	ab	17582	a	7868	a	1531	abcde	5.5	cdef
RTF 6153	617	a	89	ab	17132	a	7593	a	1010	de	4.5	def
Mtn. Fresh Plus	603	a	91	ab	16706	a	7455	a	552	e	2.8	def
Bella Rosa	571	a	93	ab	15193	a	7886	a	894	e	1.9	ef
Finishline	571	a	91	ab	15569	a	7387	a	1515	abcde	6.5	bcde
Minimum Significant Difference (MSD 5%)	304		6.7		232		3987		1458		4.1	

[1] Includes all grades except culls.
[2] A small amount of blotchy ripening was seen in some cultivars during the last two harvests in October.
[3] Means within a column followed by the same letter are not significantly different, as determined by MSD (5%).

Results and Discussion

The 2009 growing season was wetter and much cooler than normal. Rainfall totals for July through October were 6.41, 3.55, 4.88, and 0.85 inches for a total of 15.69 inches. During the trial time period, average temperatures were below normal. Cool, wet weather certainly delayed our harvest season, and tomato late blight was widespread throughout the region, requiring a short spray interval and the use of several newly labeled fungicides. Normally, we harvest fall tomatoes eight times during the growing season; this year, we obtained only six harvests. Our fall tomato yields in 2009 were about one-half that obtained in previous years.

Despite cool, wet weather and the use of potassium nitrate in the fertigation program, some blotchy ripening was found in the last two harvests for several tomato cultivars. Rocky Top had the highest total marketable yield and boxes of jumbo and extra-large tomatoes. However, there was no significant difference in the number of boxes of jumbo/extra-large tomatoes or in total income produced by the 20 tomato cultivars. Primo Red, BHN 962, BHN 871, BHN 669, and BHN 963 had the highest percentages of cull tomato fruit. Primo Red and BHN 962 had significantly more cull tomatoes than 15 of the other cultivars (Table 4). Rocky Top had the largest fruit size, but it was not significantly different from BHN964, Bella Rosa, Mountain Fresh, Mountain Glory, Red Defender, Finishline, and BHN 963 (Table 5).

Growers should use caution when selecting any vegetable cultivar based on one year's results at a single location.

Table 5. 2009 fall tomato cultivar trial, average fruit weight, Quicksand, Ky.

Cultivar	Avg. Fruit Wt. (oz)	
Rocky Top	9.9	a
BHN 964	9.3	abc
Bella Rosa	9.6	ab
Mt. Fresh Plus	9.0	abcd
Mt. Glory [NC 0392]	9.0	abcd
Red Defender [HMX 5825]	8.8	abcd
Finishline [RFT 4974]	8.8	abcd
BHN 963	8.8	abcd
Redline	8.6	bcd
Solar Fire	8.6	bcd
RTF 6163	8.6	bcd
BHN 962	8.5	bcd
Crista	8.3	cde
Nico	8.3	cde
Fletcher	8.2	cde
Primo Red	8.2	cde
BHN 871	8.2	cde
BHN 669	8.0	de
Amelia	8.0	de
BHN 876	7.2	e
Minimum Significant Difference (MSD 5%)	0.06	

Fresh-Market Tomato Variety Performance in 2009

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Introduction

Fresh-market tomatoes represent one of the most valuable vegetable crops in Kentucky. Kentucky farmers grow over 1,000 acres of fresh-market tomatoes for wholesale and farmers' markets. Several new varieties released recently have not been tested in Kentucky. Therefore, a variety trial was designed using many new varieties and some existing varieties that are commonly grown in Kentucky.

Materials and Methods

The trial was conducted at the University of Kentucky Horticulture Research Farm in Lexington during the spring and summer of 2009. Tomato varieties were seeded into greenhouse flats 18 March 2009. Seedlings were moved into 72-cell trays approximately four weeks later. Seedlings were greenhouse-grown using standard production techniques. Seedlings were transplanted into the field on 11 May 2009. Plants were set into raised beds covered with black plastic mulch with drip tape. Beds were spaced on 6-foot centers, and plants were spaced at 18 inches within rows. Plots consisted of eight plants of each variety replicated four times in a randomized complete block design. Borders containing several tomato varieties surrounded the test plots. The field received approximately 50 pounds of preplant nitrogen per acre with no additional phosphorous or potassium applied per soil test results. Tomatoes were grown using University of Kentucky standard procedures from *Vegetable Production Guide for Commercial Growers* (ID-36).

Plants were first harvested on 13 July 2009. Plants were harvested once weekly until 25 August 2009. Fruit were graded for quality and size according to USDA standards for U.S. No. 1 tomatoes. Yield data were calculated based on a plant population of 4,800 plants/acre. Statistics were performed using SAS statistical software. Data were tested for normality and transformed if necessary. Results were considered significantly different if $P < 0.5$.

Results and Discussion

The 2009 growing season was challenging for many growers in Kentucky. Severe disease pressure was present throughout the season. Despite regularly scheduled sprays, this trial was heavily impacted by a bacterial spot outbreak that occurred in late June through early July 2009. As such, our total marketable yields for fresh-market tomatoes were lower than

Table 1. Marketable yield and yields of small, medium, large, and extra-large tomatoes as well as % of culls and total harvested weights per acre for 24 fresh-market tomato varieties grown in Lexington, Ky., in 2009. Varieties are ordered based on marketable yield (highest to lowest).[1]

Variety	Marketable Yield (lb/A)		Small (lb/A)		Medium (lb/A)		Large (lb/A)		Extra Large (lb/A)		Culls (%)[2]		Total Harvested (lb/A)	
SVR1400	22623	a*	417	b	4650	bcde	6012	ab	11544	a	57	d	53031	a
NC0821	22218	ab	357	b	5292	bcde	6546	a	10023	ab	58	d	52716	a
Red Defender	19365	abc	732	b	7020	abcd	5211	abc	6402	bcde	64	bcd	52845	a
NC07245	18821	abcd	504	b	6591	abcde	6455	a	5271	cdefg	63	bcd	49412	ab
JTO-99197	17964	abcde	984	ab	8142	ab	5667	abc	3171	efgh	61	cd	45120	abcde
Mt. Crest	17505	abcdef	1287	ab	9309	a	3624	abc	3285	defgh	59	d	42297	bcde
NC07235	17121	abcdefg	600	b	4311	cde	4293	abc	7917	bc	64	bcd	47187	abcd
Mt. Fresh+	17061	abcdefg	504	b	4908	bcde	5775	abc	5874	cdef	66	abcd	49095	abc
Rocky Top	16751	abcdefg	791	ab	6036	abcde	4407	abc	5517	cdefg	64	bcd	45287	abcde
Scarlet Red	16575	abcdefg	639	b	4728	bcde	4701	abc	6507	bcde	66	abcd	48054	abcd
NC086	16484	abcdefg	656	b	4720	bcde	3740	abc	7368	bcd	66	abcd	47468	abcd
Nico	15636	abcdefg	486	b	7416	abc	4095	abc	3639	defgh	67	abcd	46617	abcd
NC0694	15279	abcdefg	1851	a	7617	abc	3615	abc	2196	fgh	68	abcd	46332	abcd
Fletcher	14601	bcdefg	801	ab	6342	abcde	3852	abc	3606	defgh	63	bcd	39522	cde
Finishline	14445	bcdefg	921	ab	5928	accde	4542	abc	3054	efgh	64	bcd	40623	bcde
Mt. Glory	14220	cdefg	840	ab	6120	abcde	3123	abc	4137	cdefgh	69	abcd	45066	abcde
Primo Red	13982	cdefg	317	b	4224	cde	3933	abc	5508	cdefg	66	abcd	40916	bcde
Mt. Spring	13701	cdefg	354	b	5301	bcde	3513	abc	4533	cdefgh	69	abcd	43185	bcde
BHN 602	12516	cdefg	291	b	4404	cde	3561	abc	4260	cdefgh	74	abc	47769	abcd
BHN 543	10965	defg	504	b	5583	bcde	2949	bc	1929	fgh	74	abc	40479	bcde
BHN 640	10192	efg	1416	ab	5292	bcde	2576	bc	908	h	75	ab	39352	de
Solar Fire	9945	fg	399	b	5016	bcde	2526	c	2004	fgh	75	ab	39861	bcde
Crista	9819	fg	738	b	3228	e	4050	abc	1803	fgh	75	ab	36617	e
Amelia	9459	g	813	ab	3828	de	3282	abc	1536	gh	78	a	41832	bcde

* Means in the same column followed by different letters were significantly different at P>0.05.
1 Yield values based on a per acre population of 4,800 plants; grading based on USDA size and quality standards.
2 % cull based on weight of nonmarketable fruit/total harvested fruit.

usual this year (Table 1). Nonetheless, some varieties stood out. SVR 1400, a newer release, had the highest marketable yields and the lowest percentage of cull fruit. Other varieties that performed well included NC0821, Red Defender, NC07245, and JTO-99197. The two NC varieties have not yet been released and are part of the North Carolina State tomato breeding program. However, both performed well in 2008, and they may be released in the future. Red Defender, a late-season tomato, has performed well in Kentucky and Tennessee for the past several years and looks to be a consistent performer. JTO-99197 is a new release from Johnny's Seeds that is reported to have resistance to early blight. It performed well in 2009, although resistance to early blight was not evaluated this year. Varieties that have performed well in the past that did not do well this year include Amelia, BHN 602, and Crista. The high cull rates resulting from the presence of bacterial spot are likely responsible for the low marketable yields of these varieties.

Per fruit weight ranged from 8.4 to just over 12 ounces. The varieties with the largest per fruit weights were NC086, NC0821, and SVR 1400. The NC varieties had the highest per fruit weights in 2008 as well. Overall, SVR 1400 performed the best in this year's trial, with low cull percentages and high per fruit weights. This was the first year testing this variety in Kentucky, so further trials are warranted. Growers should be aware that this trial tested varieties in one location for one year and that performance of varieties can vary from one year to the next.

Table 2. Seed source, average days to first harvest, average fruit weight, percentage of weight loss in storage, and soluble solids content of 24 tomato varieties grown in Lexington, Ky., in 2009. Varieties are ordered based on average fruit weight (highest to lowest).[1]

Variety	Seed Source[2]	Days to Harvest[3]	Average Fruit Wt. (oz)	
NC0821	NA	-	12.1	a*
SVR1400	RU	-	11.6	ab
NC086	NA	-	11.3	abc
Mtn. Fresh+	SW	76	11.1	abcd
NC07235	NA	-	10.8	bcde
NC07245	SW	-	10.7	bcde
Scarlet Red	SW/HR	73	10.7	bcde
Mtn. Spring	SW	74	10.4	cdef
BHN 602	SW/SI	77	10.4	cdef
Rocky Top	RU	74	10.3	cdefg
Red Defender	SW	80	10.2	cdefg
Mtn. Glory	SW/SI	74	10.0	defgh
Primo Red	HR	68	10.0	defgh
Nico	SW	77	9.8	efghi
Fletcher	SW	74	9.7	efghi
Crista	SW	74	9.7	efghi
JTO-99197	JS	78	9.3	fghij
Finishline	SI	77	9.3	fghij
Amelia	SW	80	9.2	ghij
BHN 543	SW	72	8.9	hij
Mtn. Crest	SW/SI	74	8.8	ij
NC0694	NA	-	8.8	ij
Solar Fire	SW	73	8.8	hij
BHN 640	SI	76	8.4	j

* Means in the same column followed by different letters were significantly different at P>0.05.
1 Average fruit weight in ounces based on total marketable yield/total number of marketable fruit.
2 See Appendix A for seed sources; NA = not yet commercially available.
3 Average days to harvest according to seed company data.

Fresh-Market Tomato Variety Trial Results for 2009

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Introduction

Fresh-market tomatoes are one of the most valuable vegetable crops grown in Kentucky. Several varieties have been released recently that may be of interest to Kentucky farmers. Although there have been several recent tomato trials in central and eastern Kentucky, we have not yet evaluated many of these new varieties in western Kentucky. The goal of this trial was to determine which of these varieties perform well in the western part of the state.

