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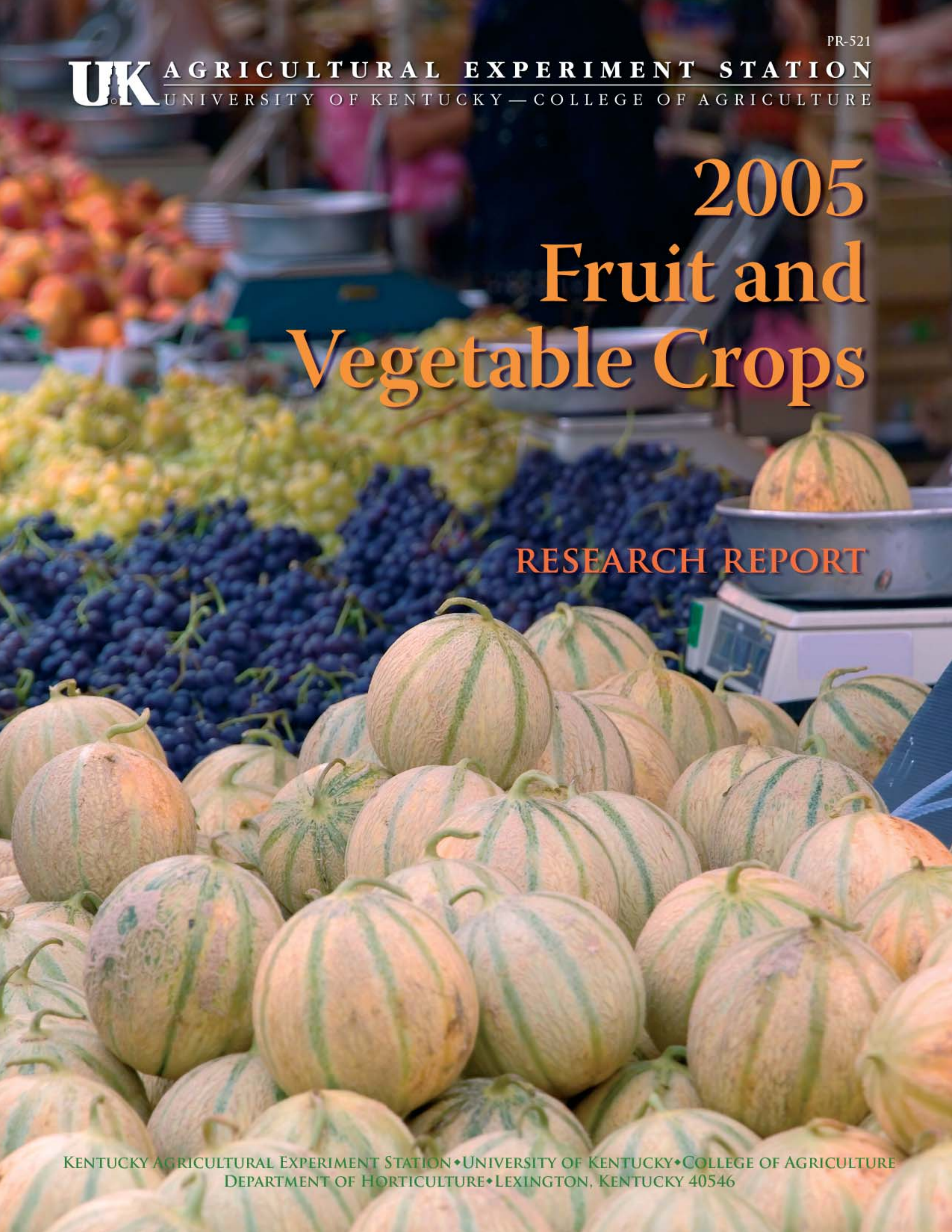
UK AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

2005 Fruit and Vegetable Crops

RESEARCH REPORT



KENTUCKY AGRICULTURAL EXPERIMENT STATION • UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE
DEPARTMENT OF HORTICULTURE • LEXINGTON, KENTUCKY 40546

2005 Fruit and Vegetable Crops Research Report

Edited by Brent Rowell, John Snyder, and Chris Smigell

Acknowledgment

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 Service if you need assistance in interpreting pesticide labels.

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UK Fruit and Vegetable Program Overview

Dewayne Ingram, Chair, Department of Horticulture

The UK Fruit and Vegetable Crops Programs are the coordinated efforts of faculty, staff, and students from several departments in the College of Agriculture who work for the benefit of Kentucky fruit and vegetable industries. The *2005 Fruit and Vegetable Crops Research Report* includes articles from four UK departments and from Berea College and Kentucky State University. In addition to the usual sections on economics, on-farm demonstrations, small fruits, tree fruits, vegetables, and diseases, this edition includes two entirely new sections titled "Grapes and Wine" and "Pest Management, Health, and Sustainable Horticulture". Research projects reported here reflect stated industry needs, expertise available at UK, and the nature of research projects around the world generating information applicable to Kentucky. If you have questions or suggestions about a particular research project, please do not hesitate to contact us.

Funds from the Agricultural Development Board through Kentucky Horticulture Council grants and U.S. Department of Agriculture grants for the New Crop Opportunities Center have allowed us to double the number of field research plots statewide. This has occurred during a time of rapid industry growth and emergence of vital questions about our production and marketing systems. These grants have also funded six Extension Associates working with fruits and vegetables. These Associates have become the backbone of our outreach program to help tobacco growers transition to horticultural crop production. The Associates are located throughout the state and are helping new and existing growers understand and apply new technologies for more profitable production and marketing. As you will see in this issue, on-farm demonstrations, on-farm consulting, and even on-farm research in collaboration with County Extension Agents have been the hallmark of this program. The investment in this approach is paying great dividends, as I think you will see in the results presented here.

We continue the development of our research facilities in Lexington. Implementation of our plans to improve the Horticulture Research Farm (South Farm) is progressing. This year we have moved and improved a greenhouse and have constructed the shell for the new headhouse which will also serve the new greenhouse complex to be constructed next year. The headhouse should be functional this spring. Transitioning 11 acres of the farm to qualify as "certified organic" is on schedule. You are invited to visit the farm at your convenience, but make sure you watch for the announcement of the field day in the summer of 2006.

The Kentucky Grape and Wine Council obtained a two-year grant from the Agricultural Development Board to fund a viticulturist and an enologist position in the Horticulture Department to support the rapidly expanding grape and wine industry. We are fortunate to have attracted Dr. Kaan Kurtural and Dr. Tom Cottrell to these positions. Their valuable expertise and great experiences are already impacting the industry, even though they just started in their respective positions this summer. Dr. Kurtural's initial focus has been on site analyses for potential plantings, selection of appropriate varieties for specific sites, and training and management systems. Dr. Cottrell is working to improve wine quality and extend wine making knowledge and skills to new wineries. Both are using a variety of approaches in their educational programs including County Agent training, workshops, conferences, and one-on-one consulting. Publications and other resource materials are being developed and distributed in print and on the UK Horticulture's New Crop Opportunities Web site (www.uky.edu/Ag/NewCrops/othercrops.html#g).

Undergraduate Program Highlights

The department offers areas of emphasis in Horticultural Enterprise Management and Horticultural Science within a Horticulture, Plant and Soil Science Bachelor of Science degree. Following are a few highlights of our undergraduate program in 2004-2005. The Horticulture Plant and Soil Science degree program had more than 100 students in the fall semester of 2005 of which almost one-half are in Horticulture. Sixteen Horticulture students graduated in the 2004-2005 academic year.

We believe that a significant portion of an undergraduate education in horticulture must come outside the classroom. In addition to the local activities of the Horticulture Club and field trips during course laboratories, students have excellent off-campus learning experiences. Here are the highlights of such opportunities in 2005.

- A 17-day study tour in Pacific Northwest states was led by Drs. McNiel, Dunwell, and Geneve involving 14 students.
- Students accompanied faculty to the following regional/national/international meetings: the American Society for Horticultural Science Annual Conference, the Southern Nursery Association, the Kentucky Fruit and Vegetable Crops Conference, and the Kentucky Landscape Industries Conference and Trade Show.

Graduate Program Highlights

The demand for graduates with M.S. or Ph.D. degrees in Horticulture, Entomology, Plant Pathology, and Agricultural Economics is high. Our M.S. graduates are being employed in the industry, Cooperative Extension Service, secondary and postsecondary education, and governmental agencies. Graduate students are active participants in the fruit and vegetable commodity teams and contribute significantly to our ability to address problems and opportunities important to Kentucky.

Getting the Most Out of Research Reports

Brent Rowell, Department of Horticulture

The 2005 Fruit and Vegetable Crops Research Report includes results of 33 research trials that were conducted in 9 counties in Kentucky (see map, below). In addition to these locations, producers statewide were surveyed about their marketing intentions.

Research was conducted by faculty and staff from several departments within the University of Kentucky College of Agriculture, including Horticulture, Entomology, Plant Pathology and Agricultural Economics. This report also includes independent and collaborative research projects conducted by faculty and staff at Kentucky State University and Berea College. Most of these reports are of crop variety (cultivar) trials.

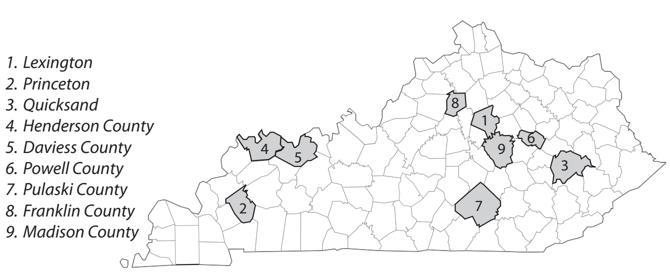
Growers usually put variety trials at the top of the list when rating projects at a public institution's research stations; this report mostly contains the results of fruit and vegetable variety trials. These trials provide a wealth of information not only to growers but also to Extension agents, researchers, and seed companies. The reports also provide us with much of the information we need in order to include varieties in our current edition of the *Vegetable Production Guide for Commercial Growers* (ID-36).

The main purpose of variety evaluation is to provide growers with practical information to assist them in selecting the most suitable variety for a given location or market. Here are some 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, our trial plot sizes range anywhere from 50 to 500 square feet. Yields per acre are calculated by multiplying these small plot yields by correction factors ranging from 100 to 1,000. These yields per acre may not be realistic, and small errors can be amplified when correction factors are used. For example, the calculations may overestimate yields because the plots harvested do not include empty spaces normally occupied by things such as drive rows in a grower's field. These empty spaces may result in a higher per acre yield from the research plots compared to a grower's yield.

Fruit and vegetable research sites in 2005.



In some cases, research plots may be harvested more often than is economically feasible in a grower's field. So do not feel inadequate if our yields are higher than yours. You should be concerned, however, if our yields are *lower* than yours. In that case, there may be good reason to suspect that the trial was conducted improperly.

It is best not to compare the yield of a variety at one location to the yield of a different variety at another location. The differences in performance among all varieties grown at the same location, however, can and should be used to identify the best varieties for growers nearest that locality. Results vary widely from one location or geographical region to another; a variety may perform well in one location and poorly in another for many reasons. Different locations may have different climates, microclimates, soil types, fertility regimes, and pest problems. Different trials at different locations are also subject to differing management practices. Only a select few varieties seem to perform well over a wide range of environmental conditions, and these varieties usually become top sellers.

Climatic conditions obviously differ considerably from one season to the next, and it follows that some varieties perform well one year and poorly the next. For this reason, we prefer to have at least two years of trial data before coming to any hard and fast conclusions about a variety's performance. In other cases, we may conduct a preliminary trial to eliminate the worst varieties and let growers make the final choices regarding the best varieties for their farm and market conditions (see Rapid Action Cultivar Evaluation [RACE] trial description on page 8).

Making Sense of Statistics

Most trial results use statistical techniques to determine if there are any real (versus accidental) differences in performance among varieties or treatments. Statistical jargon is often a source of confusion, and we hope this discussion will help. In many cases, our trials are replicated, which simply means that instead of taking data from only one plot from one spot in the trial field, we plant that variety (or repeat the spray or fertilizer treatments) in other small plots in several spots in a field. If we test 20 pepper varieties, for example, we will have a small plot for each variety (20 separate plots) and then repeat this planting in two or three additional sets of 20 plots in the same trial field. These repeated sets of the same varieties are called replications or blocks. The result is a trial field with 20 varieties x 4 replications = 80 small plots. The yield for a variety is reported as the average (also called the *mean*) of yields from the four separate small plots of that variety. The average per acre yields reported in the tables are calculated by multiplying these average small plot yields by a correction factor.

In most reports, we list the results in tables with varieties ranked from highest to lowest yielding (see Table 1). Small differences in yield are often of little importance, and it is sometimes difficult to separate differences due to chance or error from actual differences in performance of varieties. The last line at the bottom of most

Table 1. Yields, gross returns, and appearance of bell pepper cultivars under bacterial spot-free conditions in Lexington, Kentucky; yield and returns data are means of four replications.

Cultivar	Seed Source	Tot. Mkt. Yield[1] (tons/A)	% XL +Large[2]	Income[3] ($/acre)	Shape Unif.[4]	Overall Appear.[5]	No. Lobes[6]	Fruit Color	Comments
X3R Aristotle	S	25	89	10180	4	7	3	dk green	most fruits longer than wide
King Arthur	S	22.5	88	9079	3	5	4	light-med green	deep blossom-end cavities
4 Star	RG	22.2	86	9111	3.5	6	4	light-med green	
Boynton Bell	HM	21.7	92	9003	3	5	3	med-dk green	~15% of fruits 2-lobed (pointed)
Corvette	S	20.6	88	8407	3	6	3&4	med-dk green	~10% elongated (2-lobed)
X3R Red Knight	S	20.5	90	8428	3	5	4	med-dk green	
SP 6112	SW	20.2	78	8087	4	6	3	med green	
Conquest	HM	20	85	8021	2	5	3&4	light-med green	deep stem-end cavities, many misshapen
Orion	EZ	20	93	8219	4	6	4	med-dk green	
Lexington	S	19.8	87	8022	3.5	6	3	dk green	
PR99Y-3	PR	19.5	87	7947	3	5	3&4	med green	many misshapen fruits
Defiance	S	18.7	87	7568	4	7	3&4	dk green	
X3R Ironsides	S	18.4	92	7585	4	6	3	med green	~5% w/deep stem-end cavities
X3R Wizard	S	18	92	7447	3	6	3&4	dk green	
RPP 9430	RG	17.3	89	7029	3	6	4	med-dk green	~10% of fruits elongated
ACX 209	AC	17.2	89	7035	3.5	6	3	med green	
Waller-Duncan LSD (P< 0.05)		5.2	7	2133					

1 Total marketable yield included yields of U.S. Fancy and No. 1 fruits of medium (greater than 2.5 in. diameter) size and larger plus misshapen but sound fruit that could be sold as "choppers" to foodservice buyers.
2 Percentage of total yield that was extra-large (greater than 3.5 in. diameter) and large (between 3 and 3.5 in. diameter).
3 Income = gross returns per acre; average 2000 season local wholesale prices were multiplied by yields from different size/grade categories: $0.21/lb for extra-large and large, $0.16/lb for mediums, and $0.13/lb for "choppers," i.e., misshapen fruits.
4 Average visual uniformity of fruit shape where 1 = least uniform, 5 = completely uniform.
5 Visual fruit appearance rating where 1 = worst, 9 = best, taking into account overall attractiveness, shape, smoothness, degree of flattening, color, and shape uniformity; all fruits from all four replications observed at the second harvest (July 19).
6 3&4 = about half and half 3- and 4-lobed; 3 = mostly 3-lobed; 4 = mostly 4-lobed.

data tables will usually contain a number that is labeled LSD, or *Waller-Duncan LSD*. LSD is a statistical measure that stands for "Least Significant Difference."