Materials and Methods

A research plot was planted at the University of Kentucky Research and Education Center (UKREC) in Princeton in western Kentucky. Ten varieties were planted in a randomized complete block design. These varieties were BHN602, Fletcher, Mountain Fresh, Mountain Glory, Mountain Spring, Nico, Primo Red, Red Defender, Rocky Top, and Scarlet Red. Each block contained eight plants per variety, planted 2 feet apart in single rows. A soil sample was taken in early spring, and the soil was amended according to recommendations in the University of

Table 1. Marketable yields, number of fruit marketable per acre, percentage of cull fruits, and average fruit size for 10 varieties of fresh-market tomatoes grown in Princeton, Ky., in 2009.

Varieties	Marketable Yield (lb/A)[1]		Number of Fruit/A		% Cull Fruits[2]		Average Fruit Size/ oz	
Nico	40191	a*	95550	a	7.5	b	6.7	ab
Red Defender	28798	b	61650	bc	12.8	ab	7.5	ab
BHN 602	27780	b	63000	b	11.5	ab	7.1	ab
Mt Fresh	24985	b	56100	bc	15.8	ab	7.1	ab
Mt Spring	23269	b	51600	bc	11.5	ab	7.4	ab
Scarlet Red	21723	b	45300	bc	13.3	ab	7.6	ab
Rocky Top	20610	b	46050	bc	13.0	ab	7.1	ab
Primo Red	20188	b	39000	c	23.0	a	8.4	a
Mt Glory	18984	b	42600	bc	16.5	ab	7.1	ab
Fletcher	17899	b	46200	bc	15.3	ab	6.2	b

* Means in the same column followed by different letters were significantly different at P>0.05.
1 Yield values based on a per acre population of 4,800 plants; grading based on USDA size and quality standards.
2 % cull based on weight of nonmarketable fruit/total harvested fruit.

Kentucky's *Vegetable Production Guide for Commercial Growers* (ID-36). A plastic mulch layer with drip tape and a waterwheel setter were used to establish the research plot. A starter solution was used when transplanting. A tensiometer was strategically placed in the plot to monitor soil moisture content. Plants were irrigated according to University of Kentucky recommendations for plasticulture tomatoes. Fertilizer was applied by fertigation during the growing season. The fungicide sample programs found in the University of Kentucky's *Vegetable Production Guide for Commercial Growers* (ID-36) were followed.

Results and Discussion

Due to the poor weather conditions during the 2009 growing season, yields were lower than expected. In this trial, Nico was the highest yielder. With a wet spring this season, some varieties did not do as well as expected. On several occasions, enough rain was received that plants were sitting in standing water. Fruit showed significant cracking in the early part of the harvest due to excess moisture. Irrigation was subsequently reduced because of the wetness, thereby hindering fertigation. During mid-July, a short period of dryness led to a reduction in cracking and an increase in fruit quality. BHN602, a good performer in other trials, had high losses at transplant, leading to a reduction in plot size for this variety. This was the first year that these varieties have been tested in western Kentucky. Growers should be aware that these results may have been affected by the unusual weather conditions experienced this summer. Multiple years of trials are often required before recommendations can be made with confidence.

The Effects of Pulsing Drip Irrigation on Tomato Yield and Quality in Kentucky*

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Introduction

Many fruit and vegetable growers in Kentucky rely on drip irrigation to supply water to their crops. Irrigation efficiency, which is defined as the percentage of water delivered to the field that is used to grow crops, typically ranges from 90 to 95% for drip systems (Locascio, 2005; Rogers et al., 1997). In contrast, typical sprinkler irrigation systems have efficiencies of 75% (Locascio, 2005). Despite relatively high efficiencies, drip irrigation systems use large quantities of water. For example, a two-acre mixed vegetable plot grown on black plastic mulch with drip irrigation in Kentucky required more than 400,000 gallons of water during the 2007 growing season, at a cost of $1,700 (Spalding and Coolong, 2008).

Drip irrigation systems work by distributing small amounts of water (0.5 to 2.5 gal/h) under low pressure for a relatively long period of time at or below the soil surface. Because water infiltration into the soil is localized to regions near emitters, only a small portion of the total field receives water. Irrigation water use efficiency (I_{WUE}), which is defined as crop yield per unit of water supplied, often increases when crops are grown using drip irrigation (Bresler et al., 1982; Howell, 2001). Drip irrigation frequency and rate of discharge as well as soil texture and structure can significantly affect the pattern of water infiltration into the soil (Elmaloglou and Diamantopoulos, 2007; Thorburn et al., 2003). Typically, during the initial stages of irrigation, water infiltration into the root zone is high, although as the root zone soil becomes saturated, water infiltration rates decrease, and the depth of the wetting front increases (Sinai et al., 2007). Just five hours after the initiation of drip irrigation, the wetting front under the emitter may reach 45 cm (Elmalaglou and Diamantopoulos, 2007). However, many small fruits and vegetables have shallow root systems. Thus, drip irrigation at standard discharge rates for extended periods of time may result in water loss below the root zone. However, supplying water at standard rates (1 gal/h) in a number of short pulses (pulsed irrigation) may reduce water loss below the root zone. It has been shown that pulsed irrigation results in a shallower wetting front shortly after irrigation, which may increase I_{WUE}, due to decreased water loss below the root zone (Assouline et al., 2006; Zur, 1976; Zur and Savaldi, 1977). To test the effects of pulsed drip irrigation on tomatoes, the following study was conducted in the summer of 2008.

Materials and Methods

The irrigation study was initiated in June 2008. The tomato variety Sebring was used. The trial was conducted at the University of Kentucky Horticulture Research Farm in Lexington. Tomato seedlings were greenhouse-grown using standard production techniques and transplanted into the field on 11 June 2008. Plants were set into raised beds covered with black plastic mulch with drip tape. Beds were spaced on 6-foot centers, and plants were spaced at 18 inches within rows. Plots consisted of 20 plants of each treatment replicated four times in a completely randomized design. Border rows surrounded the test plots. The field received approximately 50 pounds of preplant nitrogen with no additional phosphorous or potassium applied per soil test results. Tomatoes were grown using University of Kentucky standard procedures recommended in *Vegetable Production Guide for Commercial Growers* (ID-36). Treatments were initiated 2 July 2008. The five treatments used were:

- **Manual:** Turn on irrigation at 35 cb and off at 10 cb, checked daily.
- **Automated:** Tensiometers automatically turned on at 35 cb and off at 10 cb.
- **100% pulsed:** 100% of the water delivered in the automated treatment but delivered in eight pulses of 15 to 25 minutes each.

* **Editor's note:** Data from the 2008 growing season are presented here because data collection was not complete when the *2008 Fruit and Vegetable Report* went to press.

- **80% pulsed:** 80% of the water delivered in the automated treatment but delivered in eight pulses of 15 to 20 minutes each
- **60% pulsed:** 60% of the water delivered in the automated treatment but delivered in eight pulses of 15 to 20 minutes each.

The set points of 35 and 10 cbar were taken from existing University of Kentucky recommendations for staked tomato production. The pulsed treatments were managed using a RainBird irrigation controller. Fertigation was accomplished using a 2.5 gallon pump sprayer modified to inject fertilizer into the entire plot at the same time. This was used so that fertilizer could quickly be applied to the crop. Water volume applied was monitored using 0.75-inch water meters.

Plants were first harvested on 12 August 2008. Plants were harvested once or twice weekly until 29 September 2008. Fruit were graded for quality and size according to USDA standards for U.S. No. 1 tomatoes. Yield data were calculated based on a plant population of 4,800 plants/acre. Statistics were performed using SAS statistical software. Data were tested for normality and transformed if necessary. Results were considered significantly different if $P < 0.5$.

Results and Discussion

The well-managed manual treatments used the most water per acre, followed by the fully automated treatment and the different pulsed treatments (Table 1). Although the manual treatment was monitored daily and turned off after only a few hours, we were still able to reduce water usage by over 60,000 gallons/acre by automating the system. The pulsed treatments worked well, and we were able to effectively reduce water use by roughly 40% in our 60% treatment. Interestingly, the fully automated treatment, which could be considered the most efficient way to implement current UK recommendations for irrigating tomatoes, used 222,000 gallons of water an acre. It is likely that this number would be even greater for a cultivar that produced greater foliage than Sebring, which is generally a smaller plant.

Yields were unaffected by irrigation regime. Even the 60% pulse treatment had statistically similar yields as the automated and manual treatments, despite using much less water (Table 2). Plant water potential (data not shown), which is an indicator of plant stress, was measured during the study and showed that none of the treatments appeared to stress the plants. Percentage of culls and fruit size (Table 2) were unaffected by the treatments as well. This suggests that we can greatly reduce the amount of water used for irrigation while still maintaining yield and quality in tomato plants. Due to these findings, we are currently reevaluating our current irrigation recommendations for vegetable crops in Kentucky.

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Table 1. The total amount of water used in each treatment, water used per plant and per acre, and the percent of water applied as compared to the fully automated treatment that used UK recommendations.

Treatment	Water Used (gal.)	Water Used per Plant/A (gal.)	% of Automated Treatment
Manual	6709	60 / 287,528	130%
Auto	5180	46 / 222,000	100%
100%	4670	41.7 / 200,143	90%
80%	3870	34.6 / 165,857	75%
60%	3179	28.4 / 136,242	61%

Table 2. The effects of five irrigation treatments on marketable yield and yields of small, medium, large, and extra-large fruit as well as percent of culls of Sebring tomatoes grown in Lexington, Ky., in 2008. There were no significant differences between treatments with $P < 0.05$. Varieties are ordered based on treatments.

Treatment	Marketable Yield (lb/A)[1]	Small (lb/A)	Medium (lb/A)	Large (lb/A)	Extra Large (lb/A)	Culls (%)[2]
Manual	27,056	1634	13178	7574	4715	50
Automatic	26,434	1680	12341	7596	4821	52
100% Pulse	29,729	1986	15453	8404	3882	47
80% Pulse	34,188	2157	14168	14352	3485	42
60% Pulse	32,199	2105	14720	9806	5561	41

[1] Yield values based on a per acre population of 4,800 plants; grading based on USDA size and quality standards.
[2] % cull based on weight of nonmarketable fruit/total harvested fruit.

Evaluation of Powdery Mildew Tolerance in Pumpkins in Central Kentucky

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Introduction

Powdery mildew is a serious disease of cucurbits in Kentucky. The effects of powdery mildew in pumpkins can be devastating, as hot and dry conditions in summer and early fall are generally favorable for outbreaks that can be quite severe. Large outbreaks of powdery mildew can destroy foliage, resulting in plants that are unable to support large fruit loads, thus reducing yields. In addition, powdery mildew can spread from the stem and foliage of pumpkin plants to the handles, compromising keeping quality and resulting in unmarketable fruit. As a result, pumpkin growers must rely on regularly scheduled fungicide sprays to reduce damage from powdery mildew. The cost of fungicide programs can be relatively high, depending on the materials used and the number of times they are applied. In addition, many seed companies offer a number of pumpkin varieties with varying degrees of resistance to powdery mildew. When used in combination with fungicide sprays, these varieties enable growers to effectively control powdery mildew on pumpkins. Growers may be able to reduce the number of fungicide sprays required for adequate control of powdery mildew, along with the associated expense, if they choose a variety with high resistance to powdery mildew compared to a variety with minimal resistance. Also, effective disease control can be achieved with less-expensive protectant fungicides if varieties with good resistance to powdery mildew are planted. To gain a better understanding of the inherent resistance to powdery mildew in commercially available and experimental pumpkins, 24 varieties of medium and large pumpkins with at least some resistance to powdery mildew were tested without fungicide sprays to determine the level of resistance in each when subjected to high disease pressure. Four pumpkin varieties without any reported powdery mildew resistance were included as positive controls.

Table 1. Seed source, average fruit weight, stem ratings, and color evaluations for 28 varieties of pumpkins grown in Lexington, Ky., in 2009.

Variety	Seed Source[1]	Avg. Fruit Wt. (lb)		Stem Rating (1-5)[2]	Color
Dependable	AC	18.1	a	3.1	yellow orange
Summit	OS	17.3	ab	2.5	medium orange
Checkmate	OS	17.1	abc	2.0	medium orange
Conestoga Giant	SI	16.8	abcd	1.8	medium orange
Aladdin	HM	16.8	abcd	2.5	medium orange
Pankow's Field	H	16.8	abcd	2.5	yellow orange
Hannibal	SI	15.7	abcde	2.5	medium deep orange
Superior	OS	14.9	abcdef	2.5	medium orange
King Midas	SI	13.8	bcdefg	2.5	medium orange
Camaro	HL/SW	13.2	cdefgh	2.7	yellow orange
Spartan	SW	13.2	cdefgh	2.5	dark orange
Super Herc.	HM	13.1	defgh	2.4	medium orange
ACX6501	AC	12.9	defgh	2.3	yellow orange
Gladiator	HM	12.3	efghi	1.7	dark orange
Howden	SW	12.2	efghi	2.5	medium orange
ACX7301	AC	12.2	efghi	3.3	medium orange
HSR 4710	HL	11.9	efghi	3.5	yellow orange
Magic Lantern	HM	11.8	efghi	2.7	medium deep orange
ACX7302	AC	11.6	fghi	3.5	medium orange (variable)
Magic Wand	HM	11.5	fghi	2.3	medium deep orange
HSR4721	HL	11.1	fghi	3.0	yellow orange
Warlock	HM	10.6	ghi	2.0	dark orange
Sorcerer	HM	10.5	ghi	2.4	medium orange
20 Karat Gold	RU	9.9	ghi	3.0	medium orange
Magician	HM	9.8	ghi	2.0	medium deep orange
Merlin	HM	9.6	hi	2.5	medium orange
Capital	OS	9.1	hi	2.7	medium orange
Charisma	JS	8.7	i	3.5	yellow orange

* Means in the same column followed by different letters were significantly different at P>0.05 as determined by Duncan's multiple range test.
1 Seed sources found in Appendix A.
2 Stem rating (1 = best, 5 = worst) based on stem color, architecture, thickness and attachment, and overall attractiveness.

Materials and Methods

Pumpkins were directed seeded into bare-ground raised beds on 5 June 2009. Beds were spaced on 10-foot centers, and plants were seeded at 4-foot within-row spacing. Four seeds were placed in each hole (hill) and later thinned to two plants per hill. Each plot consisted of eight plants (four hills), and plots were separated by 10 feet within rows. Drip irrigation tape was placed on the surface of each bed to provide supplemental water. Approximately 50 lb/A N were incorporated preplant using ammonium nitrate. Plants were watered as needed during growth. After seedling establishment, plants were fertigated weekly with ammonium nitrate at a rate of 10 lb/A until mid-August such that the total (preplant + fertigation) N application for the season was 110 lb/A. Based on soil tests, no additional phosphorous or potassium fertility was necessary.

Weed control. Areas between plots were mechanically cultivated throughout the growing season. Rows were hand-cultivated as needed after vines began to run. Select (clethodim) was sprayed over the top, using rates recommended in the University of Kentucky's *Vegetable Production Guide for Commercial Growers* (ID-36) to control johnsongrass within rows.

Fungicide sprays. Acrobat 50 WP was applied twice during the season to protect against downy mildew. No maintenance fungicides that affected powdery mildew were used during this study.

Insecticide sprays. Admire (imidacloprid) was applied to the soil surrounding seeds at the time of seeding for control of cucumber beetles. Capture (bifenthrin) was applied at approximately 10 and 12 weeks after seeding to control squash bugs and cucumber beetles.

Plants were routinely monitored for the presence of powdery mildew after seedling emergence. Powdery mildew evaluations were conducted on a seven- to nine- day schedule beginning 6 August 2009 and concluding on 30 August 2009. The upper and lower canopies of plants were separately evaluated using a 0 to 5 scale where 0 = no symptoms, 1 equals 1%, 2 equals 10%, 3 equals 30%, 4 equals 60%, and 5 equals 100% of the upper and lower canopy with symptoms of powdery mildew. Ratings for each plot were converted to percent diseased leaf area using the following transformation: $1.5625 - (5.625*x) + (5.0625*x^2)$, where x equals assigned rating. Stems were evaluated for powdery mildew at harvest using the same 0 to 5 scale; however, data were not transformed to percent diseased area.

Fruit were harvested during the week of 15 September 2009. Fruit were counted and weighed, and unmarketable fruit were culled. Yields and fruit per acre were based on an estimated plant population of 2,178 plants per acre. Fruit color and stem quality were assessed at this time. Stem quality was evaluated on a scale of 1 (best) to 5 (poor). Stem quality was composed of an aggregate of traits including: stem color, thickness, attachment, and overall attractiveness.

Results and Discussion

Yield and quality. Yield and quality of all of the varieties tested were likely affected by the high levels of powdery mildew present in this study. However, the following results demonstrate the relative performance of one variety compared to another when grown under high powdery mildew pressure. Average fruit weight was lower in 2009 than in previous years. Although several of the varieties tested had average fruit weights greater than 20 pounds in previous studies, no varieties had fruit weights of 20 pounds or more this year (Table 1). Dependable, Summit, Checkmate, Conestoga Giant, Aladdin, and Pankow's Field were the largest pumpkins, all weighing more than 16 pounds.

Marketable yields varied widely. Camaro, HSR 4721, Magician, Aladdin, and Gladiator all yielded better than 400 cwt/acre. The high yields associated with these pumpkins were a function of fruit per acre, pumpkin weight, and a low percentage of cull fruit. Camaro has performed very well in previous studies. It had the highest yields per acre in this study and also one of the lowest rates of powdery mildew infection. Camaro should be tested by growers prior to planting large acreages as the color of this variety is slightly more yellow than the typical medium orange color of a Howden-type pumpkin. Magician had high yields due to very high numbers of fruit per acre (4,522). Aladdin had fewer fruit per acre but high yields due to large fruit size. Other noteworthy varieties include Magic Wand, which had the lowest rate of culls (0%) and Gladiator which had good yields and the best stem ratings of the varieties tested.

Powdery mildew resistance. The varieties tested in the study showed varying levels of resistance to powdery mildew, ranging from none to moderate-high (Table 3). At the earliest evaluation (August 6), 10 varieties, including Aladdin, Camaro, HSR 4710, Gladiator, Magician, Magic Wand, and Warlock, had 10% or less of total leaf area (diseased leaf area, or DLA) affected by powdery mildew. By the final evaluation (August 30), all varieties had roughly 50% or more DLA; Camaro showed 47% DLA, making it the variety with the greatest resistance to powdery mildew in the trial, followed by HSR 4721. Season-long severity of powdery mildew, determined by calculating the area under disease progress curves (AUDPC) for each variety, was lowest for Camaro, HSR 4710, HSR 4721, Magic Wand, and Warlock. Varieties such as Checkmate, ACX 7301, ACX 7302, ACX 6501, Dependable, Howden, King Midas, and Pankow's Field showed the least resistance to powdery mildew in the trial. Severity of powdery mildew on pumpkin stems did not appear to be linked closely to foliar disease severity, as was seen in the 2008 version of this trial. However, Magician and Gladiator, varieties with moderate-high resistance to powdery mildew on foliage, tended to have less powdery mildew on stems than varieties with lower foliar resistance to the disease such as ACX 6501 and ACX 7301.

Our results suggest that there are varieties with good yields and moderate levels of powdery mildew resistance. Growing these varieties might enable a grower to reduce fungicide inputs and associated costs while still producing good marketable yields of pumpkins.

Table 2. Total yield, fruit per acre, marketable yield, marketable fruit per acre, and percentage of culls for 28 medium-large pumpkins cultivars grown in Lexington, Ky., in 2009. Varieties are ordered based on marketable yield (highest to lowest).

Variety	Marketable Yield (cwt/A)[1]		Marketable Yield (Fruit/A)		Culls (%)[2]	
Camaro	545	a	4152	abc	9	ef
HSR4721	470	ab	4220	ab	5	ef
Magician	440	abc	4522	a	6	ef
Aladdin	439	abc	2635	defg	7	ef
Gladiator	400	abcd	3267	abcd	9	ef
Checkmate	384	abcd	2227	defgh	9	ef
Spartan	384	abcd	2791	def	26	bcdef
Magic Wand	376	abcde	3151	bcde	0	f
Magic Lantern	365	abcdef	3099	bcde	13	def
HSR 4710	340	abcdefg	2859	cdef	28	bcde
ACX6501	320	bcdefg	2450	defgh	20	cdef
Merlin	319	bcdefg	3199	bcde	9	ef
King Midas	312	bcdefg	2246	defgh	18	cdef
Superior	310	bcdefg	2113	defgh	13	def
Summit	305	bcdefg	1857	efgh	20	cdef
Capital	303	bcdefg	3306	abcd	10	ef
Warlock	301	bcdefg	2937	bcde	9	ef
Sorcerer	296	bcdefg	2684	def	38	abcd
Dependable	270	bcdefg	1520	fgh	41	abc
Conestoga Giant	258	bcdefg	1517	fgh	19	cdef
20 Karat Gold	246	cdefg	2491	defg	15	def
Hannibal	240	cdefg	1503	fgh	8	ef
Super Herc.	233	cdefg	1818	efgh	28	bcde
Pankow's Field	207	defg	1212	h	26	bcdef
Charisma	164	efg	1906	defgh	21	cdef
ACX7301	153	fg	1235	h	54	a
Howden	144	g	1158	h	17	cdef
ACX7302	142	g	1274	gh	46	ab

* Means in the same column followed by different letters were significantly different at P>0.05 as determined by Duncan's multiple range test.

1 cwt/A = 100 lb weight/acre, based on a plant population of 2,178 plants per acre.

2 % cull based on weight of nonmarketable pumpkins/total yield of pumpkins.

Table 3. Severity of powdery mildew on 28 medium-large pumpkins grown in Lexington, Ky., in 2009. Varieties are ordered based on overall disease severity (lowest to highest).

Variety	Powdery Mildew (PM) Severity (% DLA)[1]						Overall PM Severity (AUDPC)[2]		Stem Rating (0-5)[3]	
	6 Aug		15 Aug		30 Aug					
Camaro	6.5	ghij[4]	29	i	47	g	843	k	2.8	bcd
Magic Wand	4.4	j	27	hi	70	e	879	jk	3.0	abcd
HSR 4721	7.3	e-j	45	efg	54	f	967	ijk	3.0	abcd
Warlock	3.8	ij	35	ghi	69	e	978	ijk	2.8	bcd
HSR 4710	4.8	hij	33	ghi	71	de	1028	ijk	3.8	abcd
Magician	4.0	j	30	hi	73	bcde	1030	hij	2.3	d
Gladiator	6.2	d-j	37	ghi	74	cde	1124	ghij	2.3	d
Summit	6.3	d-j	36	ghi	90	abcd	1259	fghi	3.3	abcd
Charisma	13.1	c-j	40	fgh	92	a	1354	efgh	3.5	abcd
Superior	6.0	fghij	43	efg	95	a	1367	defg	2.5	cd
Aladdin	6.5	d-j	58	def	91	a	1539	cdef	2.5	cd
Hannibal	11.6	a-h	68	bcd	88	abcd	1629	bcde	3.3	abcd
Magic Lantern	14.2	b-j	65	cde	93	a	1660	bcde	3.0	abcd
Merlin	17.7	abcde	62	de	91	ab	1687	abcde	2.8	
Super Herc.	26.2	abc	65	cde	90	abc	1774	abcde	4.3	ab
20 Karat Gold	21.4	a-g	77	abcd	95	a	1789	abcde	3.5	abcd
Spartan	15.7	abcd	78	abcd	91	abc	1820	abcde	2.8	bcd
Sorcerer	21.8	a-f	70	abcd	97	a	1846	abcd	3.0	abcd
Capital	14.7	b-i	80	abcd	97	a	1850	abc	2.5	cd
Checkmate	18.4	a-f	84	abcd	96	a	1945	abc	3.8	abcd
Conestoga Giant	25.0	ab	82	abcd	97	a	1962	abc	3.8	abcd
ACX 7302	31.9	a	82	abcd	92	a	1978	abc	4.5	a
Dependable	23.0	abc	84	abcd	100	a	1993	abc	4.3	ab
Howden	22.7	abc	86	abcd	96	a	2002	abc	3.7	abcd
King Midas	26.8	ab	85	abcd	96	a	2003	abc	2.5	cd
ACX 6501	27.9	ab	91	abc	100	a	2124	ab	4.0	abc
ACX 7301	27.0	abc	95	ab	97	a	2135	ab	4.3	ab
Pankow's Field	27.0	ab	99	a	100	a	2190	a	3.5	abcd

1 Severity of powdery mildew assessed as the percentage of diseased leaf area (DLA).
2 Overall (season-long) severity of powdery mildew as determined by the area under disease progress curves (AUDPC) calculated from severity ratings taken on 28 Jul, 6 Aug, 15 Aug, 22 Aug, and 30 Aug.
3 Severity of powdery mildew on stems evaluated at harvest using a 0-5 scale where 0 = no disease, 1=1%, 2 = 10%, 3 = 30%, 4 = 6%, and 5 = 100% of stem area diseased.
4 Means in the same column followed by the same letter do not differ significantly as determined by Fisher's protected LSD test ($P \leq 0.05$). Statistics for foliar disease severity were calculated on arcsin-transformed means; non-transformed means are reported in the table.