The LSD is the minimum yield difference that is required between two varieties before we can conclude that one actually performed better than another. This number enables us to separate real differences among the varieties from chance differences. When the difference in yields of two varieties is less than the LSD value, we cannot say with any certainty that there's any real yield difference. In other words, we conclude that the yields are the same. For example, in Table 1 cited above, variety 'X3R Aristotle' yielded 25 tons per acre and 'Boynton Bell' yielded 21.7 tons per acre. Since the difference in their yields (25 - 21.7 = 3.3 tons per acre) is less than the LSD value of 5.2 tons per acre, there was no real difference between these two yields. The difference between 'X3R Aristotle' and 'X3R Wizard' (25 - 18 = 7), however, is greater than the LSD, indicating that the difference between the yields of these two varieties is real.

Sometimes these calculations have already been made, and statistical comparisons among varieties are indicated by one or more letters (a, b, c or A, B, C, etc.) listed after the yields in the tables (see Table 2). If yields of two varieties are followed by one or more of the same letters, they are considered to be the same (statistically speaking, that is). Yields of two varieties are different if they have no letters in common. In this example, the average muskmelon fruit weight of 'Eclipse' and that of 'Vienna' are both followed by an "a," so they are not different, while values for 'Eclipse' and 'Athena' have no letters in common, indicating that the difference between them is real (that is, statistically significant).

What is most important to growers is to identify the best varieties in a trial. What we usually recommend is that you identify a group of best performing varieties rather than a single variety. This is easily accomplished for yields by subtracting the LSD from the yield of the top yielding variety in the trial. Varieties in the table having yields equal to or greater than the result of this calculation will belong in the group of highest yielding varieties. If we take the highest yielding pepper variety, 'X3R Aristotle,' in Table 1 and subtract the LSD from its yield (25 - 5.2 = 19.8), this means that any variety yielding 19.8 tons per acre or more will not be statistically different from 'X3R Aristotle.' The group of highest yielding varieties in this case will include the 10 varieties from 'X3R Aristotle' down the column through variety 'Lexington.'

In some cases, there may be a large difference between the yields of two varieties, but this difference is not real (not statistically significant) according to the statistical procedure used. Such a difference can be due to chance, but often it occurs if there is a lot of variability in the trial. An insect infestation, for example, could affect only those varieties nearest the field's edge where the infestation began.

It is also true that our customary standard for declaring a statistically significant difference is quite high, or stringent. Most of the trial reports use a standard of 95% probability (expressed in the

Table 2. Yields and quality of muskmelon cultivars at Quicksand, Ky., 2001; data are means of four replications.

Cultivar	Avg. Wt./ Fruit[1] (lb)	Fruit/A[1]	Pounds/A	Rind Thickness (mm)	% Soluble Solids	Comments *(shape and appearance)*	
Eclipse	8.8 a	5,601	ab	49,036	7.0	11.5	nice
Odyssey	8.8 a	6,016	ab	53,039	-	9.0	nice, elongated
Vienna	9.0 a	5,083	b	46,230	-	8.6	nice, plts showed MO deficiency
RAL 8793VP	8.7 a	5,601	ab	48,735	-	10.2	nice, good flesh color
Athena	6.4 b	6,846	a	43,440	2.6	8.8	small looking
Minerva	9.7 a	4,771	b	45,349	3.4	13.5	nice, melon chosen by customers first
LSD (P = 0.05)		1.5		1,636	ns		

[1] Means followed by the same letter are not significantly different.

tables together with the LSD as P<0.05 or P = 0.05). This means that there is a 95% probability that the difference between two yields is real and not due to chance or error. When many varieties are compared (as in the pepper example above), the differences between yields of two varieties must often be quite large before we can conclude that they are really different.

After the group of highest yielding, or in some cases, highest income[1], varieties (see Table 1 cited above) has been identified, growers should select varieties within this group that have the best fruit quality (often the primary consideration), best disease resistance, or other desirable trait for the particular farm environment and market outlet. One or more of these varieties can then be grown on a trial basis on your farm using your cultural practices.

Producers should also ask around to find out if other growers have had experience with the varieties in question. Growers who belong to a marketing cooperative should first ask the co-op manager about varieties because in some cases buyers have specified the variety to be grown and packed by the co-op. *Good marketing plans start with the customer's (market) requirements and work backward to determine variety and production practices.*

RACE Trials

In cases where there are too many new varieties to test economically or when we suspect that some varieties will likely perform poorly in Kentucky, we may decide to grow each variety in only a single plot for observation. In this case, we cannot make any statistical comparisons but can use the information obtained to eliminate the worst varieties from further testing. We can often save a lot of time and money in the process. We can also provide useful preliminary information to growers who want to try some of these varieties in their own fields.

Since there are so many new marketing opportunities these days for such a wide variety of specialty crops, we have decided that this single-plot approach for varieties unlikely to perform well in Kentucky is better than providing no information at all. We hope that RACE trials, described on this page, will help fill a need and best use limited resources at the research farms. See the 2000 and 2001 hot and specialty pepper reports for examples of such trials.

Rapid Action Cultivar Evaluation (RACE) trials are:

- a means of getting new information to growers in the least amount of time.
- a cultivar (variety) or cultural practice trial without replication or with a maximum of two replications.
- trials in which preferably the same set of cultivars can be replicated by location (Lexington and Quicksand stations, for example). Cultivars can be grown on station and/or in growers' fields.
- trials that can be applied to vegetables, small fruits, herbs, cut flowers, or other annual ornamentals.
- appropriate for new crops for which the market potential is unknown or, in some cases, for existing crops with small niche market potential.
- appropriate for screening a large number of cultivars (not breeding lines) of unknown adaptation.
- appropriate for home garden cultivars (expensive replicated trials are not appropriate for home garden cultivars in most cases).
- a means of addressing new questions about specialty crops without compromising replicated trials of priority crops.
- a good demonstration site for growers to get a general idea of cultivar's performance.

How do RACE trials differ from "observation trials" conducted in the past?

- RACE trials are planted on the best and most uniform plot ground and are well maintained, sprayed, irrigated, etc. They do not serve as guard rows in other replicated trials.
- Crops are harvested at the appropriate time, with accurate record keeping, yield data, and quality information. Results are reported/published, as are replicated trial results.
- Whenever possible, products are evaluated with assistance from knowledgeable marketers, interested produce buyers, and growers.
- Information obtained should not be used to identify one or two best cultivars but to eliminate the worst from further testing and make recommendations about a group of cultivars that can be put into further trials by growers themselves.

[1] It is often desirable to calculate a gross "income" or gross return variable for vegetable crop varieties that will receive different market prices based on pack-out of different fruit sizes and grades (bell peppers, tomatoes, cucumbers). In these cases, yields in each size class/grade are multiplied by their respective wholesale market prices to determine gross returns (= income) for each cultivar in the trial.

Hybrid vs. Open Pollinated

In general, hybrid varieties (also referred to as F1) mature earlier and produce a more uniform crop. They often have improved horticultural qualities as well as tolerance and/or resistance to diseases. Hybrid seed is usually more expensive than is seed of open-pollinated (OP) varieties. With hybrid varieties, seeds cannot be collected and saved for planting next year's crop. Hybrid seed is now available for most vegetable crops that are grown in the United States.

Despite the advantages of hybrids, there are some crops for which few hybrids have been developed (poblano peppers, for example) or for which hybrids offer no particular advantages (most bean varieties). Interest in OP varieties has resurged among home gardeners and market gardeners who wish to save their own seed or who want to grow heirloom varieties for which only OP seed is available. Lower prices for produce in traditional wholesale market channels, however, may dictate that growers use hybrids to obtain the highest possible yields and product uniformity. Selecting a hybrid variety as a component in a package of improved cultural practices is often the first step toward improved crop quality and uniformity.

Where to Get Seeds

A seed source is listed for each variety reported in the trials. Seed source abbreviations with company names and addresses are found in Appendix A at the end of this publication. Because seeds are alive, their performance and germination rate depend on how old they are, where and how they were produced, and how they have been handled and stored. It is always preferable to purchase certified, disease-free seeds from a reputable seed dealer and to ask about treatments available for prevention of seed-borne diseases.

Many factors are considered when making a final choice of variety, including type, fruit quality, resistance or tolerance to pests, how early the variety is harvested, and cost. Keep in mind that some varieties may perform differently from our trials, especially under different management systems. Producers should test varieties for themselves by trying two to three varieties on a small scale before making a large planting of a single variety. This method will be the best means of determining how well suited a particular variety is for your farm and market.

Variety Information Online

This publication is available online at http://www.uky.edu/Ag/Horticulture/comveggie.html. Other useful sources of information for commercial vegetable growers can be found by following the links at www.uky.edu/Agriculture/Horticulture/veglinks.htm. In addition, results of some pepper and blackberry trials are posted on UK's New Crop Opportunities Center Web site under current research at www.uky.edu/Ag/NewCrops.

Auburn University publishes a variety trial report twice a year in cooperation with several other universities. The 2004 reports have been posted in PDF (Acrobat) format at www.ag.auburn.edu/aaes/communications/publications/fruitsnutsvegs.html.

Produce Marketing Intentions Survey—Direct Marketing Continues to Grow

Matt Ernst and Tim Woods, Department of Agricultural Economics

Introduction

The Kentucky Produce Planting and Marketing Intentions Survey was conducted for the fifth consecutive year in 2005. Results of the survey allow producers, researchers, and others involved in Kentucky's produce industry to get a general sense of trends in individual crop acreage and marketing methods.

Responses to the 2005 Kentucky Produce Planting and Marketing Intentions Survey, combined with a decrease in acreage contracted by Kentucky's four vegetable marketing co-ops, indicated that direct marketing would continue to drive growth in Kentucky's produce industry during 2005. As in 2004, gross sales of Kentucky fruits and vegetables increased by about 5% in 2005, with total farm produce sales projected to fall between $30.5 and $35 million.

Materials and Methods

Surveys were mailed to 1,178 growers in February 2005. The survey was returned by 235 producers representing 2,433 commercial vegetable acres and 403 commercial fruit acres. An additional 50 surveys were returned but were unusable. The 24% response rate is considered good for a mail survey, but was down from past years.

Results and Discussion

Producer Demographics

Age and experience. Kentucky's farm population continues to age, and produce expansion has primarily occurred on farms operated by those over 50 (Table 1). Many new and inexperienced growers began growing produce between 1998 and 2002. Despite the efforts directed at helping new producers diversify into horticultural crops, the proportion of new growers has declined substantially since 2002; only 6% of those surveyed this year had less than three years of experience growing produce.

Table 1. Years of experience growing produce.

	2001	2002	2003	2004
Less than 3	25%	15%	15%	6%
3-6	23%	32%	33%	28%
7-10	14%	15%	13%	38%
Over 10	38%	38%	38%	48%

Tobacco production. The tobacco buyout was expected to cause significant producer exit from tobacco production in 2005. In the spring of 2005, UK estimated about a third of tobacco growers would exit the industry this season. Responses to this survey, which was conducted before planting, indicated that 37% of produce growers that produced tobacco in 2004 did not plan to grow tobacco in 2005.

The survey indicated a significant number of produce farmers (45%) still growing tobacco (Table 2). While some of these growers indicated that they were interested in expanding produce acreage, it was beyond this survey's scope to pinpoint the effects of tobacco industry changes on possible produce acreage expansion. However, many growers appear to still be treating produce and tobacco as complementary enterprises.

Table 2. Percent of surveyed produce growers also producing tobacco.

	2001	2002	2003	2004
Grew tobacco	44%	46%	41%	45%

Organic production. Past surveys have suggested that grower interest in organic production is likely tied with their perception of the ease of entry into certified organic production. In this year's survey, 20% of the growers surveyed indicated that they were interested in future organic production (Table 3). This is up sharply from the previous year's survey, where only 2% of growers indicated interest. This renewed interest in organic production may be due to increased awareness of support available in the organic certification process. Regulatory difficulties have been addressed through recent educational programs, and buyer demand continues to grow.

Table 3. Interest in growing organic produce.

Are you interested in growing organic produce in the future?	2003	2004	2005
Yes	20%	2%	20%
No/No response	80%	98%	80%

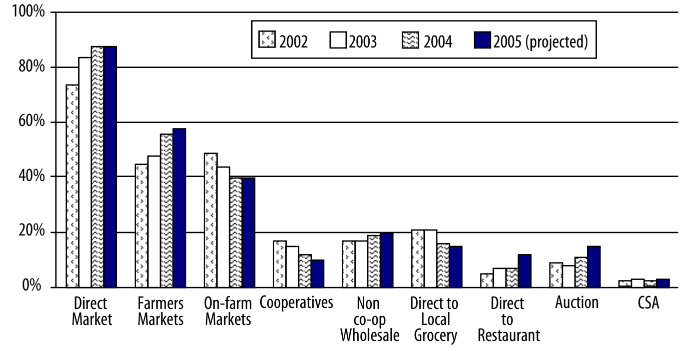
Market Use: Direct Marketing

For the purposes of reporting this survey, "direct marketing" includes sales directly to consumers on and off the farm (farmers' market, pick-your-own, roadside stand, CSA), as well as sales directly to groceries or restaurants. The frequency of surveyed growers using some form of direct marketing in 2004 was 88%, the highest ever observed in this survey (Figure 1).

Farmers' markets. The number of community farmers' markets has nearly tripled in Kentucky over the past 10 years. More than 94 farmers' markets operated in Kentucky during 2005 with projected sales of $7 to $8 million and more than 1,500 registered vendors.

More than half (59%) of the respondents to this survey indicated that they used farmers' markets to sell some of their produce; 56% indicated that 10% or more of their sales occurred at farmers' markets (Figure 1).

Figure 1. Frequency of market use, 2002-2004 and 2005 estimates (percent of surveyed growers indicating 10% or more of sales through channel).



On-farm markets. The next most frequently used market channel was the on-farm market, used by half the respondents. These markets include roadside stands and pick-your-own. While producers continue to indicate interest in developing on-farm markets, this year's survey indicated a possible decline in this interest. Producers continue to cite location and liability concerns as barriers to entering on-farm marketing efforts like pick-your-own.

Restaurants. Selling directly to local restaurants has become more popular with produce growers in Kentucky since the state park restaurants initiated a program to purchase in-season local produce in 2004. More than 20 new growers began selling to the park restaurants in 2005, doubling the number of growers who indicated marketing to any restaurants in 2004. The state parks alone indicate the capacity to purchase at least $250,000 of local produce in season. Restaurants and related foodservice buyers are a niche market that may fit into several kinds of marketing plans.

Community Supported Agriculture (CSA). CSA marketing was used by 3% of respondents. This market channel is quite popular with certified organic producers. Though currently minor, sales volume through the CSA channel is expected to increase as organic acreage increases

Market Use: Wholesale Marketing

Non-co-op wholesale and direct to grocer. Behind farmers' markets and roadside stands, wholesale marketing (not through a co-op) was the third most common market channel that Kentucky produce growers used in 2004. This channel was used by 19% of the survey respondents. This category includes larger foodservice, repackers, and other intermediate produce handlers.

Sixteen percent of respondents indicated selling 10% or more of their produce direct to a local grocery in 2004. This market channel is often managed as part of a deal with a larger chain that allows direct delivery to a local store. Independent grocers are also still a viable market for producers in communities where an independent grocer is located.