Evaluation of Cultivars and Fungicide Programs for Management of Powdery Mildew on Pumpkins

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Introduction

Powdery mildew (PM), caused by *Podosphaera xanthii*, is a serious constraint to the production of pumpkins in Kentucky each year. Leaves, petioles, and stems can be affected, resulting in premature senescence of leaves. Loss of photosynthetic area results in reduced fruit number, size, and quality. Plants infected by *P. xanthii* are predisposed to infection by other pathogens as well.

Cultural practices, host resistance, and fungicides are employed in the management of PM. The cultural practices most commonly recommended include increasing plant spacing to improve air movement between plants, removal of old crop debris, and avoiding excess applications of fertilizer, particularly nitrogen. Cultivars of pumpkins commonly planted in Kentucky have varying levels of resistance to powdery mildew, and planting them can reduce the need for fungicides to control the disease. However, when conditions favor PM, often the case with pumpkins, fungicides are usually needed to achieve acceptable suppression of disease.

Generally, a fungicide program should be in place to prevent diseases, including PM, from becoming established on cucurbits. Relatively inexpensive protectant materials (multisite inhibitors) such as chlorothalonil (Bravo, Echo, Equus) or mancozeb (Dithane, Penncozeb, Manzate) generally form the "backbone" of such programs but may not provide adequate control under heavy disease pressure. Fungicides with specific modes of action tend to be more effective than multisite inhibitors when conditions are highly favorable for disease but also are more expensive. Examples of these types of fungicide products are myclobutanil (Nova or Rally) and strobilurins (Amistar, Quadris, Flint, Pristine). Each of these products affects a broad spectrum of plant pathogens and is effective against PM. Along with high cost, fungicides with specific modes of action are more likely to select for resistance in pathogen populations than multisite inhibitors.

Growers must balance costs against expected benefits and returns when choosing fungicides to use in a PM management program. In dry years or when conditions are unfavorable to disease development, it is possible to use less expensive protectants at long (10- to 14-day) intervals. However, shorter spray intervals and higher-priced products are generally required in wet years or when the environment is conducive to disease. Planting cultivars that are PM-resistant may allow the use of fungicides at reduced rates or longer spray intervals; however, in the case of pumpkins, cultivars vary widely in their resistance, affecting fungicide requirements. This report describes an experiment designed to evaluate three fungicide programs (no input, minimum input, and maximum input) on three cultivars of pumpkin (no resistance to PM, low-to-moderate resistance, and moderate-to-high resistance) to determine if fungicide requirements could be lowered or eliminated by host resistance while maintaining acceptable yield and quality.

Materials and Methods

The experiment was conducted at the Horticultural Crops Research Station (South Farm) in Lexington. The cultivars of pumpkins planted in the trial were Howden (no PM resistance), Aladdin (low-to-moderate resistance), and Camaro (moderate-to-high resistance); resistance levels were determined in a previous trial (Coolong and Seebold, 2008).

Pumpkins were seeded into 128-cell trays during the week of 1 June and greenhouse-grown for four weeks until planting on 30 June. Plants were transplanted using a tobacco setter into bare-ground raised beds. Beds were spaced on 10-foot centers, and plants were transplanted at 4-foot within-row spacing. Two plants were placed in each hole. Each plot consisted of 10 plants (five hills), and plots were separated by 12 feet within rows. Plots were arranged in a strip-plot design with fungicide treatments comprising the main plots (strips) with the three varieties representing subplots within the main plot. Each variety was replicated four times within each fungicide treatment with each replication containing 10 plants of each variety. Drip irrigation tape was placed on the surface of each bed to provide supplemental water. Approximately 50 lb/A N were incorporated preplant using ammonium nitrate. Plants were watered as needed during growth. After seedling establishment, plants were fertigated weekly with ammonium nitrate at a rate of 10 lb/A until mid-August such that the total (preplant + fertigation) N application for the season was 110 lb/A. Based on soil tests, no additional phosphorous or potassium fertility was necessary.

Weed control. Areas between plots were mechanically cultivated throughout the growing season. Rows were hand-cultivated as needed after vines began to run.

Fungicide sprays. Acrobat 50 WP was applied twice during the season to protect against downy mildew. No maintenance fungicides that affected powdery mildew were used during this study.

Table 1. Effect of cultivar and fungicides on the severity of powdery mildew and yield of pumpkins, 2009 (Lexington, Ky.).

Treatment	PM Severity AUDPC[c]		Yield/A lb		Yield/A number		Avg. Fruit Wt. (lb)	
Fungicide Effect								
Untreated check	1894	a[d]	36,886	a	2178	a	16.9	a
Bravo WS 2 pt/A[a]	1611	a	38,674	a	2158	a	18.4	a
Bravo WS 2 pt/A alt. with Nova 40W 5 oz/A[b]	1040	b	39,282	a	2160	a	18.2	a
Cultivar Effect								
Camaro	893	b	46,983	a	2759	a	17.2	a
Aladdin	1722	a	42,515	a	2287	b	18.7	a
Howden	1930	a	24,131	b	1386	c	17.6	a

[a] Bravo WeatherStik applied on 8 Aug, 19 Aug, 30 Aug, and 11 Sep (10-day schedule).
[b] Bravo WeatherStik, alternated with Nova 40 W, applied on 8 Aug, 15 Aug, 22 Aug, 30 Aug, and 11 Sep (7-day schedule).
[c] PM severity: overall (season-long) severity of powdery mildew as determined by the area under disease progress curves (AUDPC) calculated from severity ratings taken on 15 Aug, 22 Aug, 30 Aug, 7 Sep, and 18 Sep.
[d] Means in the same column followed by the same letter do not differ significantly as determined by Fisher's protected LSD test (P≤0.05).

Insecticide sprays. Admire (imidacloprid) was applied to the soil at transplanting for control of cucumber beetles. Capture (bifenthrin) was applied at approximately 10 and 12 weeks after seeding to control squash bugs and cucumber beetles.

Two fungicide programs were initiated when symptoms were first observed in the susceptible border rows. For the first, a low-cost program, Bravo WeatherStik was applied at 2 pt/A on a 10-day schedule (8 August, 19 August, 30 August, and 11 September). The second program, the University of Kentucky standard (higher cost), consisted of Bravo WeatherStik at 2 pt/A alternated with Nova 40W on a 7-day schedule (8 August, 15 August, 22 August, 30 August, and 11 September). Unsprayed plots of each cultivar served as controls. Applications were made with a CO_2-powered backpack sprayer equipped with a three-nozzle hand boom fitted with TX-18 hollow-cone nozzles (20-inch spacing). Application volume was 40 GPA, and sprayer pressure was 48 psi.

Powdery mildew evaluations were conducted on a 7- to 11-day schedule beginning 15 August 2009 and concluding on 18 September. The upper and lower canopies of plants were separately evaluated using a 0 to 5 scale where 0 equals no symptoms, 1 equals 1%, 2 equals 10%, 3 equals 30%, 4 equals 60%, and 5 equals 100% of the upper and lower canopy with symptoms of PM. Ratings for each plot were converted to percent diseased leaf area using the following transformation: 1.5625 - (5.625*x) + (5.0625*x2), where x equals assigned rating. Stems were not evaluated for PM incidence at harvest.

Results and Discussion

Rainfall was above normal for the Lexington area during the trial period, and conditions were moderately favorable for the development of PM. Camaro and Aladdin yielded well, regardless of fungicide treatment. Camaro had the highest yields in this trial, resulting from large numbers of fruit per acre. Aladdin had statistically similar yields as Camaro, with larger but fewer fruit per acre. Howden had yields that were significantly lower than both Camaro and Aladdin. The yields of Howden increased when subjected to the fungicide program consisting of Bravo and Nova. Due to plot size and variation, however, these increases in yield were not significant. There were no fungicide by variety interactions for yield.

Cultivars differed significantly in their susceptibility to PM, as was demonstrated in previous studies (Table 1). Camaro was affected the least, while Howden showed the highest severity of disease with area under disease progress curves (AUDPC) values twice those of Camaro. Camaro and Aladdin had greater yield (weight and fruit number per acre) than Howden. Overall, the alternation of Bravo WeatherStik and Nova 40W, averaged across cultivars, gave significantly greater suppression of PM. In terms of yield, no significant differences were found in weight per acre. Numerically, however, fungicide treatments gave somewhat greater weight per acre, with the Bravo/Nova alternation having the highest amount.

Table 2. Severity of powdery mildew and yield of pumpkins as influenced by host resistance and fungicide programs, 2009 (Lexington, Ky.).

Cultivar	Fungicide Program	PM Severity AUDPC[c]		Yield/A lb		Yield/A number		Avg. Fruit Wt. (lb)	
Camaro	none	909	de[d]	46,043	a	2941	a	15.6	a
Camaro	Bravo[a]	1117	de	47,145	a	2723	ab	17.4	a
Camaro	Bravo + Nova[b]	654	e	47,763	a	2614	ab	18.6	a
Aladdin	none	2332	ab	42,703	a	2287	abc	18.5	a
Aladdin	Bravo	1745	bc	45,312	a	2505	ab	18.6	a
Aladdin	Bravo + Nova	1087	de	39,531	ab	2069	bc	19.1	a
Howden	none	2443	a	21,912	cd	1307	de	16.7	a
Howden	Bravo	1969	abc	18,528	d	944	e	19.6	a
Howden	Bravo + Nova	1379	cd	30,551	bc	1797	cd	17.0	a

[a] Bravo WeatherStik applied on 8 Aug, 19 Aug, 30 Aug, and 11 Sep (10-day schedule).
[b] Bravo WeatherStik, alternated with Nova 40 W, applied on 8 Aug, 15 Aug, 22 Aug, 30 Aug, and 11 Sep (7-day schedule).
[c] PM severity: overall (season-long) severity of powdery mildew as determined by the area under disease progress curves (AUDPC) calculated from severity ratings taken on 15 Aug, 22 Aug, 30 Aug, 7 Sep, and 18 Sep.
[d] Means in the same column followed by the same letter do not differ significantly as determined by Fisher's protected LSD test ($P \leq 0.05$).

The effect of fungicides was greatest on the PM-susceptible Howden and moderately resistant Aladdin (Table 2). For these varieties, no difference was seen between the untreated control and the Bravo 10-day program; however, Bravo alternated with Nova resulted in a 40 to 50% reduction in PM severity. No differences in disease were observed between any fungicide treatment on Camaro. Yield (weight per acre) was similar between fungicide treatments for each variety; a trend toward greater yield for the Bravo/Nova alternation was seen for Camaro and Howden.

Data from the trial indicate that a variety such as Camaro, with moderate-to-high resistance to PM, can potentially eliminate or reduce the need for fungicides while maintaining acceptable yields. When varieties with little or no resistance to PM are planted, a PM-specific fungicide such as Nova 40W (now sold as Rally 40WP) will be required in addition to a protectant fungicide such as Bravo to provide adequate suppression of disease.

Acknowledgments

We would like to thank Darrell Slone and the crew at the South Farm for assistance in setting up and maintaining the trial.

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Summer Squash Production in Soil Amended with Sewage Sludge

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Introduction

Use of municipal sewage sludge (MSS) as an alternative to synthetic fertilizers in agricultural fields is gaining popularity. Soil incorporation of composted MSS usually results in a positive effect on the growth and yield of a wide variety of crops and promotes the restoration of ecologic and economic functions of agricultural soil. Agricultural uses of MSS have shown promise for a variety of field crops (e.g., maize, sorghum, forage grasses) and many vegetables (e.g., lettuce, cabbage, beans, potatoes, cucumbers). [1]

The organic-matter content of composted MSS (biosolids) is high, and its addition to agricultural soils often improves soil physical and chemical properties and enhances biological activities. Most agricultural benefits from MSS compost application are derived from improved physical properties related to the increased organic-matter content rather than its value as a fertilizer. Composts provide a stabilized form of organic matter that improves the physical properties of soils by increasing nutrient- and water-holding capacity, total pore space, aggregate stability, erosion resistance, and temperature insulation and by decreasing apparent soil density. [2] Application of MSS compost treated with lime improves the chemical properties of soil by increasing pH (in acidic soils) and soil nutrient content. [3] The increased production of MSS in the United States has led many municipalities to consider its application to agricultural soil as a means of sludge and nutrient recycling. The U.S. Environmental Protection Agency (USEPA) promotes the use of municipal solids for farming because it decreases dependence on chemical fertilizers and provides significant economic advantages. On the other hand, potential accumulation of heavy metals by plants grown in MSS-amended soil [3] requires a better understanding. Risks of soil contamination when waste materials are used as fertilizers have been a matter of frequent concern [4] since heavy metals in the composted product may accumulate in crops grown on MSS-treated agricultural soil.

Presently, some of the pollutants of most concern around the world are heavy metals. [5] Elevated Cd concentrations in soil resulting from the application of biosolids has been perceived as a potential environmental hazard. [6, 7] Lead causes liver, brain, and central nervous system dysfunction and is classified by the USEPA as a probable human carcinogen. [8] According to the Institute of Medicine [9] and the Agency for Toxic Substances and Disease Registry [10], Ni can cause respiratory problems and is carcinogenic. There is limited information on heavy-metal absorption by vegetable crops from sewage sludge-treated soil. The objective of this study was to investigate the effect of mixing soil with municipal sewage sludge and/or yard waste from vegetable remains on the mobility of heavy metals (Cd, Cr, Ni, Pb, Zn, Cu, and Mo) from soil amendments into squash fruits at harvest.

Materials and Methods

A field study was conducted on a Lowell silty loam soil (2.8% organic matter, pH 6.9) located at Kentucky State University Research Farm, Franklin County, Kentucky. Eighteen plots of 22 × 3.7 m each were established and separated using metal borders along each side 20 cm above ground level to prevent cross contamination between adjacent treatments. Three soil management practices were used: 1) Municipal sewage sludge (MSS) obtained from Nicholasville Wastewater Treatment Plant, Versailles, Kentucky, was treated with lime (CaO) at 1:10 (w/w) ratio and mixed with native soil at 15 t $acre^{-1}$ (on a dry weight basis); 2) MSS mixed with yard waste (MSS-YW) made from yard and lawn trimmings and vegetable remains (obtained from Kentucky State University Research Farm, Franklin County, Kentucky) and mixed with native soil at 15 t $acre^{-1}$ (on a dry weight basis); and 3) A no-mulch (NM) control treatment (roto-tilled bare soil) was used for comparison purposes. Plots were planted with 45-day-old squash (*Cucurbita pepo* var. Conqueror III) seedlings at 10 rows $plot^{-1}$ against the contour of the land slope and irrigated by a uniform drip system.

Soil and soil incorporated with MSS, MSS-YW mix, and NM bare soil were collected immediately after treatments to a depth of 15 cm from field plots using a soil core sampler equipped with a plastic liner (Clements Associates, Newton, IA, USA) of 2.5 cm i.d. Soil samples were oven-dried at 105° C and sieved to a size of 2 mm. Quantitative analyses of Mehlich-3 extractable Cd, Cr, Ni, Pb, Zn, Cu, and Mo were conducted using inductively coupled plasma (ICP, Varian Vista-Pro spectrometer). At harvest, 25 squash fruits of comparable size were collected at random from each of the 18 field plots (six replicates for each soil treatment), washed with tap and deionized water, and dried in an oven at 65°C for 48 hours. The dried samples were ground manually with a ceramic mortar and pestle to pass through a 1-mm sieve. Samples were redried to constant weight using an oven. To 1 g of each dry sample, concentrated nitric acid (10 mL) was added, and the mixture was allowed to stand overnight and then heated for 4 hours at 125°C on a hot plate. The mixture was then diluted to 50 mL with double-distilled water and filtered through No. 1 filter paper. Concentrations of Cd, Cr, Ni, Pb, Zn, Cu, and Mo were determined using ICP spectrometry. Heavy metals in soil and mature fruits were related to soil management technique and statistically analyzed using ANOVA and Duncan's multiple range tests for mean comparisons.

Table 1. Concentrations of seven heavy metals in summer squash fruits grown in soil amended with municipal sewage sludge or yard waste compost, and native soil at Kentucky State University Research Farm, Franklin County, Kentucky. Statistical comparisons were carried out among three soil management practices for each element. Values of each element accompanied by the same letter(s) are not significantly different (P> 0.05) using Duncan's multiple range test.

$\mu g\ g^{-1}$ Dry Fruit	Soil Management Practice					
	Sewage Sludge		Yard Waste-Sludge Mix		Native Soil	
Cd	0.006	a	0.010	a	0.009	a
Cr	0.52	a	0.70	a	0.62	a
Ni	2.1	a	1.9	a	1.8	a
Pb	0.001	a	0.002	a	0.003	a
Zn	48.9	b	53.6	a	51.0	ab
Cu	16.6	a	15.8	a	15.6	a
Mo	3.4	a	2.6	b	2.2	c

Table 2. Concentrations of seven heavy metals in soil amended with municipal sewage sludge or yard waste compost, and native soil at Kentucky State University Research Farm, Franklin County, Kentucky. Statistical comparisons were carried out between three soil management practices for each element. Values of each element accompanied by the same letter are not significantly different (P> 0.05) using Duncan's multiple range test.

$\mu g\ g^{-1}$ Dry Soil	Soil Management Practice					
	Sewage Sludge		Yard Waste + Sewage Sludge		Native Soil	
Cd	0.10	a	0.01	a	0.10	a
Cr	0.21	b	0.50	a	0.13	b
Ni	1.11	b	1.83	a	0.40	b
Pb	1.37	c	2.43	a	1.80	b
Zn	41.93	a	36.40	b	10.30	c
Cu	32.63	a	9.13	b	3.90	c
Mo	0.10	a	0.10	a	0.10	a

Table 3. Concentrations of Zn and Cu in summer squash fruits collected from each of 15 harvests of plants grown at Kentucky State University Research Farm, Franklin County, Kentucky. Values indicate averages ± standard error.

	Zn	Cu
Harvest	$\mu g\ g^{-1}$ Dry Fruit	
1	59.5 ± 3.3	17.9 ± 1.2
2	56.6 ± 8.2	17.2 ± 9.3
3	50.8 ± 4.1	16.0 ± 9.2
4	55.5 ± 7.3	17.8 ± 2.0
5	44.1 ± 9.0	14.5 ± 6.2
6	57.2 ± 2.0	15.6 ± 8.0
7	48.6 ± 1.2	13.5 ± 5.4
8	54.4 ± 0.0	16.5 ± 1.1
9	54.5 ± 7.3	13.2 ± 7.3
10	59.5 ± 2.2	19.0 ± 4.0
11	44.8 ± 7.3	14.0 ± 7.3
12	37.3 ± 1.1	12.9 ± 5.3
13	49.1 ± 2.1	15.9 ± 9.4
14	46.3 ± 9.2	15.5 ± 7.3
15	49.7 ± 1.3	18.3 ± 2.0

Results and Discussion

Soils in the agricultural or urban areas often serve as the major sink for heavy metals released into the environment from various anthropogenic sources. Accumulation of heavy metals in arable soils can increase the potential transfer of heavy metals through crops to animals (feed crops) and humans (food crops). Reduction of the heavy metal pool for root uptake in soil can be achieved by naturally occurring or artificial additives such as lime, clay, and organic matter. [11] Yuan and Lavkulich [12] reported that the adsorption capacity of a soil for Zn was reduced by 72% when 11% of the organic carbon content was lost. Generally, Zn and Cu levels in squash fruits (Table 1) and sewage sludge (Table 2) were lower than the permissible limits, and they are of no major concern in the present study. Zinc and Cu were accumulated in squash fruits grown even in the no-mulch soil. Zinc and Cu concentrations in MSS were extremely high compared to other metals in MSS. However, these concentrations are below the pollutant concentration limit in sewage sludge as described by USEPA. [13]

Table 4. Concentrations of Cd and Pb in summer squash fruits collected from each of 15 harvests of plants grown at Kentucky State University Research Farm, Franklin County, Kentucky. Values indicate averages ± standard error.

Harvest	Cd (μg g^{-1} Dry Fruit)	Pb (μg g^{-1} Dry Fruit)
1	0.009 ± 0.012	0.002 ± 0.003
2	0.018 ± 0.025	0.007 ± 0.007
3	0.012 ± 0.014	0.001 ± 0.001
4	0.018 ± 0.019	0.001 ± 0.001
5	0.019 ± 0.025	0.001 ± 0.002
6	0.007 ± 0.008	0.001 ± 0.002
7	0.001 ± 0.001	0.001 ± 0.002
8	0.001 ± 0.001	0.001 ± 0.001
9	0.001 ± 0.001	0.001 ± 0.002
10	0.034 ± 0.038	0.014 ± 0.017
11	0.006 ± 0.007	0.001 ± 0.001
12	0.001 ± 0.002	0.001 ± 0.002
13	0.001 ± 0.001	0.001 ± 0.001
14	0.001 ± 0.001	0.001 ± 0.001
15	0.001 ± 0.001	0.001 ± 0.001

Table 5. Concentrations of Ni, Mo, and Cr in summer squash fruits collected from each of 15 harvests of plants grown at Kentucky State University Research Farm, Franklin County, Kentucky. Values indicate averages ± standard error.

Harvest	Ni (μg g^{-1} Dry Fruit)	Mo (μg g^{-1} Dry Fruit)	Cr (μg g^{-1} Dry Fruit)
1	2.0 ± 2.1	2.4 ± 2.5	0.8 ± 0.93
2	1.8 ± 2.0	2.8 ± 3.0	0.5 ± 0.72
3	1.8 ± 1.8	2.8 ± 3.3	0.5 ± 0.71
4	2.0 ± 2.2	3.6 ± 3.7	0.6 ± 0.73
5	1.9 ± 1.8	2.5 ± 2.4	1.1 ± 1.60
6	1.8 ± 1.8	3.4 ± 3.6	0.5 ± 0.72
7	1.8 ± 1.7	2.7 ± 2.5	0.5 ± 0.72
8	2.2 ± 2.4	2.5 ± 2.7	0.6 ± 0.80
9	1.8 ± 1.7	2.8 ± 2.9	0.5 ± 0.73
10	2.5 ± 2.7	4.0 ± 4.2	0.6 ± 0.73
11	2.2 ± 2.3	2.4± 2.4	0.9 ± 1.40
12	1.5 ± 1.6	2.0 ± 2.2	0.5 ± 0.72
13	2.0 ± 2.2	2.2 ± 2.1	0.7 ± 1.00
14	2.3 ± 2.3	2.1 ± 2.5	0.6 ± 7.30
15	1.7 ± 1.8	3.2 ± 3.3	0.4 ± 0.62

Fifteen squash fruit harvests were conducted during the summer season. Zinc and Cu concentrations in each of the 15 fruit harvests are presented in Table 3. Concentrations of Zn were generally greater than Cu. Although Zn has relatively low toxicity to humans, studies have shown allergies and zinc poisoning could occur along the food chain. [14] Cadmium and Pb are the heavy metals of greatest concern to human health since plants can take them up and introduce them into the human food chain. Levels of Cd and Pb in soil amended with MSS averaged 0.1 and 1.4 mg kg^{-1}, respectively. These levels were much lower than the limits in the U.S. guidelines for using MSS in land farming. Thus, there was no major concern posed by Cd and Pb levels in MSS for use as agricultural fertilizer. Data revealed that concentrations of Cd and Pb in squash fruits collected at the tenth harvest were 0.03 and 0.01 mg kg^{-1}, respectively. These concentrations are significantly higher than levels in the other 14 fruit harvests (Table 4). Human exposure to Cd has been associated with cancers of the prostate, lungs, and testes. [15] Lead is defined by USEPA as potentially toxic to most forms of life. According to the Codex Alimentarius Commission of the Joint FAO/WHO Food Standards [16], the maximum level for Pb in most vegetables is 0.1 mg kg^{-1} on fresh weight basis. Although Pb has no biological role in microrganisms, animals, and plants, it forms a bond with the sulfhydryl group of proteins and hence can disrupt the metabolism and biological activities of many proteins and has caused cancer in kidneys of rodents. Data for all heavy metals in squash fruits analyzed in this investigation are expressed on a dry weight basis. Considering that water content of squash fruits was 95%, therefore, the Cd and Pb concentrations were far below their Codex-established maximum limit of 0.1 mg kg^{-1} for squash fruits.