Cooperatives. Co-ops were used by 12% of the respondents to this survey. Co-op acreage and sales leveled out in 2003 after rapid expansion from 2000-2002 and declined in 2004. Through 2003, less than 20% of Kentucky's produce growers belonged to a vegetable co-op, but these co-ops contributed more than 25% of Kentucky gross sales. For the 2004 season, the percent of growers using co-ops as a marketing mechanism and the percent contribution by co-op sales to gross income from produce in Kentucky were approximately even (10 to 15%). Both these numbers are projected to decrease in 2005.

Auctions. Nine percent of respondents indicated that they used auctions to market some of their produce in 2004. Kentucky's sole produce auction until 2004 was the Fairview Produce Auction in Christian County. This auction, which also sells hay, straw, and small-scale farm equipment, reported an estimated $1.5 million in sales. The Lincoln County Produce Auction began in 2004 with estimated sales of $300,000.

New auctions emerged in Bath and Mason counties in 2005. Produce sales from all auctions were expected to total $2 million in 2005 with more than 300 growers expected to market produce through an auction

Crop Changes

Each year, this survey asks respondents to indicate anticipated changes in crop acreage. While not every produce grower in the state is surveyed, these anticipated changes in acreage provide general indications of what crops are viewed favorably or unfavorably for expansion (expansion potential).

Survey respondents indicated increases in commercial broccoli and hot pepper acreage in 2005; this was confirmed by co-op and independent grower shipper increases during the season. Other minor vegetable crops (under 50 acres each) with projected acreages increases greater than 20% included sweet potatoes, winter squash, eggplant, okra, and ornamental corn. These are all crops with both direct and wholesale market potential for Kentucky growers.

The survey also indicated increases in bearing blueberry acreage, which increased from 15 acres in 1997 to 60 to 65 acres in 2005. Bearing acreage of wine grapes has also continued increasing to 220 bearing acres in 2004 and 250 acres estimated for 2005.

Summary

Producers using direct markets comprise the majority of fruit and vegetable growers and generate most of the sales volume in Kentucky. Wholesale production has shifted more to auction and grower-shippers and is expected to continue to do so in 2005, when Kentucky's commercial produce sales will increase again. The industry continues to work through significant marketing challenges and is impacted by changes across all of agriculture. Volume requirements in wholesale production, infrastructure for direct marketing, and delivery of quality products to market represent the biggest marketing issues facing Kentucky growers.

Acknowledgment

This research was funded by the New Crop Opportunities Center at the University of Kentucky through a USDA Special Grant.

Price Trends for Selected Kentucky Vegetable Crops from Different Market Channels in 2004 and 2005

Matt Ernst and Tim Woods, Department of Agricultural Economics

Introduction

Increased price reporting has come with the growth in Kentucky's commercial vegetable industry. The USDA Agricultural Marketing Service now reports Kentucky produce in terminal market prices from St. Louis and Atlanta. Reports from Kentucky's produce auctions, farmers' markets, and links to terminal market prices are available in-season from the UK New Crop Opportunities Center (*www.uky.edu/Ag/NewCrops*) which also publishes a farmers' market price report. The Kentucky Department of Parks also publishes electronically a weekly list of prices state park restaurants pay for local produce. This list is available for producers to receive by e-mail and may be obtained by contacting Jessica Patton in the state parks foodservice office (Jessica.Patton@ky.gov).

The purpose of this report is to compare each of these market channels with regard to prices paid for selected major vegetable crops (tomatoes, bell peppers, and melons) throughout the 2004 and 2005 seasons. These prices are primarily reported as market "High" and "Low," the top and bottom prices during a given day or week. Terminal market prices are also reported as weekly average prices which are calculated based on daily reported weekly price ranges.

State Park Wholesale vs. Other Wholesale Market Channels for Tomatoes (2004)

An analysis of the prices paid for vine-ripe staked tomatoes by Kentucky's state parks versus other market channels from July 28 to September 23 was completed for marketing meetings during the winter of 2005. This analysis is illustrated in Figure 1 (State Park and Atlanta Terminal Prices), Figure 2 (State Park and Fairview Auction Prices), and Figure 3 (State Park and Farmers' Market Prices).

These figures reveal what was expected: local wholesale prices from a restaurant will usually be higher than other wholesale options. This is because the restaurant is typically paying farmers what they would pay a produce distributor who has to cover several markups from the farm level, including transportation. Surprisingly, state park prices approached some farmers' market prices during some weeks.

Atlanta Terminal Market Prices for Kentucky Bell Peppers (2005)

Peppers have become a major wholesale crop for Kentucky co-ops and grower-shippers. Figure 4 reports Atlanta Terminal Market price ranges for large green bell peppers from 28 July through 30 August, indicating Kentucky price ranges that fall consistently in the mid- to top ranges at this market. Again, these prices are f.o.b., meaning that is the price received for product being delivered in Atlanta. Grower prices at the farm gate or co-op are less due to shipping expenses.

Fairview Auction Price Trends (Cantaloupes 2004-05)

The Fairview Produce Auction has become a significant point of delivery for Kentucky cantaloupes. Melon acreage in Christian and surrounding counties more than doubled between 1992 and 2002 (Census of Agriculture), and many of these melons are being marketed through the auction. Figure 5 indicates similar price trends for the second week in August through the first of October for large melons in both 2004 and 2005.

Figure 6 indicates wholesale terminal market prices for half-cartons of cantaloupes (12s) in Atlanta during the same time period tracked in Figure 5. While there are many differences between these two market channels, general price trends up and down through July and August are similar between the two markets. For 2004 and 2005, terminal market prices do not reflect as great a trend downward (in terms of percentage of price) during the first part of September.

Summary/Recommendations

Market price information is more available than ever for Kentucky produce market channels. The existence of historical market data for a variety of markets—terminal wholesale, auction, farmers' market, and restaurant—can be used by producers to project profitability and manage risk throughout the season. Produce growers should study and monitor each market to anticipate price trends, especially to identify where earlier or later marketing can capture higher prices, lower risk, and maximize profitability.

Acknowledgment

This research was funded by the New Crop Opportunities Center at the University of Kentucky through a USDA Special Grant.

Figure 1. State park and Atlanta terminal market prices for vine-ripe tomatoes, 2004.

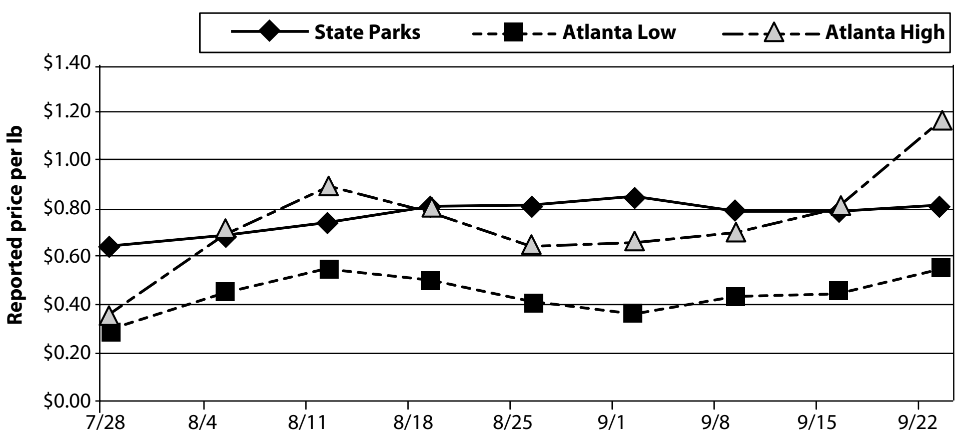


Figure 2. State park and Fairview Produce Auction prices for vine-ripe tomatoes, 2004.

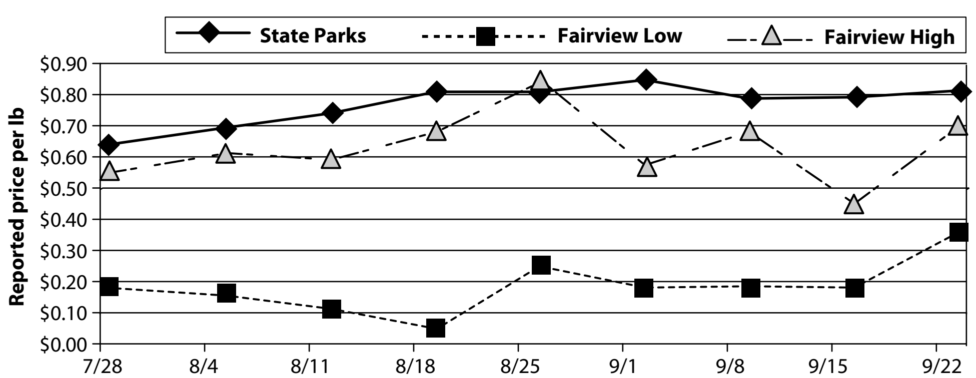


Figure 3. State park and farmers' market prices for vine-ripe tomatoes, 2004.

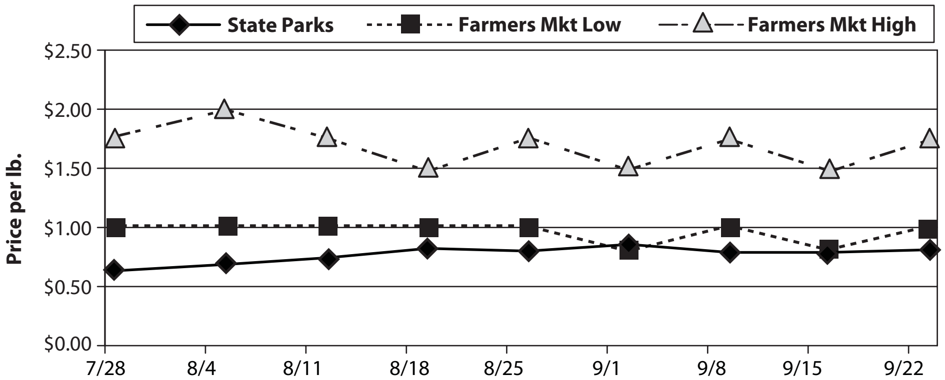


Figure 4. Atlanta terminal market prices for large green bell peppers, 2005.

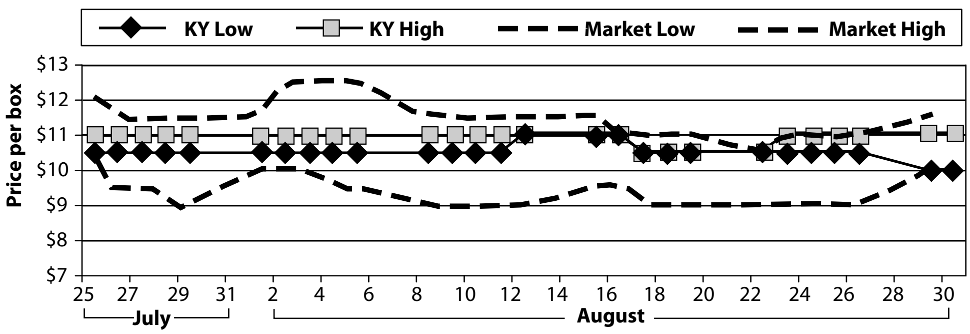


Figure 5. Fairview Produce Auction cantaloupe prices for 2004 and 2005.

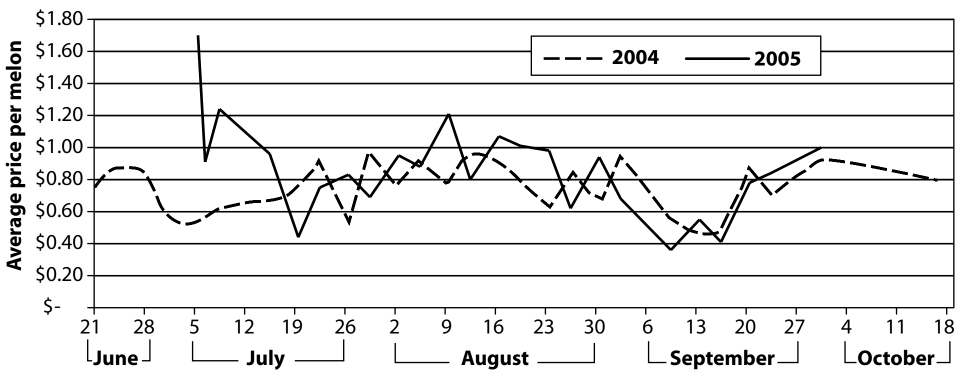
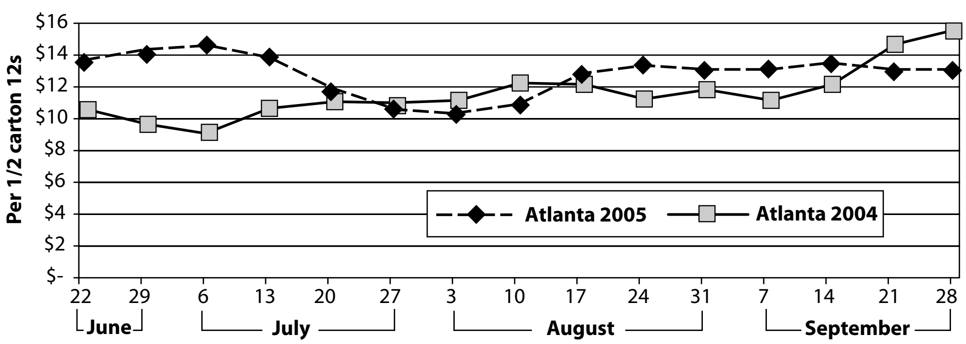


Figure 6. Atlanta terminal market prices for cantaloupes in 2004 and 2005.



On-Farm Commercial Vegetable Demonstrations in Central Kentucky

Dave Spalding and Brent Rowell, Department of Horticulture

Introduction

Five on-farm commercial vegetable demonstrations were conducted in central and south-central Kentucky in 2005. Grower/cooperators were from Bath, Madison, Marion, Scott, and Taylor counties. There were two grower/cooperators producing bell peppers with the cooperator in Scott County growing two acres and the cooperator in Marion County growing four acres. The cooperators in Bath, Madison, and Taylor counties each grew about two acres of mixed vegetables (tomatoes, peppers, squash, green beans, melons, and sweet corn) for their local farmers' markets.

Materials and Methods

As in previous years, grower/cooperators were provided with black plastic mulch and drip irrigation lines for up to one 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 cooperators, County Extension Agents took soil samples 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 bell pepper demonstration plot was transplanted using bacterial spot-resistant variety 'Aristotle.' Peppers were transplanted into 6-inch-high raised beds covered with black plastic with drip lines under the plastic in the center of the beds. Plants were transplanted 15 inches apart in an offset manner in double rows that were 15 inches apart. Raised beds were 6 feet from center to center. Plots were sprayed with the appropriate fungicides and insecticides on an as-needed basis, and cooperators were asked to follow the fertigation schedules provided.

The mixed vegetable plots were planted into 6-inch-high beds covered with black plastic and drip lines under the plastic in the center of the beds. The beds were planted at the appropriate spacing for the vegetable crop being grow (i.e., tomatoes were planted in a single row 18 inches apart, beans were planted in double rows 12 inches apart, etc.). Raised beds were 6 feet from center to center. Plots were sprayed with the appropriate fungicides and insecticides on an as-needed basis, and cooperators were asked to follow the fertigation schedules provided.