Concentrations of Ni, Mo, and Cr in fruits obtained at each of the 15 harvests are presented in Table 5. Nickel and Mo concentrations in squash fruits fluctuated, reaching a maximum of 2.5 and 3.9 μg g^{-1} dry fruit, respectively, at harvest 10. There is a lack of U.S. Food and Drug Administration guidance on Ni limits in food. According to the State Environmental Protection Administration (SEPA) [17] in China, the maximum permissible limits of Cd, Cr, Cu, Ni, Pb, and Zn for vegetables and fruits are 0.2, 0.5, 20, 10, 9, and 100 mg kg^{-1}, respectively, on a dry weight basis. These guidelines indicated that Ni in squash fruits collected at harvest 10 did not exceed the SEPA limits.

Over time, demand for food is expected to increase, and a lot of future plant production systems will depend on the use of fertilizers and other nutrients that, when incorrectly applied, can harm the environment. MSS is a valuable source of plant nutrients but also a potential source of heavy metals. The use of municipal sewage sludge-yard waste (MSS-YW) compost mix is a simple, inexpensive, energy-conserving method for farming and nutrient recycling.

Acknowledgments

We would like to thank the KSU farm crew for maintaining the runoff plots and the Soil Test Laboratory at the University of Kentucky for soil and plant ICP analyses. This investigation was supported by a grant from USDA/CSREES to Kentucky State University under agreement No. KYX-10-08-43P and 1890 National Facilitation Project for Water Resources award No. 2005-51130-02367.

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Persistence of Bensulide Residues in Soil and Runoff Water from Agricultural Soil

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Introduction

Contaminated surface water has become a critical environmental problem. Soil erosion, nutrient runoff, loss of soil organic matter, and the impairment of environmental quality from sedimentation and pollution of natural waters by agrochemicals have stimulated interest in proper management of natural resources. Bensulide (O, O-diisopropyl S-2-phenylsulfonylaminoethyl phosphorodithioate) or $C_{14}H_{24}NO_4PS_3$ is a preemergent organophosphate herbicide that inhibits cell division in meristematic root tissues and seedling growth of broadleaf weeds.

Agricultural activities are frequently conducted in close proximity to lakes, reservoirs, and streams. Over 500 million kg of pesticides are used each year in the United States in both agricultural and urban settings. [1] Contaminated runoff from farmland contributes a significant proportion of the pesticide load released to surface waters. The objectives of this investigation were to: 1) determine the half-life ($T_{1/2}$) of bensulide in soil under three management practices: sewage sludge mixed with yard waste compost (SS-YW), sewage sludge (SS), and no mulch rototilled bare soil (NM) and 2) monitor the concentration of bensulide residues in runoff and infiltration water under field conditions.

Materials and Methods

A field study was conducted on a Lowell silty loam soil (2.8% organic matter, pH 6.9) located at Kentucky State University Research Farm, Franklin County, Kentucky. The soil has an average of 12% clay, 75% silt, and 13% sand. Eighteen plots of 22 × 3.7 m each were established on 10% slope. Plots were separated using metal borders 20 cm above ground level to prevent cross-contamination between adjacent treatments. Three soil management practices were used: 1) Sewage sludge obtained from Nicholasville Wastewater Treatment Plant, Versailles, Kentucky, was treated with lime (CaO) and mixed with yard waste at 15 t $acre^{-1}$ (on a dry weight basis) with a plowing depth of 15 cm; 2) yard waste compost made from yard and lawn trimmings and vegetable remains obtained from Kentucky State University Research Farm (Franklin County) was mixed with native soil at 15 t acre^{-1} (on a dry weight basis) with a plowing depth of 15 cm; and 3) a no-mulch (NM) roto-tilled bare soil was used for comparison purposes. Bensulide (Prefar 4-E, EPA Reg. No. 10163-200) was sprayed at 2L of formulated product (2.7 kg a.i. acre^{-1}) on the three soil treatments and mixed with the top 2.5 to 5 cm (1 to 2 inches). Plots (n = 18) were planted against the contour of the land slope with 60-day-old squash seedlings (*Cucurbita pepo* var. Conqueror III) at 10 rows plot^{-1}. Soil, runoff, and infiltration water samples were collected during the growing season for bensulide residue analyses.

One hundred grams of soil were shaken with a mixture of methylene chloride:acetone (1:1 v/v) for 1 hour using a Multi-wrist shaker. The solvent was filtered through Whatman 934-AH glass microfiber discs (Fisher Sci., Pittsburgh, PA) of 90 mm diameter. Extracts were passed through anhydrous Na_2SO_4 and concentrated by rotary vacuum and N_2 stream evaporation. Each concentrated extract was subsequently passed through a 0.45 µm GD/X disposable syringe filter. One µL (n = 3) of the concentrated extracts was injected into a gas chromatograph (GC) equipped with a NP detector. The gas chromatograph (HP 5890, Hewlett Packard, Palo Alto, CA) was equipped with a 30-m (0.23-mm diameter, 0.33-µm film thickness) fused silica capillary column with HP-5 (5% phenyl polysiloxane, 95% methyl polysiloxane) liquid phase. Operating conditions were 230°, 250°, and 280°C for injector, oven, and detector, respectively. Under these conditions, the retention time (Rt) of bensulide averaged 13.45 min. Bensulide residues were also confirmed using a GC/MS (Hewlett Packard Model 5971a, Palo Alto, CA). Half-lives were calculated from regression lines using the methods described by Anderson [2] using the equation $T_{1/2} = \ln 2/K$, where K = -2.302 × slope of the line.

Results and Discussion

One hour following the Prefar 4-E application, bensulide residues in the top 15 cm of the no-mulch (NM) soil averaged 2.8 µg g^{-1} dry soil (Table 1). Considerable residues were detected 90 days following bensulide incorporation into soil mixed with SS. This could be due to bensulide's strong adsorption to soil organic matter. The two most important characteristics determining soil adsorption of a pesticide are the organic-matter content of the soil and the water solubility of the pesticide. While half-lives ($T_{1/2}$) of bensulide were reported to range from eight to 34 days in California and from 91 to 210 days in Mississippi (EPA Office of Pesticide Programs) [3], results of this investigation indicated that $T_{1/2}$ values of bensulide in the top 6 inches of soil were 44.3, 37.6, and 27.1 days in SS-YW, SS, and NM treatments, respectively (Table 2).

Runoff water volume was greater from NM and SS treatments compared to SS-YW treatment (Table 3). In June rainfall, runoff water volume was significantly higher in NM soil and SS amended soil (76,041 and 39,908 L acre^{-1}, respectively) compared to soil amended with SS-YW mix (23,827 L acre^{-1}). This may be due to reduced bulk density and increased soil interspaces in SS-YW treatments that increased water infiltration into the soil column toward the vadose zone, reducing surface water runoff down the land slope. Water infiltration into the vadose zone varied between soil treatments. Volume of infiltration water increased from 40 L acre^{-1} in NM soil to 87 L acre^{-1} (117 %) in YW-SS amended soil.

Environmentally and economically viable agriculture requires the use of cultivation practices that maximize agrochemical efficacy while minimizing their off-site movement. Bensulide is one of the few herbicides from the organophosphate group

Table 1. Persistence of bensulide residues expressed as µg g^{-1} dry soil at different time intervals (days) following a single application of Prefar 4E at 2.7 kg a.i. acre^{-1} under three soil management practices.

Time Following Spraying	Soil Management Practice: Sewage Sludge + Yard Waste	Sewage Sludge	No Mulch
0	1.3	2.4	2.8
1	0.82	1.1	1.3
4	0.65	1.3	0.88
8	0.62	1.2	0.83
14	0.58	1.0	0.77
17	0.52	0.82	0.56
21	0.53	0.88	0.46
23	0.44	0.62	0.42
31	0.46	0.60	0.39
37	0.47	0.55	0.32
43	0.32	0.60	0.28
52	0.33	0.56	0.30
58	0.30	0.53	0.21
64	0.21	0.56	0.14
75	0.18	0.65	0.10
90	0.13	0.45	0.08

Table 2. Average initial residues extracted one hour following application, dissipation constants, and half-life ($T_{1/2}$) values of bensulide in native soil and soil incorporated with amendments in the rhizosphere of squash plants grown at Kentucky State University Research Farm, Franklin County, Kentucky.

	Soil Management Practice: Sewage Sludge Incorporated with Native Soil	Sewage Sludge + Yard Waste Compost Incorporated with Native Soil	Native Soil
Initial Residues (µg g^{-1} dry soil)	2.4	1.3	2.8
Dissipation Constant (K)	0.018	0.016	0.026
$T_{1/2}$ Values (days)	37.6 b	44.3 a	27.1 c

† Each value in the table is an average of three replicates. $T_{1/2}$ values in a row accompanied by a different letter are significantly different (P < 0.05).

Table 3. Runoff water collected down the land slope of a squash field using tipping bucket runoff metering apparatus and infiltration water volume collected using pan lysimeters installed at 1.5 m soil depth under three soil management practices. Statistical comparisons were carried out among soil treatments. Values accompanied by a different letter in each column are significantly different (P < 0.05).

Soil Management Practice	Liter Acre^{-1}: June Runoff Water		July Runoff Water		Infiltration Water	
Sewage Sludge	39,900	b	774	a	72	b
Yard Waste + Sludge Mix	23,800	c	309	b	87	a
No Mulch	76,000	a	789	a	40	c

used for control of weeds that threaten numerous crops. Addition of SS-YW to native soil increased water infiltration, lowering runoff water volume and bensulide residues in runoff following natural rainfall events (Table 4).

Soil organic matter (SOM) has an important effect on the bioavailability, persistence, biodegradability, leaching, and volatility of pesticides. In fact, SOM is the soil component most important in pesticide retention. Pesticide adsorption to soil is related more to soil organic matter than to other soil chemical and physical properties [4, 5]; therefore, addition of soil amendments having high organic-matter content is a management practice that could be exploited to trap nonionic pesticides like bensulide and reduce its surface and subsurface mobility under field conditions. In addition, the use of sewage sludge for land farming could decrease dependence on synthetic fertilizers (Table 5) and provide alternatives to farmers dealing with the sharply escalating production costs associated with increasing costs of energy.

Acknowledgments

This investigation was supported by two grants from USDA/CSREES to Kentucky State University under agreements No. KYX-10-08-43P and No. KYX-2006-1587.

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Table 4. Bensulide concentrations in runoff water and infiltration water collected under three soil management practices. Statistical comparisons were carried out among soil treatments. Values accompanied by a different letter in each column are significantly different (P< 0.05).

Soil Management Practices	Liter Acre^{-1} Runoff Water		Infiltration Water	
Sewage Sludge	3.3	b	0.03	c
Yard Waste + Sludge Mix	2.1	b	1.64	b
No Mulch	10.2	a	3.56	a

Table 5. Impact of mixing native soil with municipal sewage sludge and yard waste compost on the soil properties in the rhizosphere of squash plants grown at Kentucky State University Research Farm, Franklin County, Kentucky.

Soil Parameters	Soil Management Practices: Sewage Sludge Incorporated with Native Soil		Sewage Sludge + Yard Waste Compost Incorporated with Native Soil		Native Soil	
% Organic Matter	5.0	b	8.1	a	2.8	c
pH	7.9	a	7.7	b	6.9	c
% Carbon	3.5	a	3.8	a	1.6	b
% Nitrogen	0.24	b	0.41	a	0.17	c
C/N Ratio	15.8	a	8.5	b	9.4	b
P (lb acre-1)	1020	a	903	b	740	c
K (lb acre-1)	467	c	856	a	566	b
Ca (lb acre-1)	26,439	a	20,495	b	8,121	c
Mg (lb acre-1)	360	b	695	a	405	b

† Each value in the table is an average of five replicates. Statistical comparisons were carried out among the three soil management practices. Values in each row accompanied by a different letter are significantly different (P < 0.05).

Fruit and Vegetable Disease Observations from the Plant Disease Diagnostic Laboratory—2009

Julie Beale, Paul Bachi, Sara Long, Kenneth Seebold, and John Hartman, Department of Plant Pathology

Introduction

Diagnosis of plant diseases and providing recommendations for their control are the result of University of Kentucky College of Agriculture research (Kentucky Agricultural Experiment Station) and Cooperative Extension Service activities through the Department of Plant Pathology. We maintain two branches of the Plant Disease Diagnostic Laboratory, one on the UK campus in Lexington and one at the University of Kentucky Research and Education Center in Princeton. Of the more than 3,000 plant specimens examined to date in 2009, approximately 25% were fruits and vegetables, and 40% of those were from commercial growers (1). Although the growers are not charged for plant disease diagnoses at UK, the estimated direct annual expenditure to support diagnosis of fruit and vegetable specimens by the laboratory is $25,000, excluding UK physical plant overhead costs. During recent years, we have acquired funds from Kentucky Integrated Pest Management and the Southern Plant Diagnostic Network to help defray some of the laboratory operating costs. In addition to receiving physical diagnostic samples, we also provide a Web-based digital consulting system where Cooperative Extension agents can submit images for consultation on plant disease problems. In 2009, approximately 39% of digital cases involved fruit and vegetable diseases and disorders.

Materials and Methods

Diagnosing fruit and vegetable diseases involves a great deal of research into the possible causes of the problems. Most visual diagnoses include microscopy to determine what plant parts are affected and to identify the microbe(s) involved. In addition, many specimens require special tests such as moist chamber incubation, culturing, enzyme-linked immunosorbant assay (ELISA), polymerase chain reaction (PCR) assay, electron microscopy, nematode extraction, or soil pH and soluble salts tests. In particular, many commercial fruit and vegetable diagnoses require consultation with UK faculty plant pathologists and horticulturists and/or need specialized testing. The Extension plant pathology group has tested, in our laboratory, protocols for PCR detection of several pathogens of interest to fruit and vegetable growers. These include the difficult-to-diagnose pathogens causing bacterial wilt of cucurbits, bacterial leaf spot of pepper, cucurbit yellow vine decline, and Pierce's disease of grape. The laboratory also has a role in monitoring pathogen resistance to fungicides and bactericides. These exceptional measures are efforts well spent because fruits and vegetables are high-value crops. Computer-based laboratory records are maintained to provide information used for conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs. New Homeland Security rules now require reporting of all diagnoses of plant diseases to USDA-APHIS on a real-time basis.

The 2009 growing season in Kentucky was an excellent one for most fruit crops, with the exception of apples and grapes, but was difficult for most vegetable crops due to intense disease pressure during the summer.

January precipitation was 1.4 inches above normal, and February and March were 2.2 inches below normal, April and May were 5.28 inches above normal, and August was 0.2 inches below normal. For this period, January temperatures were 3°F below normal, March through July temperatures were above normal, while June and August temperatures were a total of 5 degrees below normal. It was the second coolest and eighth wettest July and the 24th coolest August and 56th driest August in the past 115 years. Over the past 12 months, the temperature was on average only 0.4°F lower than normal.

Results and Discussion

New, Emerging, and Problematic Fruit and Vegetable Diseases in Kentucky

Pierce's disease of grape caused by *Xylella fastidiosa* was detected in vineyards in several Kentucky counties using a combination of ELISA and PCR testing methods. This disease was first detected in Kentucky in 2001 and has only been seen rarely until this year. Growers and Extension agents should continue careful scouting for symptoms and submit samples from any suspect vines to the UK Plant Disease Diagnostic Laboratory (PDDL). Early detection and prompt removal of diseased vines are critical in preventing spread of Pierce's disease.

Plum pockets disease (*Taphrina communis*) was an unusual find for the second consecutive year. Although the related disease, peach leaf curl, is a common occurrence, plum pockets is seen less often in Kentucky. Leaves and developing shoots become thickened, curled, and deformed; infected fruits are much larger than normal and hollow.

Thread blight (*Corticium stevensii*) is not a new disease but is only seen in years with abundant moisture and cooler temperatures. It was diagnosed on apple in several eastern Kentucky counties; in one location, it was also seen on filbert. This disease blights the leaves, matting them together with fungal mycelium; the fungus produces thickened mycelial threads (rhizomorphs) and overwintering sclerotia on infected twigs.

Diseases caused by Oomycete pathogens—Phytophthora and Pythium diseases of root/crown, foliar Phytophthora blights, and downy mildews—can be problematic in most years in locations with wet soils, heavy irrigation, or susceptible crops grown in shade. The persistent cool, wet weather throughout much of the 2009 growing season, however, favored epidemic levels of certain Oomycete diseases:

Late blight (*Phytophthora infestans*) was officially diagnosed (in the PDDL) on tomato samples from 25 Kentucky counties and was locally devastating in both commercial and home plantings in some areas. This disease is only rarely seen in

Kentucky; the widespread occurrence was truly extraordinary for the state.

Downy mildew was seen commonly on grape and at damaging levels in certain cucurbit plantings. Sentinel (monitoring) plots were useful in early detection of cucurbit downy mildew, enabling UK plant pathologists to quickly alert growers of disease potential in their area.

Other unusual diagnoses of **Phytophthora diseases** included Phytophthora root rot of turnip and Phytophthora fruit rot of fig.

Tree Fruit Diseases

Pome fruits. Wet weather favored common foliar diseases of apple. Particularly abundant were apple scab (*Venturia inaequalis*), cedar-apple rust (*Gymnosporangium juniperi-virginianae*), and frogeye leaf spot (*Botryosphaeria obtusa*). Most primary fire blight (*Erwinia amylovora*) infections of apple occurred late in April (April 18-20 and after) with symptoms appearing about one month later. Thread blight (*Corticium stevensii*) was diagnosed on apple in several eastern Kentucky locations (see above).

Stone fruits. Leaf spot diseases of cherry caused by fungal pathogens *Coccomyces hiemalis* and *Cercospora circumscissa* were seen much more frequently than in the past several years; powdery mildew (*Podosphaera clandestina*) was also common on cherry, causing leaf distortion. Scab (*Cladosporium carpophilum*) and brown rot (*Monilinia fructicola*) were diagnosed on apricot and peach. Spring rains favored the development of peach leaf curl (*Taphrina deformans*), and the related disease plum pockets (*Taphrina communis*) was also diagnosed (see above).

Small Fruit Diseases

Grapes. Pierce's disease of grape caused by the bacterium *Xylella fastidiosa* was diagnosed in multiple locations (see above). Foliar diseases were common due to wet weather and high humidity throughout the season. Black rot (*Guignardia bidwellii*) was quite common; anthracnose (*Elsinoe ampelina*), downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*), and a few isolated cases of zonate leaf spot (*Cristulariella moricola*), a disease favored by extremely wet conditions, were diagnosed.

Brambles. Cane blight (*Leptosphaeria coniothyrium*) and spur blight (*Didymella applanata*) were both diagnosed on blackberry canes, while anthracnose (*Elsinoe veneta*) was seen on leaves and canes of blackberry and raspberry. Leaf spots were common on blackberry (*Septoria rubi*, *Cercospora rubi*) and raspberry (*Sphaerulina rubi*). Double blossom disease, also known as rosette (*Cercosporella rubi*), was diagnosed in a number of blackberry samples. Root and collar rot caused by *Phytophthora* spp. affected raspberry in wet locations.

Blueberries. Phomopsis dieback (*Phomopsis vaccinii*), leaf spot (*Phyllosticta* spp.), powdery mildew (*Microsphaera vaccinii*), and root and collar rot caused by *Phytophthora* spp. were diagnosed.

Strawberries. Diseases were common, including leaf spot (*Mycosphaerella fragariae*), leaf blight (*Phomopsis obscurans*), anthracnose (*Colletotrichum acutatum*), black root rot (various fungi), red stele (*Phytophthora fragariae*), and crown rot (*Phytophthora cactorum*).

Vegetable Diseases

Beans. Foliar diseases including angular leaf spot (*Phaeoisariopsis griseola*), web blight (*Rhizoctonia solani*), and common bacterial blight (*Xanthomonas phaseoli*) and foliar and pod infections of anthracnose (*Glomerella lindemuthianum*) were favored by wet weather throughout the growing season. Root rot (*Rhizoctonia* sp.) and southern blight (*Sclerotium rolfsii*) were also observed on bean. Southern blight was also seen on peanut from a home garden.

Cucurbits. Cucurbit diseases were plentiful in 2009 and included numerous cases of bacterial wilt (*Erwinia tracheiphila*), which is vectored primarily by the striped cucumber beetle (*Acalymma vittatum*) in cucumber and melon fields. A wide variety of other fungal and bacterial foliar/vine diseases were common in all cucurbit crops: anthracnose (*Colletotrichum orbiculare*), Alternaria leaf blight (*Alternaria cucumerina*), angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*), Cercospora leaf spot (*Cercospora citrullina*), powdery mildew (*Podosphaera xanthii* and *Erysiphe cichoracerarum*), gummy stem blight (*Didymella bryoniae*), and Plectosporium blight (*Plectosporium tabacinum*). Cucurbit downy mildew (*Pseudoperonospora cubensis*) developed in late summer and became widespread; sentinel (monitoring) plots were useful in early detection of cucurbit downy mildew, enabling UK plant pathologists to quickly alert growers of disease potential in their area.

Tomatoes. Although the epidemic of late blight in tomato (see above) eclipsed other tomato problems in many locations, foliar diseases such as early blight (*Alternaria solani*), Septoria leaf spot (*Septoria lycopersici*), leaf mold (*Fulvia fulva*), bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), and bacterial speck (*Pseudomonas syringae* pv. *tomato*) were also common. Buckeye rot (*Phytophthora nicotianae*) was also seen occasionally on tomato fruits. Timber rot (*Sclerotinia sclerotiorum*) was diagnosed from several locations and was active for a much longer period than usual—another consequence of prolonged cool, wet weather. Southern blight (*Sclerotium rolfsii*) was diagnosed in some areas, and bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*) was found in a number of commercial plantings. Tobacco mosaic virus and tomato spotted wilt virus were also diagnosed.

Peppers. Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), southern blight (*Sclerotium rolfsii*), and root rot (*Rhizoctonia* spp., *Pythium* spp.) were seen frequently. Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*), common on tomato but only occasionally seen on pepper, was found in one location. Pepper mild mottle virus, a potyvirus which produces only mild foliar symptoms but can cause more severe mottling, mosaic, and distortion in fruits, was confirmed via ELISA.

Other vegetables. Bacterial soft rot (*Erwinia chrysanthemi* var. *zeae*), Stewart's wilt (*Erwinia stewartii*), and northern leaf blight (*Setosphaeria turcica*) were diagnosed on sweet corn. Rhizoctonia root rot (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora beticola*), bacterial leaf spot (*Pseudomonas syrin-*

gae), and southern blight (*Sclerotium rolfsii*) were diagnosed on beet. Common scab (*Streptomyces scabies*) of potato and scurf (*Monilichaetes fuscans*) of sweetpotato were diagnosed.

Because fruits and vegetables are high-value crops, and many of them are new or expanding crops in Kentucky, the Plant Disease Diagnostic Laboratory should be an important resource for Cooperative Extension agents and the growers they assist. Several new vegetable diseases are being investigated this year due to the teamwork of Extension personnel and growers. The information gained from diagnostic experiments will help to improve production practices and reduce disease in the future. We urge county Extension agents to stress in their programming the importance of accurate disease diagnosis and timely sample submission to provide Kentucky fruit and vegetable producers with the best possible disease management information.