The grower/cooperator in Marion County sowed annual rye grass in the middles between beds of plastic in mid-April shortly after laying the plastic and drip lines. On two acres of the plot, rye grass was sown at the rate of 75 pounds per acre, while on the other two acres rye grass was sown at the rate of 100 pounds per acre.

Results and Discussion

After timely early rains, most of the 2005 growing season was very hot and very dry. Producers generally were able to get crops transplanted in a timely manner, and most had good growing conditions into the middle of the season; many growers, however, had problems getting enough water to their crops during the very hot and dry period of mid- and late summer.

Despite the very hot and dry summer growing conditions, bell pepper yields were good (Table 1) with production running a week or more ahead of normal. Bell pepper prices were relatively high for the early harvest but dropped substantially as the harvest season progressed and averaged a little below normal for the whole harvest season. Because of the hot and dry conditions, weeds were not as big of a problem as in recent years, and bacterial leaf spot though present in a few fields was not a problem. The cooperator in Marion County got a good stand of rye grass in the middles with the timely early season rains. There was not a significant difference in yields for the different rye grass seeding rates (Table 1), and early season weed control appeared to be essentially the same. Because of the very hot and dry conditions of late June and early July, the grower elected not to kill down the rye grass as it entered the boot stage which allowed the grass to head out. It appeared that when the grass

Table 1. Bell pepper costs and returns of grower/cooperators in central Kentucky, 2005.

Inputs	Marion County (2 acres/75 lbs rye)	Marion County (2 acres/100 lbs rye)	Scott County (2 acres)
Plants and seeds	$1,560	$1,560	$2,719.50
Fertilizer	320	320	400
Black plastic	240	240	240
Drip lines	285.50	285.50	285
Fertilizer injector	65*	65*	65*
Herbicide	45	60	40
Insecticide	126	126	80
Fungicide	64	64	44
Water	410** (410,000 gal)	410** (410,000 gal)	1,060** (410,250 gal)
Labor	1,660*** (420 hrs)	1,660*** (420 hrs)	1,500*** (236.0 hrs)
Machine	96.40 (14.5 hrs)	96.40 (14.5 hrs)	106.20 (20.0 hrs)
Marketing	2,410.50	2,420.50	4,812.24
Total expenses	7,282.40	7,306.90	11,357.96
Income	12,624.40	12,712.90	8,562.50
Net income (loss)	5,342	5,406	(2789.44)
Net income (loss) /acre	$2,671	$2,703	($1,374.72)
Dollar return/ Dollar input	1.7	1.7	0.9

* Cost amortized over three years.
** Includes cost of water and five-year amortization of irrigation system.
*** Does not include unpaid family labor.

started heading out it began to lose its weed controlling ability, and weeds soon became an issue at both seeding rates.

The mixed vegetable plot in Taylor County used a portion of the plot to look at local marketability of specialty melons (Honey Orange, Napoli, Sancho, Sprite, Golden Beauty, and Serenade). Because the cooperator had grown most of these varieties the previous year, many of the production problems of the previous year were avoided, and all the varieties had good marketable yields except for Serenade. Nearly all Serenade fruit cracked so badly they were essentially unmarketable. It appears that this variety requires less water than the others, but there was no way to isolate that particular variety. The highest market acceptance was for Sprite followed by Golden Beauty and Honey Orange with lesser acceptance for Napoli and Sancho. The melons along with other vegetables from the plot were marketed through the local farmers' market and some local restaurants and stores with very good results. The cooperator also devoted one acre to cantaloupe production for marketing through the Green River Produce Marketing Cooperative. Serious marketing problems at the co-op resulted in a negative return even though the grower had a high yield of good quality melons.

The Bath County plot (data not shown) had to be moved to an isolated area because of water availability issues and was essentially abandoned at the start of harvest because it was all but destroyed by deer, groundhogs, and rabbits. The plots in Madison and Taylor counties were still harvesting well into late October, which was unusually late for the crops they were growing. Nearly all of the late production from the Madison County plots was marketed through an on-farm restaurant (Table 2).

In Scott County, the grower/cooperator grew two acres of bell peppers to be marketed through the Central Kentucky Growers Association. The plot was prepared and transplanted in a timely manner with good early growth and a heavy fruit set, but the very hot and dry conditions that ensued caused the grower to deplete the planned water supply. By the time the grower implemented an alternative water source (i.e., county water), the plot had suffered a good bit of blossom end rot and some sun scald which reduced the potential yield by one-third or more. To compound the production problems, prices for the later harvests were significantly lower than expected which reduced the grower's satisfaction with the crop (Table 1).

Table 2. Mixed vegetable costs and returns of grower/cooperators in central Kentucky, 2005.

	Madison County (1.5 acres)	Taylor County (2 acres)
Plants and seeds	$1,750	$1,175
Fertilizer	160	225
Black plastic	200	240
Drip lines	280	330
Fertilizer injector	65*	65*
Herbicide	12	127.50
Insecticide	36	125
Fungicide	24	160
Water	1,400** (110,000 gal)	420** (280,000 gal)
Labor	6,000*** (1,000.0 hrs)	2,650*** (450.0 hrs)
Machine	99.75 (15.0 hrs)	96.40 (17.5 hrs)
Total expenses	10,026.75	5,613.90
Income	15,000	9,700
Net income	4,973.25	4,086.10
Net income/acre	3,315.50	2,043.05
Dollar return/Dollar input	1.5	1.7

* Cost amortized over three years.
** Includes cost of water and five-year amortization of irrigation system.
*** Does not include unpaid family labor.

On-Farm Commercial Vegetable Demonstrations in South-Central Kentucky with Observations on Seedless Mini-Watermelon Production

Nathan Howell, Department of Horticulture

Introduction

Two on-farm commercial vegetable demonstrations were conducted in south-central Kentucky together with an observation plot to look at the "Super Pollenizer" in mini- or personal-sized seedless watermelon production. Grower/cooperators for the demonstrations were located in Barren and Hart counties. The cooperator in Hart County had a demonstration plot of approximately 0.5 acre consisting of mixed vegetables including tomato, cantaloupe, watermelon, pepper, cabbage, broccoli, okra, zucchini, cucumber, and squash. The cooperator marketed his product through roadside stands, direct marketing to restaurants, and farmers' markets. The demonstration plot in Barren County was approximately 0.75 acre of ornamental gourds. Gourd varieties included both small mixed decorative gourds and large ornamental gourds such as the apple, birdhouse, bottle, snake, swan, and dipper types. These gourds were grown by the demonstrator for replacement of raw gourds that had to be purchased outside of Kentucky in previous years; such gourds will be used for folk art projects for resale.

The Super Pollenizer SP-1 observation plot was located in Todd County and consisted of one acre of personal-sized watermelon with the Super Pollenizer used as a unique pollinator. The cooperator in Todd County marketed melons through the Green River Produce Marketing Cooperative located in Horse Cave, Kentucky. However, cost and return data could not be collected due to a disorder that was found in the personal-sized Mohican variety. The disorder is known as internal rind necrosis; very little is known about this problem, but it is believed to be related to the presence of bacteria and drought stress. This disorder cannot be detected until fruit is actually cut and a brownish area can be seen within the rind area of the melon.

Materials and Methods

Grower/cooperators for the demonstrator plots were provided with black plastic mulch and drip irrigation lines for up to one acre and the use of the University of Kentucky Horticulture Department's equipment for raised-bed preparation and transplanting. For the cooperator participating in the Super Pollenizer SP-1 observation plot, the SP-1 transplants were provided by Syngenta Seeds.

Field preparation was followed by fertilizer application according to soil test results and recommendations provided by the University of Kentucky. Plastic for the demonstrations was laid in April, several weeks before transplanting. The plastic was laid in rows with irrigation runs no longer than 400 feet. Both drip irrigation systems used a city water source.

The Barren and Hart county demonstration cooperators provided their own transplants; local greenhouse managers in the region grew the transplants. Plants were set from May 7 to May 17; three- to four-week-old plants were used for most vegetables. The mixed vegetable plot used spacings of 18-24 inches in single rows and 6 feet between bed centers. The gourd plot in Barren County used a 24-36 inch in-row spacing with 6 feet between the rows. The Super Pollenizer SP-1 plot had unique plant spacings: the seeded personal-sized melons were planted 18 inches apart in the row, with a total plant population of 4800 plants/acre. Once the seeded melons were transplanted, the Super Pollenizer SP1 was hand transplanted between the third and fourth seedless melons in the field; this allowed the SP-1 Pollenizer to be inter-planted at a 3:1 ratio with a total pollinator plant population of 1200 plants per 7200 linear feet of plastic.

After plants were established, insecticides were applied to prevent damage from cucumber beetles and other insects. Imidacloprid, endosulfan, and permethrin were used for cucumber beetle control. Imidacloprid (Admire) was used as a soil drench and was effective for three weeks; the remaining control was achieved by alternating insecticides on a weekly basis until harvest. Almost two weeks after transplanting, Bravo Weather Stick, Mancozeb, and Quadris were applied on the mixed vegetable plot and personal-sized watermelon plot on an alternating weekly schedule for disease control. The demonstrator with the gourd plot could not use Bravo Weather Stick because gourds are not on the label for this product. The University of Kentucky's recommendations from *Vegetable Production Guide for Commercial Growers* (ID-36) were used for insecticides and fungicides. Plants were irrigated/fertigated weekly using 5 to 7 pounds actual nitrogen per week. Harvest for the mixed vegetable plot began in the first part of July and ran until September; the personal-sized watermelon plot was harvested in July. The gourd plot was harvested in September (smaller gourds); the larger gourds were not harvested until after the first fall frost.

Results and Discussion

The 2005 season was very dry throughout; however, the region experienced extreme amounts of rain during harvest season due to the impacts of hurricanes. The dry weather caused many of the plants to have deficiencies in secondary nutrients and micronutrients, and these had to be applied to the crops throughout the year through drip irrigation systems. The two weeks of wet weather caused some fruit loss during harvest due to fruit decay and diseases in the field.

Weed control with ryegrass. Ryegrass was used for the third year this season for weed control; the ryegrass was sown between the plastic mulch middles at a rate of 70 pounds per acre. Once the ryegrass was at the head stage of development, it was sprayed with Poast 1.5 E at a rate of 1.5 pints per acre; additional spot spraying with Round-up was needed in some areas. *This method and seeding rate provided good weed control for the season.*

Gourd production using plasticulture. The ornamental gourd plot was unique in that it was produced on plastic mulch with trickle irrigation. The cooperator had grown gourds on bare ground in previous years, but was very pleased to see yields nearly doubled and tripled for some varieties. The cooperator had been purchasing gourds from numerous states in the past. He thought that the gourds produced on this plot were just as high quality as the out-of-state gourds and that the shells were cleaner and thicker than those he had been purchasing. The production measures used were much like those used for commercial pumpkin production on plastic mulch.

Super Pollenizer SP-1. This observation plot for seedless watermelons was the first time the new SP-1 type plants had been used in the region. Super Pollenizers are a unique pollinator in that they do not compete with seedless watermelons, are earlier flowering than many traditional pollinators, and flower for an extended period during harvest. The Super Pollenizer also produces a small leaf vine that grows over the top of the seedless watermelon vines in the field and produces a very small, distinct fruit that is brittle to the touch. The Super Pollenizer can only be purchased as transplants and are somewhat expensive if not purchased with a Syngenta Seed package that includes a seedless variety such as TRI-X Brand 313 or TRI-X Brand Palomar. If the Super Pollenizer is purchased without seedless watermelon transplants, the cost in 2005 was nearly $500 per thousand; however, if you purchased a seedless watermelon with the Super Pollenizer, the cost including the SP-1 dropped to $380 per thousand.

Bacterial rind necrosis. Unfortunately, the plot's seedless melons (Mohican) were unmarketable due to a condition known as bacterial rind necrosis. Symptoms of the disorder are brown, corky, dry necrotic areas on the interior rind, which rarely extend into the flesh. No external symptoms were noticeable; once a melon was found with the disorder, the entire field was considered unmarketable. The causal organism is believed to be a bacterium (*Erwinia* sp.) that becomes damaging under certain environmental conditions. The only known control to this date is producing less susceptible cultivars. It appears that some of the personal-sized watermelon varieties may for some unknown reason be susceptible to this problem.

Spacings for personal-sized melons. Harvest data were collected on the personal-sized watermelons in spite of the rind necrosis problem. In addition to the SP-1 Super Pollenizer, we tried reduced plant spacings in this plot. Most personal-sized watermelons produced in Kentucky in 2004 were grown at 24 inch in-row spacings with a seeded pollinator planted in every fourth transplant hole. This plot, however, had 18 inch in-row spacings with the Super Pollenizer planted between every third and fourth seedless transplant. The closer spacing was used because in previous years nearly 30% of the seedless melons were too large to be packed as a personal-sized melon. The harvest data collected showed that the 18 inch spacing did reduce fruit size so that only 5% of the harvested fruit was too large to be marketed as personal-sized melons. However, the number of fruit too small to be marketed increased and accounted for 19% of the total harvested fruit. Nevertheless, 76% of the harvested fruit was marketable as personal-sized melons; this was an increase of nearly 6% from previous years.

In my opinion, the Super Pollenizer SP-1 is an excellent choice for pollinating seedless watermelon if growers don't have a market for or don't want to market the larger seeded melons normally used as pollenizers for seedless melons. However, if a producer had to buy SP-1 plants without a seedless watermelon package provided by Syngenta Seeds, I would question the economic impact the cost would have in relation to the expected yield increase. As for plant spacings, in my opinion, the observation plot most likely over-corrected the problem of having too many melons that were too large for personal-sized markets. I believe the 18 inch in-row spacing is superior to the 24 inch. Unlike what we did in the observation plot, however, I feel the pollinator (normal seeded or SP-1) should be planted in every fourth or fifth transplant hole. I feel this would decrease the number of melons that were too large and also decrease the number of fruit that were too small. This possibility deserves further testing in field trials.

Table 1. Costs and returns from on-farm demonstrations of mixed vegetable crops and gourds in Hart and Barren counties, 2005.

Inputs	Hart County Mixed Vegetables (0.5 acre)	Barren County Gourds (0.75 acre)
Transplants	$289	$237
Fertilizer/Lime	40	146
Black plastic	77	119
Drip line	63	98
Herbicides[1]	25	35
Insecticides	20	130
Fungicides	80	88
Pollination	None	free service
Machine[2]	125	175
Irrigation/Water[3]	130	186
Labor[4]	280	320
Market fees	10	25
Total expenses	1139	1559
Income—retail	1535	5500
Net income	396	3941
Net income per acre	$792	$5255
Dollar return/Dollar input	1.35	3.52

[1] Includes cost of annual ryegrass.
[2] Machine rental, fuel and lube, repairs, and depreciation.
[3] Five-year amortization or irrigation system plus city water cost.
[4] All unpaid family labor.

Overall, it was a very productive year for the demonstrators. The Hart and Barren county growers are planning to continue their efforts and expand upon the knowledge gained in the 2005 demonstration plots. The cooperators' costs and returns are listed in Table 1.

On-Farm Commercial Vegetable Demonstrations in Southeastern Kentucky

Bonnie Sigmon, Department of Horticulture

Introduction

In 2005, one on-farm commercial vegetable demonstration was conducted in southeastern Kentucky along with two observation plots. Grower/cooperators were located in Laurel, Rockcastle, and Wayne counties. The grower/cooperator in Laurel County grew an observation plot of approximately one-tenth of an acre of heirloom tomatoes that were marketed through the London-Laurel County Farmers' Market. In Rockcastle County, the grower/cooperator grew a demonstration plot of approximately three acres of minimal-till pumpkins; UK assisted with and collected data from one-quarter acre of this production. The cooperator sold through direct on-farm sales and an agritourism venture consisting of a pumpkin festival with u-pick pumpkins. In Wayne County, the grower/cooperator grew an observational plot of approximately 0.08 acre of seedless miniature watermelons that were marketed through Cumberland Farm Products Farmers' Market.