Literature Cited

1. Bachi, P., J. Beale, J. Hartman, D. Hershman, S. Long, K. Seebold, and P. Vincelli. 2010. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2009. UK Department of Plant Pathology (in press).

Appendix A: Sources of Vegetable Seeds

We would like to express our appreciation to these companies for providing seeds at no charge for vegetable variety trials. The abbreviations used in this appendix correspond to those listed after the variety names in tables of individual trial reports.

AAS .... All America Selection Trials, 1311 Butterfield Road, Suite 310, Downers Grove, IL 60515
AS/ASG .... Formerly Asgrow Seed Co., now Seminis (see "S" below)
AC.................. Abbott and Cobb Inc., Box 307, Feasterville, PA 19047
AG.................. Agway Inc., P.O. Box 1333, Syracuse, NY 13201
AM................. American Sunmelon, P.O. Box 153, Hinton, OK 73047
AR.................. Aristogenes Inc., 23723 Fargo Road, Parma, ID 83660
AT.................. American Takii Inc., 301 Natividad Road, Salinas, CA 93906
B..................... BHN Seed, Division of Gargiulo Inc., 16750 Bonita Beach Rd., Bonita Springs, FL 34135
BBS................ Baer's Best Seed, 154 Green St., Reading, MA 01867
BC.................. Baker Creek Heirloom Seeds, 2278 Baker Creek Rd., Mansfield, OH 65704
BK.................. Bakker Brothers of Idaho Inc., P.O. Box 1964, Twin Falls, ID 83303
BR.................. Bruinsma Seeds B.V., P.O. Box 1463, High River, Alberta, Canada, TOL 1B0
BS.................. Bodger Seed Ltd., 1800 North Tyler Ave., South El Monte, CA 91733
BU.................. W. Atlee Burpee & Co., P.O. Box 6929, Philadelphia, PA 19132
BZ.................. Bejo Zaden B.V., 1722 ZG Noordscharwoude, P.O. Box 9, The Netherlands
CA.................. Castle Inc., 190 Mast St., Morgan Hill, CA 95037
CF.................. Cliftons Seed Co., 2586 NC 43 West, Faison, NC 28341
CG.................. Cooks Garden Seed, P.O. Box C5030, Warminster, PA 18974
CH.................. Alf Christianson, P.O. Box 98, Mt. Vernon, WA 98273
CIRT............... Campbell Inst. for Res. and Tech., P-152 R5 Rd 12, Napoleon, OH 43545
CL.................. Clause Semences Professionnelles, 100 Breen Road, San Juan Bautista, CA 95045
CN.................. Canners Seed Corp. (Nunhems), Lewisville, ID 83431
CR.................. Crookham Co., P.O. Box 520, Caldwell, ID 83605
CS.................. Chesmore Seed Co., P.O. Box 8368, St. Joseph, MO 64508
D.................... Daehnfeldt Inc., P.O. Box 947, Albany, OR 97321
DN................. Denholm Seeds, P.O. Box 1150, Lompoc, CA 93438-1150
DR.................. DeRuiter Seeds Inc., P.O. Box 20228, Columbus, OH 43320
EB.................. Ernest Benery, P.O. Box 1127, Muenden, Germany
EV.................. Evergreen Seeds, Evergreen YH Enterprises, P.O. Box 17538, Anaheim, CA 92817
EX.................. Express Seed, 300 Artino Drive, Oberlin, OH 44074
EW................. East/West Seed International Limited, P.O. Box 3, Bang Bua Thong, Nonthaburi 1110, Thailand
EZ.................. ENZA Zaden, P.O. Box 7, 1600 AA, Enkhuisen, The Netherlands 02280-15844
FED................ Fedco Seed Co., P.O. Box 520, Waterville, ME 04903
FM................. Ferry-Morse Seed Co., P.O. Box 4938, Modesto, CA 95352
G.................... German Seeds Inc., Box 398, Smithport, PA 16749-9990
GB.................. Green Barn Seed, 18855 Park Ave., Deephaven, MN 55391
GL.................. Gloeckner, 15 East 26th St., New York, NY 10010
GO................. Goldsmith Seeds Inc., 2280 Hecker Pass Highway, P.O. Box 1349, Gilroy, CA 95020
GU................. Gurney's Seed and Nursery Co., P.O. Box 4178, Greendale, IN 47025-4178
HL/HOL......... Hollar & Co. Inc., P.O. Box 106, Rocky Ford, CO 81067
H/HM............ Harris Moran Seed Co., 3670 Buffalo Rd., Rochester, NY 14624
HMS.............. High Mowing Organic Seeds, 76 Quarry Rd., Walcott, VT 05680
HN................. HungNong Seed America Inc., 3065 Pacheco Pass Hwy., Gilroy, CA 95020
HO................. Holmes Seed Co., 2125 46th St., N.W., Canton, OH 44709
HR................. Harris Seeds, 60 Saginaw Dr., P.O. Box 22960, Rochester, NY 14692-2960
HS................. Heirloom Seeds, P.O. Box 245, W. Elizabeth, PA 15088-0245
HZ................. Hazera Seed Ltd., P.O.B. 1565, Haifa, Israel
JU.................. J. W. Jung Seed Co., 335 High St., Randolf, WI 53957
JS/JSS........... Johnny's Selected Seeds, Foss Hill Road, Albion, MA 04910-9731
KS.................. Krummrey & Sons Inc., P.O. 158, Stockbridge, MI 49285
KY.................. Known-You Seed Co., Ltd. 26 Chung Cheng Second Rd., Kaohsiung, Taiwan, R.O.C. 07-2919106
KZ.................. Kitazawa Seed Co., P.O. Box 13220, Oakland, CA 94661-3220
LI.................... Liberty Seed, P.O. Box 806, New Philadelphia, OH 44663
LSL................. LSL Plant Science, 1200 North El Dorado Place, Suite D-440, Tucson, AZ 85715
MB................. Malmborg's Inc., 5120 N. Lilac Dr., Brooklyn Center, MN 55429
MK................. Mikado Seed Growers Co. Ltd., 1208 Hoshikuki, Chiba City 280, Japan 0472 65-4847
ML................. J. Mollema & Sons Inc., Grand Rapids, MI 49507
MM................ MarketMore Inc., 4305 32nd St. W., Bradenton, FL 34205
MN................. Dr. Dave Davis, Univ. of Minnesota Horticulture Dept., 305 Alderman Hall, St. Paul, MN 55108
MR................. Martin Rispins & Son Inc., 3332 Ridge Rd., P.O. Box 5, Lansing, IL 60438
MS................. Musser Seed Co. Inc., Twin Falls, ID 83301
MWS............. Midwestern Seed Growers, 10559 Lackman Road, Lenexa, KS 66219
NE.................. Neuman Seed Co., 202 E. Main St., P.O. Box 1530, El Centro, CA 92244
NI................... Clark Nicklow, Box 457, Ashland, MA 01721
NU................. Nunhems (see Canners Seed Corp.)
NS.................. New England Seed Co., 3580 Main St., Hartford, CT 06120
NZ.................. Nickerson-Zwaan, P.O. Box 19, 2990 AA Barendrecht, The Netherlands
OE.................. Ohlsens-Enke, NY Munkegard, DK-2630, Taastrup, Denmark
ON................. Osbourne Seed Co., 2428 Old Hwy 99 South Road Mount Vernon, WA 98273
OS.................. Outstanding Seed Co., 354 Center Grange Road, Monaca, PA 15061
OLS................ L.L. Olds Seed Co., P.O. Box 7790, Madison, WI 53707-7790
OT.................. Orsetti Seed Co., P.O. Box 2350, Hollister, CA 95024-2350

P .... Pacific Seed Production Co., P.O. Box 947, Albany, OR 97321
PA/PK............. Park Seed Co., 1 Parkton Ave., Greenwood, SC 29647-0002
PARA.............. Paragon Seed Inc., P.O. Box 1906, Salinas, CA 93091
PE.................... Peter-Edward Seed Co. Inc., 302 South Center St., Eustis, FL 32726
PF.................... Pace Foods, P.O. Box 9200, Paris, TX 75460
PG................... The Pepper Gal, P.O. Box 23006, Ft. Lauderdale, FL 33307-3006
PL.................... Pure Line Seeds Inc., P.O. Box 8866, Moscow, ID
PM .... Pan American Seed Company, P.O. Box 438, West Chicago, IL 60185
PR .... Pepper Research Inc., 980 SE 4 St., Belle Glade, FL 33430
PT.................... Pinetree Garden Seeds, P.O. Box 300, New Gloucester, ME 04260
R...................... Reed's Seeds, R.D. #2, Virgil Road, S. Cortland, NY 13045
RB/ROB .... Robson Seed Farms, P.O. Box 270, Hall, NY 14463
RC .... Rio Colorado Seeds Inc., 47801 Gila Ridge Rd., Yuma, AZ 85365
RE.................... Reimer Seed Co., P.O. Box 236, Mt. Holly, NC 28120
RG................... Rogers Seed Co., P.O. Box 4727, Boise, ID 83711-4727
RI/RIS .... Rispens Seeds Inc., 3332 Ridge Rd., P.O. Box 5, Lansing, IL 60438
RS.................... Royal Sluis, 1293 Harkins Road, Salinas, CA 93901
RU/RP/RUP .. Rupp Seeds Inc., 17919 Co. Rd. B, Wauseon, OH 43567
S .... Seminis Inc. (may include former Asgrow and Peto cultivars), 2700 Camino del Sol, Oxnard, CA 93030-7967
SE.................... Southern Exposure Seed Exchange, P.O. Box 460, Mineral, VA 23117
SHUM .... Shumway Seed Co., 334 W. Stroud St., Randolph, WI 53956
SI/SG.............. Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503
SIT................... Seeds From Italy, P.O. Box 149, Winchester, MA 01890
SK.................... Sakata Seed America Inc., P.O. Box 880, Morgan Hill, CA 95038
SN .... Snow Seed Co., 21855 Rosehart Way, Salinas, CA 93980
SO .... Southwestern Seeds, 5023 Hammock Trail, Lake Park, GA 31636
SOC................ Seeds of Change, Santa Fe, NM
SST .... Southern States, 6606 W. Broad St., Richmond, VA 23230
ST.................... Stokes Seeds Inc., 737 Main St., Box 548, Buffalo, NY 14240
SU/SS............. Sunseeds, 18640 Sutter Blvd., P.O. Box 2078, Morgan Hill, CA 95038
SV .... Seed Savers Exchange, 3094 North Winn Rd., Decorah, IA 52101
SW .... Seedway Inc., 1225 Zeager Rd., Elizabethtown, PA 17022
SY.................... Syngenta/Rogers, 600 North Armstrong Place (83704), P.O. Box 4188, Boise, ID 83711-4188
T/TR .... Territorial Seed Company, P.O. Box 158, Cottage Grove, OR 97424
TGS................. Tomato Growers Supply Co., P.O. Box 2237, Ft. Myers, FL 33902
TS.................... Tokita Seed Company Ltd., Nakagawa, Omiya-shi, Saitama-ken 300, Japan
TT.................... Totally Tomatoes, P.O. Box 1626, Augusta, GA 30903
TW.................. Twilley Seeds Co. Inc., P.O. Box 65, Trevose, PA 19047
UA................... U.S. Agriseeds, San Luis Obispo, CA 93401.
UG .... United Genetics, 8000 Fairview Road, Hollister, CA 95023
US .... U.S. Seedless, 12812 Westbrook Dr., Fairfax, VA 22030
V....................... Vesey's Seed Limited, York, Prince Edward Island, Canada
VL.................... Vilmorin Inc., 6104 Yorkshire Terr., Bethesda, MD 20814
VS .... Vaughans Seed Co., 5300 Katrine Ave., Downers Grove, IL 60515-4095
VTR................. VTR Seeds, P.O. Box 2392, Hollister, CA 95024
WI .... Willhite Seed Co., P.O. Box 23, Poolville, TX 76076
WP .... Woodpraire Farms, 49 Kinney Road, Bridgewater, ME 04735
ZR .... Zeraim Seed Growers Company Ltd., P.O. Box 103, Gedera 70 700, Israel