Materials and Methods

For those cooperators participating in observation plots, only the plastic mulch and mulch laying equipment were provided. Field preparation was followed by a pre-plant fertilizer application according to University of Kentucky soil test results and recommendations. The grower purchased all supplies such as pesticides, fertilizers, and irrigation supplies. Transplants were treated with a starter fertilizer and soil drench of Imidacloprid (Admire 2F) when transplanted.

The grower/cooperators of observational plots followed the University of Kentucky recommendations with alternating insecticides and fungicides when needed, starting after transplanting. Plant irrigation needs were determined by use of tensiometers. Plants were fertigated according to the University of Kentucky recommendations in the *Vegetable Production Guide for Commercial Growers* (ID-36).

The demonstration plot of minimal-till pumpkins began in late fall of 2004 with the seeding of annual ryegrass as a cover crop following sweet corn production in the summer. The ryegrass was harvested in late spring as straw for sale as fall decorations. The field was then sprayed with a contact herbicide to kill any actively growing plant material. The field was then laid off into rows by subsoiling down to about 10 inches with rows 10-12 feet apart. Drive roads were left throughout the field to accommodate the use of an air blast sprayer and wagon rides. The recommended amounts of fertilizer were banded down the rows. The grower/cooperator then removed all but the two center tines on a 5 foot rotary tiller and ran the center of the tiller down the subsoiled rows to break up clods and make a smooth seedbed about 12-14 inches wide. Pumpkins were planted in mid-June with the use of a waterwheel transplanter. The waterwheel was used with a 48 inch wheel and without water. One rider would place two seeds in the dibble that the wheel left in the seedbed while the other rider covered the seeds by hand to a depth of about one inch. After planting, the field was treated with the pre-emergence herbicides Curbit EC and Command 4EC at the recommended rates. The cooperator followed the University of Kentucky's recommended pumpkin spray schedule for fungicide and insecticide applications.

The observation plot and demonstration cooperators each hosted an area field day on their farms. The plasticulture system and farmers' markets were highlighted at the Laurel County Farm Diversification Tour. The minimal tillage pumpkin plot was the focus of a twilight tour with the discussion including disease management, agritourism, and weed control. The miniature seedless watermelon plot was utilized by Cumberland Farm Products as a decision aid for next year's contracted crops and grower recruitment.

Results and Discussion

The 2005 growing season was very hot and dry in southeastern Kentucky. Growers had difficulty controlling fungal diseases due to high humidity and frequent light rainfall of 0.1 to 0.2 inches followed immediately by high temperatures. Nutrient deficiencies became a problem, especially for home garden growers as nutrients were unavailable due to lack of soil moisture. Commercial growers' spray and irrigation applications were often inadequate due to their overconfidence in dry conditions to control disease and their inattention to tensiometers provided.

The minimal tillage pumpkin plot yielded exceptional results considering the amount of rain and the lack of irrigation. The grower/cooperator was able to suppress powdery mildew and downy mildew until the latter part of the growing season. This spared most of the fruit from damage but caused the loss of vines a little early and increased the amount of sunscald problems. Weed control was impressive throughout the growing season. The use of minimal tillage production and the clean field made the u-pick pumpkin operation remarkably profitable for the cooperator. The grower plans to continue this type of production. The grower's cost and returns are listed in Table 1.

Table 1. Minimum tillage pumpkin costs and returns in Rockcastle County, 2005.

Inputs	Costs & Returns/0.25 acre
Seeds	$13.74
Fertilizer	21.76
Insecticide	9.21
Fungicides	83.34
Herbicides	57.89
Machinery[1]	43.19
Labor[2]	45.00
Total expenses	280.13
Total income retail 327 pumpkins @ $2.00	654.00
Net income	373.87
Net income per acre	1,495.48
Dollar Return/Dollar Input	2.33

[1] Machinery depreciation, fuel, lube, and repair.
[2] Does not include grower's labor.

The observation plots were all a success due to the utilization of plasticulture and tensiometers. The plots were used to educate the public about new and available technology for vegetable production in their communities. The plots also increased the grower/cooperators' production above that of traditional production practices. The growers plan to continue and increase this type production in the years to come.

On-Farm Vegetable Demonstrations in Northwestern Kentucky

Nathan Howard, Department of Horticulture

Introduction

Five on-farm vegetable demonstrations were conducted in northwestern Kentucky in 2005. Grower/cooperators were located in Daviess, Ohio, and Breckinridge counties. One grower/cooperator in Daviess County raised 5 acres of bell peppers for the West Kentucky Grower Cooperative in Owensboro. One acre was included in the demonstration program. The other Daviess County grower/cooperator raised 1.6 acres of cucumbers for the cooperative; one acre was also included in the program. The Ohio County grower/cooperator raised 0.33 acre of mixed vegetables. His sales concentrated on the Owensboro Regional Farmers' Market. The Breckinridge County grower/cooperators each had one acre in the demonstration program. One grower/cooperator raised an acre of mixed vegetables for the Breckinridge County Farmers' Market and other wholesale markets. The other grower/cooperator raised 5 acres of bell peppers for the West Kentucky Grower Cooperative. Most of the grower/cooperators had previous production experience in crops such as tobacco and had other enterprises on their farms. All were first-time vegetable growers trying to determine if this enterprise was a good fit for their farming operation.

Materials and Methods

As in previous years, each grower/cooperator was provided with up to an acre of black plastic mulch and drip irrigation lines for production. Also, each grower/cooperator was able to utilize the University of Kentucky Department of Horticulture's plastic mulch layer, waterwheel setter, and plastic mulch lifter. An Extension Associate made weekly visits to the farms to answer questions and address problems the cooperator could be having in the field. County Extension Agents for agriculture and horticulture also assisted in each county to coordinate visits and field days. All cooperators took soil tests and fertilized according to University of Kentucky recommendations. Fungicides were sprayed on a weekly basis for prevention of disease, and fields were scouted using Integrated Pest Management techniques. Insects were controlled using insecticides when populations reached unacceptable levels. Every grower/cooperator irrigated out of a farm pond or well adjacent to the production site.

Results and Discussion

The 2005 growing season was good for growers in the area. Rainfall for the summer was below average, but growers were pleased with the ability to irrigate. Growers using farm ponds did see problems toward the end of July with water levels reaching very low levels. The only significant precipitation throughout the summer came from Hurricane Dennis that brought rain to the area in July. Despite nature's challenges, all grower/cooperators were able to achieve good yields. The first cooperator from Daviess County grew one acre of the cultivar Speedway and was very pleased with his cucumber yields. This grower is a current tobacco grower and wanted to diversify into vegetable production. He was able to build an alliance with two other experienced growers to produce and harvest his crop. His cucumber production gave him a net income of more than $2600/acre (Table 1). The second grower from Daviess County had very little experience in agriculture and wanted to raise 5 acres of bell peppers with his family. He raised the varieties Aristotle and Revolution for co-op sales. The grower had an excellent production season and was one of the top producers in the cooperative, with more than 1300 boxes per acre. Although market prices for bell peppers were average for the season, the co-op had to take adjustments to final pepper prices due to quality issues. The issues centered on peppers being harvested during the week of Hurricane Dennis. The cooperative sold to buyers that found the product unacceptable, and the market price was adjusted accordingly. This led to a net loss for the season for this particular cooperator.

The Ohio County cooperator wanted to try mixed vegetables on a small scale. He was very successful in his production and generated extra farm income from farmers' market sales. Mixed vegetables grown included tomatoes, peppers, and green beans. One grower/cooperator in Breckinridge County raised an acre of mixed vegetables including tomatoes, green beans, squash, watermelons, and sweet corn on plastic. He had a successful production season and was able to generate sales at the local farmers' market; toward the end of the production season, he was also able to make some other wholesale contacts. This grower also ended up posting a net profit for the season. The last grower/cooperator was also located in Breckinridge County. He is an experienced tobacco grower looking to diversify into vegetable production. He raised 5 acres of peppers and contracted to sell them through the West Kentucky Grower Cooperative in Owensboro. One acre was included in the demonstration program. This grower planted his crop a week later than most growers in the cooperative. This held his harvest back a week later as well, and he ended up being a victim of declining pepper prices in late July. Although the fresh market opportunity disappeared, the cooperative negotiated a deal for the growers to sell remaining peppers on the vine for red peppers to a wholesale buyer. This grower/cooperator picked over half of his crop for this wholesale red market. He also had irrigation issues as two ponds he was irrigating out of became low late in the summer. The grower/cooperator had a below-average yield for the summer and a net loss for the season.

All five of the grower/cooperators noticed the benefit that vegetable production on black plastic with drip irrigation made for their crops. They all also learned a lot about marketing opportunities in this area of the state and ways they can make changes in their operations to make them more profitable in the future. Three of the five cooperators express eagerness to grow vegetables in 2006. The other two cooperators do not plan to raise vegetables next year due to other business interests.

Table 1. Costs and returns of five commercial vegetable demonstrations conducted in northwestern Kentucky in 2005.

	Daviess County		Ohio County	Breckinridge County	
Inputs	**Cucumbers (1 acre)**	**Peppers (1 acre)**	**Mixed veg. (0.33 acre)**	**Mixed veg. (1 acre)**	**Peppers (1 acre)**
Plants/seed	$789	$956	$61	$106	$956
Fertilizer/lime	103	230	85	63	87
Black plastic	135	135	40	135	135
Drip lines	145	145	50	145	145
Herbicide	22	96	35	49	67
Insecticide	77	100	17	23	93
Fungicide	93	200	44	38	135
Irrigation/Water[1]	173	1,751	234	156	190
Field labor[2] (193 hrs)	1,541	1,345	0	54	1,063
Machinery	107	150	15	170	123
Bee hives	45	-----	-----	-----	-----
Marketing[3]	1,780	1,187	188	49	273
Co-op labor[4]	3,425	2,678	-----	-----	681
Total yield	1,449 boxes	1,304 boxes	-----	-----	725 boxes
Total expenses	8,435	8,973	769	988	3,948
Income	11,124	7,418	1,425	1,157	2,223
Net income (loss)	2,689	(1,555)	656	169	(1,725)
Net income (loss) per acre	$2,689	($1,555)	$1,968	$169	($1,725)
Dollar return/Dollar input[5]	1.32	0.83	1.85	1.17	0.56

1 Includes the cost of fuel and 5-year amortization of irrigation system.
2 Includes labor paid for field planting, harvesting, and field clean-up; does not include unpaid family labor.
3 16% marketing commission from gross income for cooperative and marketing expenses.
4 Includes cost of packing product at co-op, charge for box, and cooling charge.
5 Dollar return/Dollar input = Income/Total expenses.

On-Farm Commercial Vegetable Demonstrations in Western Kentucky

Joe Williams and Joe Masabni, Department of Horticulture

Introduction

Four on-farm commercial vegetable demonstrations were conducted in western Kentucky. Grower cooperators were located in Lyon and Caldwell counties.

Materials and Methods

The cooperator in Lyon County planted 0.6 acres of mixed vegetables. This included beans, cantaloupe, sweet corn, cucumbers, yellow squash, peppers, pumpkins, tomatoes, and watermelons. There were three cooperators in Caldwell County. One cooperator grew 0.3 acres of tomatoes and watermelons. Another grower in Caldwell County grew 0.2 acres of tomatoes, cantaloupe, and watermelon. The third cooperator in Caldwell County grew 0.6 acres of mixed vegetables. This included beans, beets, cantaloupe, cucumbers, eggplant, yellow and zucchini squash, tomatoes, and watermelons.

As in previous years, the growers were provided with black plastic mulch and drip irrigation lines for up to one acre and the supervised use of University of Kentucky Department of Horticulture equipment for laying plastic mulch and transplanting. Soil samples were taken at each site and tested at the University of Kentucky Research and Education Center located in Princeton. Fertilizer was then applied according to soil test recommendations. The cooperators were responsible for acquiring seeds and transplants. Each cooperator provided labor for spraying, staking, and harvesting. The growers used well and county water. The Extension Associate visited weekly and on an as-needed basis to address the needs of the new growers. The local County Extension Agents also assisted the new cooperators. The Extension agents helped promote and coordinate field days.

All growers followed UK's *Vegetable Production Guide for Commercial Growers* (ID-36) recommendations for cultural practices. Two cooperators used different planting dates to meet early and late market needs. Tomatoes were planted around April 15 and May 15. Fresh market tomato varieties such as Celebrity, Whopper, Goliath, and Parks were grown at all locations. Tomatoes were transplanted into plastic mulch-covered raised beds with drip irrigation. The beds were on 6 ft centers, and transplants were spaced 18 in. apart in the row. Tomatoes were trellised using the Florida weave system with stakes driven every 3 ft.

Watermelons were planted on 6 ft centers in raised beds and spaced 36 in. apart in the row. Crimson Sweet, Stars and Stripes, Independence, and Constitution were the most common watermelon varieties planted. Cantaloupes were planted 24 to 36 in. apart in the row. Athena was the most popular cantaloupe variety.

Results and Discussion

The 2005 growing season proved to be a challenge for most growers. Late frosts and cool spring weather damaged or delayed vegetable plantings. The cool spring was followed by a very hot and dry summer. The extreme heat and drought made vegetable production a challenge, even with irrigation. Growers had to irrigate more than usual because of the extreme heat. Most rainfall was due to tropical storms and hurricanes throughout the summer; when it did rain, it rained entirely too much. Conditions improved during the later half of the summer. August proved to be an excessively wet month in western Kentucky; 11 inches of rain fell in August alone. Given these conditions, many of the earliest plantings were delayed until about the time of second plantings. This led to a flooded wholesale market situation.

The first grower and his family in Caldwell County marketed their mixed vegetables through the farmers' markets in Caldwell and Lyon counties. They managed to sell all their produce at retail prices. To their surprise, eggplant was one of the best sellers. Weed control was their biggest problem. Even with herbicide application, weed pressure was high. The weed pressure did not affect yield but made harvest difficult. The grower was pleased with the income and plans to continue growing vegetables.

The second grower in Caldwell County grew tomatoes, cantaloupes, and watermelons. The grower marketed his produce at the Caldwell County Farmers' Market and directly from his farm. Yields were outstanding. The vegetables grown on plastic beds with trickle irrigation exceeded his expectations. The grower saw profit after only his first week selling. The cooperator is pleased with his success and plans to expand next year.

The third cooperator in Caldwell County grew tomatoes and watermelons. The yields were exceptional. The cooperator marketed his vegetables direct from his farm, at local stores, and through the Fairview Produce Auction. The grower experienced problems marketing his vegetables due to a saturated market. Even with the flooded market, the cooperator saw acceptable returns. The grower realized the importance of planting time and plans to plant earlier to avoid selling during the main harvest season.

The grower in Lyon County grew beans, cantaloupe, sweet corn, cucumber, pepper, pumpkin, tomato, and watermelon. The cooperator had some of the earliest tomatoes around. He experienced a heavy frost two days after transplanting and had to take measures to save his crop. Even with the cool weather, he was harvesting tomatoes within a week of the projected harvest date. The grower marketed his produce through the Lake Barkley Farmers' Market and wholesale to local restaurants and groceries. The cooperator experienced heavy tomato losses due to blossom end rot because of inconsistent moisture. A more consistent supply of moisture along with supplemental fertigated calcium curtailed the problem. Late blight was also seen in his tomatoes. The cooperator was satisfied with the returns in spite of the difficulties encountered.

The cooperators' major concerns this year were weed control, disease control, and timeliness of planting. Even with herbicide application, weed control was difficult. Most cooperators experienced satisfactory weed control early in the season. Weed pressure was a problem toward the later half of the season. Another concern this year was disease control. The cooperators were interested in better ways to apply fungicides. None of the cooperators had sprayers that were set up to spray fungicides correctly. They plan to have larger spray equipment in the future. Timeliness of planting was another concern to new growers. The cooperators realized the importance of planting early and the importance of staggering plantings of crops like tomato, cantaloupe and watermelon. Despite difficult growing conditions, these western Kentucky vegetable growers considered the 2005 season a success. Costs and returns for the four vegetable crop demonstrations are shown in Table 1.

Table 1. Expenses, income, and net income for four vegetable cooperators in western Kentucky, 2005.

Inputs	Caldwell County (0.6 acre)	Caldwell County (0.2 acre)	Caldwell County (0.3 acre)	Lyon County (0.6 acre)
Plants	$168	$242	$10	$416
Fertilizer/Lime	110	46	7	159
Black plastic	99	26	45	99
Drip lines	95	25	42	95
Fertilizer injector[1]	---	---	35	17
Herbicide[2]	---	40	3	100
Insecticide	102	50	---	14
Fungicide	---	18	11	68
Water[3]	---	20	15	24
Labor[4]	(500 hrs)	(60 hrs)	(60 hrs)	(500 hrs)
Machine ($6/hr)	60	36	36	60
Marketing	20	---	12	50
Misc. expense	223	6	---	206
Total expense	877	509	216	1308
Income	5,000	1,250	585	3442
Net income (Loss)	4,123	741	369	2134
Net income (Loss) per acre	$6,872	$3,705	$1,230	$3,557
Dollar return/ Dollar input	5.7	2.5	2.7	1.6

1 Fertilizer injector amortized over three years.
2 Does not include herbicide treatment provided by the University of Kentucky.
3 Includes fuel and irrigation supplies amortized over three years.
4 Labor cost was not included with the expenses as it consisted of unpaid family and personal labor.

Enology Extension Overview

Tom Cottrell, Department of Horticulture

A new enology Extension program began in Kentucky in 2005. Enology Extension is disseminating information on sound winemaking practices and on producing sound wines from grapes selected for specific trials.

The winemaking focus is on the accurate measurement of pH and of free sulfur dioxide (SO_2). "Free" form SO_2 is what keeps microbes under control and prevents premature oxidation. The "free SO_2" effectiveness is dependent on the wine pH. Since the free SO_2 concentration gradually decreases all the time and the pH can vary, both need to be checked often.

Making wine from selected grapes. Nine lots of wine were made from 'Traminette' grapes harvested from vines having three levels of pruning: normal crop, heavy crop, and very heavy crop. Each group was subjected to three different processing regimens: immediate pressing of the crushed grapes, 6-hour cold soak (holding the crushed grapes at cool temperature) prior to pressing, and 12-hour cold soak prior to pressing. We will measure the total phenolics of the finished wines.

Twenty-nine other wine lots were mostly made from Eastern European varieties planted at the Research and Education Center in Princeton, Kentucky, while some were from well-known varieties grown on the same farm. In January, taste panels will evaluate the Eastern European wines for viability in the market, assess the quality of the production of the better-known varieties, and identify any differences in the Traminette samples.

Mapping Grape Growing Regions for Kentucky

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Introduction

The renewed interest in Kentucky viticulture has made it necessary to identify viticultural regions within the state. Kentucky vineyards are exposed to biotic and abiotic stresses that reduce crop yields and quality or kill grapevines. Damaging winter temperatures, spring frosts, and higher than optimal growing season temperatures occur regularly within the state. Despite these challenges, viticulture can be a successful enterprise in many areas of the state. Due to the relative youth of the industry in Kentucky, much of the terrain remains uncharted for viticultural purposes. The objectives of this study were to identify grape growing regions based on growing degree day accumulation and frost-free days (length of growing season) based on historical climate data and topography.

Materials and Methods

The data used in calculating growing degree day summation (GDD, 50°F base) and frost-free days (FFD, 32°F base) were obtained from the Office of the Kentucky State Climatologist. For both data sets, a relational database (RDba) was created by assigning an index number to each of the weather stations. The RDba was summarized in SAS by creating means for each of the weather stations throughout the span of the years included in the set. The RDba was then linked to a data set containing the latitude, longitude, and elevation of each weather station.

The weather station data for GDD and FFD were fitted to a tri-variate smoothing spline in ArcGIS 8.2. (ESRI Inst., Redlands, CA). The data were fitted to equi-samples comprised of the three-dimensional latitude, longitude, and elevation values. The degree of data smoothing imposed by the procedure was optimized to minimize the predicted error of the fitted spline, as assessed by the generalized cross validation (GCV). The GCV is calculated by systematically calculating the residual of each data point, as it is withheld from the fitting procedure, and then adding a suitably normalized sum of the squares of these residuals. This is a reliable, intuitively direct assessment of the predictive error (Wahba, 1990, Hutchinson and Gessler, 1994). The surfaces created by the tri-variate spline fitting of weather data were then clipped (an intersection procedure in GIS that uses the political boundaries as a template over the surfaces created) using the political county boundary projections for both weather variables.

Results and Discussion

Growing Degree Days (GDD). Grape growing regions based on growing degree days (Amerine and Winkler, 1944) are presented in Table 1 and Figure 1. The GDD summation between 1 April and 31 October has been used to predict a vine's ability to mature a high quality crop in the northern hemisphere (Amerine and Winkler, 1944). Therefore, vineyard suitability must adhere to the baseline heat unit accumulation to ensure sufficient crop maturity (Wolf, 2003). The Amerine and Winkler GDD summation divides a given area into five regions based on the GDD summation. Region I is characterized as regions accumulating less than 2500°F, region II accumulating between 2501°F and 3000°F GDD, region III between 3001°F to 3500°F GDD, region IV between 3501°F GDD to

Table 1. Grape growing regions based on Growing Degree Days (Amerine and Winkler, 1944).

Region	Growing Degree Days	Suggested Varieties
I	≤2,500	Early ripening varieties to achieve high quality
II	2,501 – 3,000	Early and mid-season table wine varieties
III	3,001 – 3,500	High yield of standard to good quality wines
IV	3,501 – 4,000	High yield, but wine quality is only acceptable
V	≥ 4,000	High production of late-season wine and table varieties for bulk production

4000°F GDD, and region V more than 4000°F GDD. In Kentucky, there are no areas that fall within Region I or Region II; eastern Kentucky falls into Region III (Figure 1). For this region, high yields of standard to good quality table wines can be expected. The majority of the Bluegrass region, southern Kentucky, and portions of western Kentucky fall into the Region IV designation. In these areas, high yields and acceptable wine quality are expected from suitable cultivars. The majority of western Kentucky falls within the Region V designation.

Figure 1. Grape growing regions based on growing degree days (50°F base).

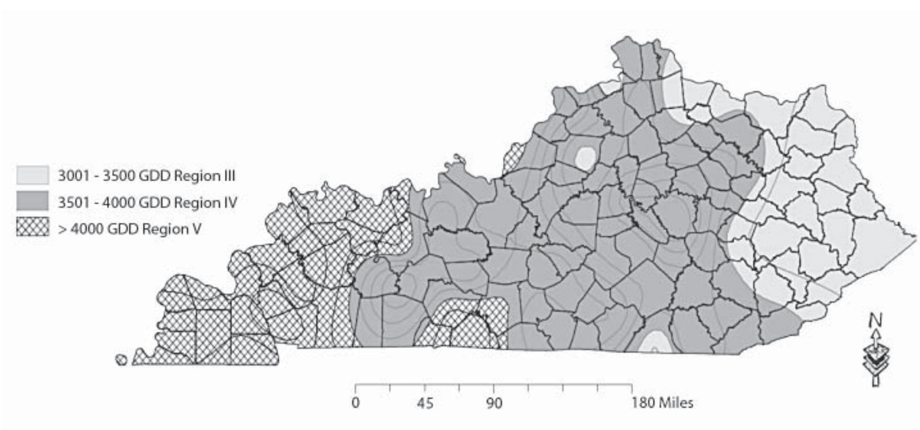
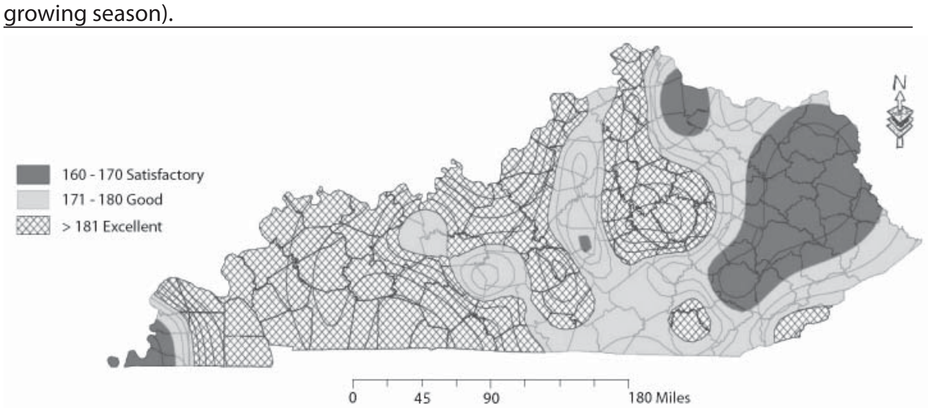


Figure 2. Grape growing regions based on the number of frost-free days (>32ºF, length of growing season).



Frost-Free Days (FFD). The length of the growing season (FFD) is more limiting to viticulture than GDD accumulation. The FFD actually determines ecological boundaries of sustainable viticulture. The majority of the state has more than 180 FFD, which is deemed "Excellent" for growing most varieties recommended for the Midwest (Figure 2). Portions of the Bluegrass region, however, have between 171-180 FFD. This corresponds to a "Good" designation, where early, mid-season, and some late-season varieties for the Midwest can be grown successfully (Figure 2). Portions of northern Kentucky and the most westerly counties have 160 to 170 FFD which is deemed "Satisfactory." For these regions, the early and most mid-season maturing varieties are recommended.

However, site selection should not be based on just these macroclimate maps, as most grape cultivars that can be grown with economic success in Kentucky are site-specific. Frequent occurrence of critical winter temperatures (-8°F for *vinifera*, -15°F for French American hybrids) is the limiting factor for expansion of viticulture in the lower Midwest. A more detailed analysis of any proposed vineyard site at the mesoclimate level is required. The mesoclimate of any site would be affected by the topography (relative elevation, slope, aspect) and the soil's chemical and physical properties. This report identifies the state's grape growing regions based on the GDD accumulation and the length of the growing season. These are determining factors for the types and quality of wines that can be expected within a given climate.

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2000 Wine Grape Cultivar Trial

Joe Masabni, S. Kaan Kurtural, Dwight Wolfe, Brandon O'Daniel, Chris Smigell, June Johnston, and Hilda Rogers, Department of Horticulture

Introduction

There is increasing interest in growing grapes for wine production in Kentucky. Grapes have the potential for high income if planted on suitable sites. Grape growers need varieties that are adapted to Kentucky's varied climates, are capable of sustainable yields, and have optimum fruit composition.

There are three types of wine grapes grown in the lower Midwestern United States: American (*Vitis labrusca, Vitis aestivalis*), European (*Vitis vinifera*), and interspecific hybrids. The majority of the wine from Europe and the West Coast of the United States is made from European grapes. Generally, European grapes are not adapted to Kentucky's environment. On the other hand, American grapes grow well, but the wine is usually not on par with European wines, and their per-acre net incomes are low. Many interspecific hybrids grow well, and wine quality is similar to those of the *vinifera* parents, with high net per-acre income.

The objectives of this project are to evaluate eight wine grape cultivars grown in different regions of the United States for their adaptability to Kentucky and to establish a baseline of performance by which other wine grape cultivars may be compared.

Material and Methods

Eight cultivars were planted in the spring of 2000 at the University of Kentucky Research and Education Center, Princeton, Kentucky. These included two American cultivars ('Niagara' and 'Norton'), two interspecific hybrids ('Chambourcin' and 'Vidal blanc'), one recently released interspecific hybrid ('Traminette'), and three *vinifera* selections ('Cabernet Franc,' 'Pinot Noir,' and 'Chardonnay'). The vines were planted 8 ft apart in rows 16 ft apart (340 vines•acre^{-1}) with the rows oriented north-south. The American cultivars and the interspecific hybrids were trained to a single high-wire bilateral cordon and the *vinifera* to vertically shoot positioned (VSP) training systems. The eight cultivars were arranged in a randomized complete block with six replications where three vines constitute an experimental unit.

We report pruning weights (referred to hereafter as "vine size"), yield components, fruit composition, and canopy light relations measurements collected during the 2005 growing season. Yield per vine, crop level (number of clusters per vine), cluster weight, and tons per acre are reported for yield components. Total soluble solids (TSS), juice pH, titratable acidity (TA), berry weight, and number of berries per cluster are reported for fruit composition. The TA of each sample was determined by titrating to pH 8.2 with 0.1 *N* sodium hydroxide; and expressed as g·L^{-1} tartaric acid. The canopy light relations were measured with a hand-held ceptometer at the onset of veraison on the same date for all cultivars. The ratio of sunlight intercepted within the fruit zone (60 in. above the ground for the singe high-wire bilateral cordon, 38 in. above the ground for the VSP grapevines) is reported.

Results and Discussion

The vine size (pruning weight per foot of row) is an indicator of vine balance. The optimum vine size is between 0.2 to 0.4 pounds per foot of row. The 'Cabernet Franc' and 'Pinot Noir' had the largest vine size of all cultivars tested (Table 1). The interspecific and American cultivars that have the propensity to overcrop, 'Chambourcin,' Vidal blanc' and 'Niagara,' respectively, had the lowest vine size in 2005. The 'Cabernet Franc,' 'Pinot Noir,' 'Traminette,' 'Chardonnay,' 'Norton,' and 'Niagara' had optimum vine sizes in response to 2004 crop levels. The 'Chambourcin,' and 'Vidal blanc' had vine sizes of less than 0.2 pounds per foot of row, indicating that they were overcropped in 2004. The number of nodes retained per vine and per foot of row was influenced by using balanced pruning formulae in 2005. In response to the vine size measured during the dormant season pruning, 'Cabernet Franc' and 'Pinot Noir' had the highest number of nodes retained per vine, respectively (Table 1). The 'Vidal blanc' and the 'Chambourcin' had the lowest number of nodes retained per vine in 2005.

The 'Cabernet Franc' and the 'Pinot Noir' had the most clusters per vine in 2005 in response to the high number of nodes retained per vine (Table 2). Even though there were more nodes retained, and thus more clusters per vine on 'Cabernet Franc' and 'Pinot

Table 1. Pruning weight and number of nodes retained in 2005 from the 2000 wine grape cultivar trial at the UKREC, Princeton, Ky.

Cultivar[1]	Pruning Weight per Vine (lb)	Pruning Weight per Foot of Row	Number of Nodes Retained	Number of Nodes Retained per Foot of Row
Vidal blanc	1.4 de	0.18 cd	19 d	2.4 d
Niagara	1.7 cde	0.21 cd	32 cd	4.0 cd
Chardonnay	2.2 bc	0.28 bc	49 ab	6.2 ab
Traminette	2.8 ab	0.35 ab	38 bc	4.8 bc
Pinot Noir	3.1 a	0.38 a	61 a	7.6 a
Cabernet Franc	3.1 a	0.39 a	63 a	7.8 a
Chambourcin	1.3 e	0.16 d	22 d	2.7 d
Norton	2.1 bcd	0.27 bc	40 bc	5.0 bc
p <	0.0001	0.0001	0.0001	0.0001

[1] Numbers followed by the same letters within columns are not statistically different according to Duncan's Multiple Range Test at p<0.005.

Table 2. Yield components for 2005 from the 2000 wine grape cultivar trial at the UKREC, Princeton, Ky.

Cultivar[1]	Clusters per Vine	Yield per Vine (lb)	Cluster Weight (g)	Yield (tons/a)[2]
Vidal blanc	94 bc	43.4 a	209 a	7.4 a
Niagara	82 cd	38.1 a	152 b	4.7 b
Chardonnay	83 cd	24.4 b	137 bc	4.2 b
Traminette	72 cd	24.1 b	154 b	4.1 b
Pinot Noir	112 b	22.4 b	90 d	3.8 b
Cabernet Franc	135 a	38.1 a	128 c	6.5 a
Chambourcin	63 d	28.5 b	202 a	4.8 b
Norton	81 cd	13.4 c	74 d	2.3 c
p <	0.0001	0.0001	0.0001	0.0001

[1] Numbers followed by the same letters within columns are not statistically different according to Duncan's Multiple Range Test at p<0.005.
[2] Based on 8 ft x 16 ft vine spacing, equal to 340 vines/A.

Noir,' their yields were less than those of the interspecific hybrids in 2005. The influence of cluster weight on total yield is evident, where the low cluster weight (an indicator of overcropping) for 'Pinot Noir' resulted in far less overall yield. 'Vidal blanc' yielded the most fruit. 'Vidal blanc' and 'Chambourcin' had the highest cluster weights in 2005, with 'Norton' and 'Pinot Noir' having the lowest cluster weights.

The 'Chambourcin' had the most desirable fruit composition values in 2005 (Table 3). Its TSS, juice pH, and TA were desirable from a wine-making point of view. This is in response to the percent light intercepted within the fruit zone; 'Chambourcin' grapevines had the highest percentage in the study (Table 3). Other cultivars of note in 2005 for fruit composition values were 'Vidal blanc' and 'Traminette,' where fruit composition values reached near optimum values with far less percent light interception compared to 'Chambourcin.' The high TA values measured in 'Norton,' 'Chardonnay,' and 'Niagara' indicate a canopy shading response in 2005. The individual berry weights and the number of berries per cluster (Table 3) indicate that berry set was optimum in 'Vidal blanc,' 'Chambourcin,' 'Niagara,' and 'Traminette.' The low number of berries set per cluster is in response to increased number of nodes retained and therefore the increased canopy shading during fruit set in 2005.

Table 3. Fruit composition for 2005 from the 2000 wine grape cultivar trial at the UKREC, Princeton, Ky.

Cultivar	TSS[1,2]	Juice pH	TA[3] (g/l)	Berry Weight (g)	Berries per Cluster	% Light[4] Interception
Vidal blanc	20.2 ab	3.57 c	8.3 abc	1.7 bc	211 a	9.6 b
Niagara	17.1 c	3.31d	9.3 abc	3.7 a	153 ab	7.2 b
Chardonnay	19.0 bc	3.64 c	10.0 ab	1.6 bc	124 bcd	3.0 b
Traminette	20.9 ab	3.62 c	8.8 ab	1.6 bc	152 ab	9.1 b
Pinot Noir	21.1 ab	4.08 a	7.2 bc	1.1 c	89 cd	6.7 b
Cabernet Franc	19.0 bc	3.86 b	7.8 c	1.7 bc	135 bc	3.4 b
Chambourcin	21.5 a	3.47 cd	8.3 abc	2.3 b	199 a	17.1 a
Norton	19.7 ab	3.49 c	10.8 a	1.2 bc	72 d	9.5 b
p <	0.0076	0.0001	0.0222	0.0002	0.0002	0.0083

1 Numbers followed by the same letters within columns are not statistically different according to Duncan's Multiple Range Test at p<0.005.
2 TSS = Total soluble solids measured as degrees Brix.
3 TA = Titratable acidity measured as grams of tartaric acid in liter of juice.
4 % light interception measured at the onset of veraison within the fruit zone and is the ratio of ambient sunlight to the sunlight intercepted within the fruit zone.

In 2005, 'Traminette' was the best performer at the UKREC, Princeton, Kentucky, location even though it did not have the highest yield per acre, nor the highest fruit composition values. The other interspecific cultivars will need more intense canopy management such as shoot and cluster thinning. It is evident that 'Norton' performs poorly on a single high-wire bilateral cordon system where berry set is reduced due to mutual shading. The European cultivars in this study need training system improvements, such as post extenders to increase the canopy height, thus increasing exposed leaf area. These varieties also need detailed canopy management, such as shoot thinning, to improve berry set. Before any recommendations can be made from this study, sustainable yield data correlated to cold-hardiness and fruit composition need to be generated.

Evaluation of Eastern European Wine Grape Cultivars for Kentucky

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Introduction

Interest in producing grapes for wine in Kentucky has increased dramatically as the number of wineries has increased from 6 in 1997 to 24 in 2005. This was partially due to the cost-share program initiated by the Grape Industry Advisory Committee to help tobacco growers diversify their operations into other crops.

There are four types of grapes grown in the United States for wine: American (*Vitis labrusca*), Muscadine (*Vitis rotundifolia*), European (*Vitis vinifera*), and American French hybrids (*Vitis labrusca* x *V. vinifera*). Generally, Muscadine grapes are not well adapted to Kentucky's climate, and European grapes can survive Kentucky weather only with extra care in vine management. American grapes grow well, but fruit quality for wine is usually substandard. Many American French hybrids grow well, and fruit quality for wine is intermediate between the American and French parents. The majority of wines from Europe and the West Coast of the United States are made from European grapes.

European grapes are not well suited for the cold climate of northern Europe. Vines are usually buried with soil or mulch to prevent winter injury, a very labor-intensive operation. Northern Europeans have crossed the *vinifera* with different *Vitis* species, including some from China. The resulting cultivars have shown improved hardiness as well as outstanding fruit quality in Eastern Europe. The late Dr. Bob Goodman of the University of Missouri evaluated these cultivars in Eastern Europe and selected several, based on winter hardiness, disease resistance, and fruit quality. These selections were brought to the U.S. and grown in Missouri under post-entry quarantine. In 1998, the first of these selections were distributed to selected land-grant institutions in the U.S., including the University of Kentucky. This project is being conducted in cooperation with the Missouri State Fruit Experiment Station of Southern Missouri State University, Mountain Grove, Missouri.

The objective of the project is to evaluate these selections in different regions of the U.S. To participate in this project, the University of Kentucky signed an agreement specifying that no one could collect bud wood from this planting.

Material and Methods

Eighteen advanced selections were released from post-entry quarantine in the spring of 1998 and planted at the University of Kentucky Research and Education Center, Princeton, Kentucky (UKREC). The vines were set 8 ft within rows spaced 12 ft apart. The planting stock was small potted cuttings. These were trained to two leaders and tied to 5 ft bamboo canes during the first year. During the second year, vines were trained to a high bilateral cordon system. The planting is trickle irrigated, and a 4 ft wide herbicide strip is maintained beneath the vines with mowed sod alleyways. The vines were balance pruned according to the previous year's yields. When balance pruning, the number of buds left on a vine is determined by the vine vigor and growth in the previous season as measured by the weight of the wood removed.

Beginning in 2000, the yield, cluster weight, berry weight, pH, and Brix (% soluble solids) were recorded for each selection. The harvested grapes were then distributed to cooperating wine makers, and the quality of the wines produced from these selections was evaluated beginning in 2001. Wines collected from these wine makers are all stored on their sides in constant darkness at 55°F. The American Wine Society evaluation form was used. Each white wine vintage is evaluated at one and two years after harvest; the red wine vintages will be evaluated at one through five years after harvest. Vintages that do not rate well are omitted from future evaluations.

During the spring of 2001, an additional advanced selection of nine varieties was released from post-entry quarantine and planted at UKREC. The planting was established in an area previously used for a high density apple planting. The remaining end posts were left in place and used for the grape trellising. Consequently, vines were spaced 8 ft apart in rows 16 ft apart. Other aspects of planting and training were similar to those of the 1998 planting described above. A number of the vines were killed during a late spring freeze. The surviving plants were trained to two trunks and tied to 5 ft bamboo canes during the first year. Vines were not balance-pruned in 2003 because they did not have a crop in the previous season due to their poor growth after the late spring freeze.

Beginning in 2003, the same yield and berry measurements were recorded, and wines were made, as described for the vines planted in 1998.

Results and Discussion

Yield and fruit quality components for grapes harvested in 2004 and 2005 are listed in Tables 1 and 2 (1998 planting). In 2005, the varieties Iskorka, Liza, Petra, Rani Riesling, I-31/67, and M-39-9/74 were dropped from the project due to mediocre wine quality or poor vine growth. This planting is eight years old. Nearly all varieties harvested this year yielded acceptably, with a range of 4.6 tons/A to 10.9 tons/A. Interestingly, the three lowest yielding varieties have ranked among the best in the wine evaluations.

Yield and fruit quality components for the 2005 harvest of the 2001 planting are listed in Table 3. These vines are in their fifth year and have been slow to produce economically viable yields. In 2004, only Bromariu and II 70/20 produced more than one ton per acre. This year their yields increased to 4.6 and 4.8 tons/A, respectively. Demetra, IR 26/5, Plai, and L4-9-18 also had yields of more than one ton/A this year. Wine was made from only Demetra, Nero, and II 70/20 in 2003. In 2004 Golubok, II 70/20, Bromariu, and Ir 26/5 yielded enough to make wines. This year, eight of the nine (Golubok excluded) yielded enough to make wines.

Table 4 compares the fruit yields, % soluble solids, and pH for years 2003-2005 from the 1998 planting and for years 2004 and 2005 from the 2001 planting. Malverina, Toldi, and Rubin Tairovski averaged the highest yields for the last three years. Fruit sugar content averaged 19, 20, and 19 for the years 2003, 2004, and 2005, respectively. The average fruit pH at harvest was 3.2, 3.4, and 3.3, for 2003, 2004, and 2005, respectively.

Table 5 lists all the white wine tasting results. The 2000 vintage whites were tasted in 2001 and 2002, the 2001 vintages were tasted in 2002 and 2004, the 2002 vintages were tasted in 2004 and 2005, and the 2003 vintages in 2005. Table 6 lists all the red wine tasting results. The 2000 vintage wines were tasted in 2001, 2002, 2004, and 2005, and the 2001 vintages were tasted in 2002, 2004, and 2005. The 2002 vintages were tasted in 2004 and 2005, and the 2003 vintages in 2005. Members of the Kentucky Vineyard Society evaluated the wines. Average ratings for each wine are listed as well as the range of ratings between tasters and the comments from the most recent tasting. Comments for previous tasting evaluations are found in last year's report.

Table 7 summarizes the wine evaluations. The two French-American hybrid wine standards, Chambourcin and Vidal blanc, and the American Norton standard have received the highest average cumulative ratings so far. They have been included for comparison as they are some of the better non-*vinifera* grapes grown in Kentucky. They are followed by 34-4-49, Laurot, XIV-186, Malverina, Kozma 55, and Kozma 525. In this year's evaluation, the three highest rated white wines were of the 2003 vintage (Seyval [hybrid standard],

Table 1. 2004 yield and fruit quality results from the 1998 Eastern European wine grape cultivar trial at UKREC, Princeton, Ky.

Cultivar[1]	Harvest Date	Number of Vines	Pruning Wt/Vine (lbs)	Yield (T/A)[2]	Cluster Weight (g)	Berry Weight (g)	Soluble Solids (%)	pH
Rubin Tairovski	8-18	15	0.9	3.8	161	1.4	22	3.3
Malverina	9-8	11	2.2	3.7	277	2.2	19	3.4
Toldi	9-7	14	1.7	3.5	293	3.7	18	3.5
Liza	9-8	11	2.0	2.9	213	1.2	21	3.3
XIV-1-86	8-18	13	1.5	2.8	161	2.1	20	3.5
Bianca	8-9	30	1.1	2.7	153	2.2	20	3.3
34-4-49	9-8	14	0.5	2.3	258	1.2	19	3.3
XX-15-51	7-28	15	0.9	2.3	230	1.2	20	3.3
Rani Riesling	8-26	14	1.6	2.0	127	1.8	21	3.4
XIV-11-57	9-8	14	1.6	1.9	230	1.2	18	3.4
Kozma 55	8-18	26	0.3	1.5	91	1.4	21	3.5
I 31/67	7-28	12	0.3	1.4	300	2.0	16	3.3
Kozma 525	9-8	14	1.6	1.1	314	2.0	20	3.5
M39-9/74	9-8	14	1.5	0.9	282	2.5	19	3.4
Laurot	9-8	12	0.7	0.8	155	1.3	19	3.3
Petra	8-9	13	0.7	0.5	135	1.1	21	3.3
Iskorka	7-28	14	0.3	0.3	197	1.8	19	3.3

1 Cultivars are arranged in descending order of yield.
2 Tons per acre, calculated based on an 8 x 12 ft. vine spacing, equivalent to 454 vines per acre.

Malverina, 34-4-49). The Malverina and 34-4-49 were also among the three highest rated whites last year. The three highest rated reds were the 2002 Norton, the 2003 II 70/20, and the 2003 Laurot. Last year, the same Norton and the 2002 Laurot were among the highest rated reds. Most red wines have received lower ratings as they have aged.

After three evaluations, the four highest rated white wines are 34-4-49, XIV-186, Malverina, and Vidal blanc (Table 7). The four highest rated red wines are Norton, Chambourcin, Laurot, and Kozma 55 (Table 7). Most of the top-ranked wines are the same as in last year's report. The XX-15-51 and Kozma 525 dropped out of the top rankings. Both bottles of 2003 XX-15-51 rated under 7 this year. The 2000, 2001, and 2002 Kozma 525 vintages all rated lower than in last year's evaluation. Their cumulative average was 10.7 in last year's tasting but only 6.8 in this year's evaluation.

The individuals who made these wines and some professional winemakers feel that some of these varieties could make decent wines or at least good blenders.

Acknowledgments

The authors would like to express their appreciation for all the help that they received in this study from the many Kentucky Vineyard Society members who cooperated in making and evaluating these wines.

Table 2. 2005 yield and fruit quality results from the 1998 Eastern European wine grape cultivar trial at UKREC, Princeton, Ky.

Cultivar[1]	Harvest Date	Number of Vines	Pruning Wt/Vine (lbs)	Yield (T/A)[2]	Cluster Weight (g)	Berry Weight (g)	Soluble Solids (%)	pH
Toldi	9-7	15	1.8	10.9	360	3.2	18	3.3
Rubin Tairovski	9-20	5	3.4	10.7	382	1.6	21	3.3
Malverina	8-29	11	2.8	9.0	280	1.9	17	3.3
Bianca	8-18	15	2.7	6.5	118	1.1	18	3.3
XIV-11-57	9-21	5	2.3	6.4	260	0.9	19	3.3
XIV-1-86	8-18	10	2.1	6.2	184	1.4	17	3.3
XX-15-51	8-18	15	1.3	5.3	212	1.1	21	3.5
34-4-49	9-28	13	1.0	5.1	274	1.3	18	3.1
Kozma 55	8-31	16	1.5	4.6	145	1.3	18	3.4
Laurot	9-14	15	2.3	3.8	190	1.0	21	3.1
Kozma 525	9-21	13	3.5	2.8	265	1.8	17	3.2

1 Cultivars are arranged in descending order of yield.
2 Tons per acre, calculated based on an 8 x 12 ft. vine spacing, equivalent to 454 vines per acre.

Table 3. 2005 yield and fruit quality results from the 2001 Eastern European wine grape cultivar trial at UKREC, Princeton, Ky.

Cultivar[1]	Harvest Date	Number of Vines	Pruning Wt/Vine (lbs)	Yield (T/A)[2]	Cluster Weight (g)	Berry Weight (g)	Soluble Solids (%)	pH
II 70/20	9-6	11	1.1	4.8	191	2.6	18	3.4
Bromariu	9-12	9	1.2	4.6	247	1.7	21	3.4
Demetra	8-23	6	1.7	4.3	182	1.3	19	3.4
Ir 26/5	9-1	9	1.0	4.1	133	1.2	17	3.3
Plai	8-29	8	1.3	3.3	174	1.6	20	3.5
L4-9-18	9-14	11	0.3	2.0	227	1.0	22	3.2
I 55/8	8-18	11	0.3	1.9	309	1.4	21	3.4
Nero	7-27	8	0.8	0.4	97	1.3	20	3.2
Golubok	7-27	10	0.3	0.1	–[3]	–[3]	–[3]	–[3]

1 Cultivars are arranged in descending order of yield.
2 Tons per acre, calculated based on an 8 x 16 ft. vine spacing, equivalent to 340 vines per acre.
3 Crop size was insufficient to obtain representative samples.

Table 4. Yield summary, 2003-2005.

	Yield (T/A)[1]				Soluble Solids (%)				pH			
Cultivar	2003	2004	2005	Avg	2003	2004	2005	Avg	2003	2004	2005	Avg
Whites												
Bianca	8.1	2.7	6.5	5.8	18	20	18	19	3.1	3.3	3.3	3.2
Bromariu	–[2]	1.4	4.6	3.0	-	21	21	21	-	3.5	3.4	3.5
Iskorka	1.5	0.3	-	0.9	22	19	-	21	3.4	3.3	-	3.4
Liza	6.2	2.9	-	4.6	21	21	-	21	3.3	3.3	-	3.3
Malverina	9.7	3.7	9.0	7.5	19	19	17	18	3.2	3.4	3.3	3.3
Petra	1.6	0.5	-	1.1	21	21	-	21	3.3	3.3	-	3.3
Rani Riesling	10.3	1.9	-	6.1	18	21	-	20	3.2	3.4	-	3.3
Toldi	10.5	3.5	10.9	8.3	16	19	18	18	3.1	3.5	3.3	3.3
XIV-1-86	5.1	2.8	6.2	4.7	17	20	17	18	3.3	3.5	3.3	3.4
XX-15-51	6.1	2.3	5.3	4.6	18	20	21	20	3.2	3.3	3.5	3.3
34-4-49	4.9	2.3	5.1	4.1	20	19	18	19	3.2	3.3	3.1	3.2
Reds												
Golubok	-	0.2	0.1	0.2	-	18	-	18	-	3.4	-	3.4
Demetra	-	-	4.3	4.3	-	-	19	19	-	-	3.4	3.4
Kozma 55	3.5	1.5	4.6	3.2	19	21	18	19	3.2	3.5	3.4	3.4
Kozma 525	6.1	1.1	2.8	3.3	19	20	17	19	3.3	3.5	3.2	3.3
Laurot	6.2	0.8	3.8	3.6	19	19	21	20	3.2	3.3	3.1	3.2
Nero	-	0.1	0.4	0.3	-	18	20	19	-	3.3	3.2	3.3
Plai	-	-	3.3	3.3	-	-	20	20	-	-	3.5	3.5
Rubin Tairovski	10.3	3.8	10.7	8.3	20	22	21	21	3.4	3.3	3.3	3.3
II 70/20	-	2.3	4.8	3.6	-	20	18	19	-	3.4	3.4	3.4
Ir 26/5	-	0.8	4.1	2.5	-	21	17	19	-	3.3	3.3	3.3
I 31/67	3.5	1.4	-	2.5	17	16	-	17	3.2	3.3	-	3.3
I 55/8	-	0.5	1.9	1.2	-	17	21	19	-	2.9	3.4	3.2
L 4-9-18	-	-	2.0	2.0	-	-	22	22	-	-	3.2	3.2
M 39-9/74	5.0	0.9	-	3.0	18	19	-	19	3.1	3.4	-	3.3
XIV-11-57	6.8	1.7	6.4	5.0	18	18	19	18	3.3	3.4	3.3	3.3
Overall Average	6.2	1.7	5.1	3.7	19	20	19	19	3.2	3.2	3.3	3.3

1 Tons per acre, calculated based on an 8 x 12 ft. vine spacing, equivalent to 454 vines per acre.
2 Vines planted in 2001 were not fruited in 2003. Varieties dropped in 2005 due to inadequate performance.

Table 5. Wine tasting evaluation results for the 2000 through 2003 vintage years—white varieties.

Vintage Year and Cultivar[1]	2001 Average Rating[2]	2002 Average Rating[2]	2004 Average Rating[2,3]	2005 Average Rating[2,4]	Range of Ratings[5]	Comments from Most Recent Tasting
2000 Whites						
Bianca	9.7	9.0			6–14	Good body; some sugar would help balance
Iskorka	11.1	9.9			6–13	None
Liza	15.0	8.5			2–13	Nice color, off aroma; disagreeable odor; lack of free nitrogen in must
Malverina	12.7	10.4			7–14	None
Malverina	11.2	6.4			0–11	Unpleasant aroma, taste, aftertaste; not indicative of grapes
Petra	12.8	10.2			6–15	High alcohol; too sweet; unbalanced
Toldi	10.8	11.1			6–15	Good balance
XIV-1-86	15.2				12-17	Sweet, spicy, cleansing sweet
XIV-1-86	9.4	7.6			5–11	No taste
XIV-1-86	14.2	10.8			2–15	Good balance; unpleasant aroma; unpleasant taste; no aftertaste; short aftertaste
XX-15-51	13.0	10.4			6–14	Needs sugar; citrus taste; sulfur aroma; good acidity, high alcohol
34-4-49	11.6	11.9			5–15	Acid and sugar not balanced; best of the 2000 whites
Cayuga white (std) 2001 tasting only	8.8				6-11	The best white from this trial, good acid, crisp, very pleasant, good for the long haul
Vidal blanc (std)	14.8				11–17	Well made, great balance; a "ringer" for a nice Vidal Blanc
2001 Whites						
Bianca (sweet)		9.0	9.4		8-13	None
Bianca (dry)		9.2	8.8		6-11	Nail polish aroma; slight oxidation
Iskorka		3.1				None
Liza, (Cote des Blanc Yeast)		5.4				None
Liza, (Montrachet Yeast)		5.1				None
Malverina		10.9	12.4		6-17	None
Rani Riesling		10.5	12.5		3-18	Good aroma, acids; extremely poor
XIV-1-86		15.6	11.8		3-17	Slightly musty; good acid; heavy sulfur; nitrogen deficient
XX-15-51		2.8				None
34-4-49		14.1	12.2		6-18	None
Vidal blanc (std)		10.4				None
2002 Whites						
Bianca			4.3		2-10	Poorly made; off taste
Liza			8.4	9.4	6.5-14	Slightly thin body, agreeable taste
Rani Riesling			9.7	9.1	2-14.5	Slightly thin body, tart taste
Toldi			7.6	9.1	7.5-11.5	Nearly correct finish, green taste
Toldi			4.0		1-7	None
Traminette (std) 2004 tasting only			6.2		1-11	High volatile acidity; off aroma; off odor
Vidal/Seyval blend (std)			10.7		3-17.5	Nice fruit; good balance; brilliantly clear; high total and volatile acidity
2003 Whites						
Bianca				5.3	1-12.5	Very dry; harsh; too much sulfite; colorless
Bianca				7.1	0-13.5	Cleaning agent taste; stemmy taste; all around bad
Iskorka				2.6	0-7.5	Cloudy (2); very acidic; flawed
Liza				7.6	3.5-13.5	Excellent aroma; tart, thin, lacks flavor
Liza				4.1	0-5	Harsh, chemical taste, bitter
Malverina				10.1	6-13.5	Fruity aroma; no exceptional features
Malverina				4.6	1-10	Too much oak (2); too little fruit
Petra				6.6	0-11.5	Needs sugar; shows potential; thin body; spicy aroma; slightly bitter
Rani Riesling				7.2	4.5-8.5	Burnt match aroma; off aroma
Toldi				4.8	0-9	Cleaning agent taste; off aroma (3)
XIV-1-86				13.4	9-15	Fruity aroma and taste; skillfully made
XX-15-51				6.9	1-14	Low acidity
XX-15-51				6.6	0-9	Bitter (2); musty; sour apple taste; light oxidation
34-4-49				3.5	0-7	Off taste
Seyval (std)				11.0	8-16.5	High acid; no exceptional features

[1] Cayuga white, Traminette, Vidal/Seyval blend, and Vidal blanc were included as quality American and French-American wine standards for comparison. Each was only evaluated one year.

[2] Average rating: 0-5 = poor or objectionable, 6-8 = acceptable, 9-11 = pleasant, 12-14 = good, 15-17 = excellent, 18-20 = extraordinary. Each wine was evaluated by 7-10 tasters: (2001) Jim Bravard, Danny Buechele, Dave Miller, Bud Mirus, Mickey Mirus, Butch Meyer, Dr. Chris Nelson, Eddie O'Daniel, Jay Pruce, Gina Pruce, Gari Thompson, and George Wessel; (2002) Lynda Hogan, Elmer Klaber, Tom Kohler, Jerry Kushner, Marilyn Kushner, Butch Meyer, Dave Miller, Ben O'Daniel, Gari Thompson ,and James Wight; (2004) Jerry Kushner, Marilyn Kushner, Butch Meyer, Dave Miller, Frances Miller, Ben O'Daniel, Gari Thompson, and James Wight; (2005) Jerry Kushner, Jeffery Tatman, John Pitcock, Dave Miller, Butch Meyer, Ben O'Daniel, Mike Windhorn.

[3] 2000 whites were not rated in 2004, due to their age. The 2001 Iskorka, Liza, and XX-15-51 were not rated in 2004 due to very low scores in previous evaluations.

[4] 2000 and 2001 whites were not rated in 2005, due to their age. The 2001 Iskorka, Liza, and XX-15-51, and the 2002 Bianca and Toldi were not rated in 2003 due to very low scores in previous evaluations.

[5] Range: 1st number = lowest score received, 2nd number = highest score received from most recent tasting.

Table 6. Wine tasting evaluation results for the 2000 through 2003 vintage years—red varieties.

Vintage Year and Cultivar[1]	2001 Average Rating[2]	2002 Average Rating[2]	2004 Average Rating[2,3]	2005 Average Rating[2,4]	Range of Ratings[5]	Comments from Most Recent Tasting
2000 Reds						
I31/67	8.6	3.2				none
Kozma 55	8.8	12.2	12.1	10.5	1.5-15	Harsh finish
Kozma 525	11.2	10.5	11.0	6.3	3-12.5	None
Laurot	12.8	12.2	10.7	11.6	3.5-16	Harsh
M39-9/74	11.5	11.9	9.5		2-13	Dark; cloudy and spoiled; bitter aftertaste; flat—no tannins
Rubin Tairovski	11.2	10.2	8.7	7.6	1-12	Off aroma
XIV-11-57	10.4	7.2				None
Chambourcin (std) 2001 tasting only	14.3					None
2001 Reds						
I 31/67		9.3	10.4	10.7	5-13.5	Too much oak
Kozma 55		12.5	10.1	11.6	2.5-14.5	None
Kozma 525		13.0	11.3	9.1	3-14.5	None
Laurot		12.3	13.1	10.3	6-16.5	Green taste
M 39-9/74		11.7	12.0	8.4	4-14.5	Fruity aroma; very flowery aroma
Rubin Tairovski		9.5	7.7		3-12	Poor density
Rubin Tairovski (blended)		9.8	8.8	8.3	3-12.5	Light color
XIV-11-57		11.5	7.7		4-11	Thin appearance; very light
Chambourcin (std) 2002 tasting only		13.4				None
2002 Reds						
Kozma 55 blend			12.7	9.6	0-15.5	None
Kozma 525			9.7	5.1	2.5-8	None
Laurot			13.4	10.3	4-14	Too much oak; green
M 39-9/74			8.2	9.3	3-14	None
Rubin Tairovski			4.6		1-7.5	Oxidized taste
XIV-11-57			10.2	9.1	2-10.5	Light color; simple aroma
Chambourcin (std) 2004 tasting only			11.5		6.5-16	Perfume aroma; slight phenolic instability; good fruit, too sweet; a bit too high acidity
Norton (std)			14.9	15.6	9.5-17.5	Nice flowery aroma; tastes like Norton
2003 Reds						
Demetra				9.5	4-16.5	None
I 31/67				6.0	2-9.5	Oxidized
II70/20				13.8	12-16	Rich, silky body; fruity; balanced; very dark
Kozma 55				9.0	1.5-15	None
Kozma 525				12.0	9.5-13.5	None
Laurot				15.3	12.5-18.5	None
M 39-9/74				7.1	2-16	None
Nero				12.6	10.5-14	Excellent balance
Rubin Tairovski				0.5	0-2	Oxidized
Rubin Tairovski				12.4	9.5-16	None
XIV-11-57				0.6	0-2	Oxidized

1 Chambourcin and Norton were included as quality French-American and American wine standards for comparison.

2 Average rating: 0-5 = poor or objectionable, 6-8 = acceptable, 9-11 = pleasant, 12-14 = good, 15-17 = excellent, 18-20 = extraordinary. Each wine was evaluated by 7-10 tasters: (2001) Jim Bravard, Danny Buechele, Dave Miller, Bud Mirus, Mickey Mirus, Butch Meyer, Dr. Chris Nelson, Eddie O'Daniel, Jay Pruce, Gina Pruce, Gari Thompson, and George Wessel; (2002) Lynda Hogan, Elmer Klaber, Tom Kohler, Jerry Kushner, Marilyn Kushner, Butch Meyer, Dave Miller, Ben O'Daniel, Gari Thompson, and James Wight; (2004) Jerry Kushner, Marilyn Kushner, Butch Meyer, Dave Miller, Frances Miller, Ben O'Daniel, Gari Thompson, and James Wight; (2005) Jerry Kushner, Jeffery Tatman, John Pitcock, Dave Miller, Butch Meyer, Ben O'Daniel, Mike Windhorn.

3 The 2000 I-31/67, and XIV-1157 were not rated in 2004 due to very low scores in previous evaluations.

4 The 2000 I-31/67, and XIV-1157, the 2001 Rubin Tairovski, and the 2002 Rubin Tairovski were not rated in 2005 due to very low scores in previous evaluations.

5 Range: 1st number = lowest score received, 2nd number = highest score received from most recent tasting.

Table 7. Wine evaluation summary.

	2000 Vintage Average Rating[6]				2001 Vintage Average Rating[6]			2002 Vintage Average Rating[6]		2003 Vintage Avg. Rating[6]	
Cultivar[1]	**2001 Tasting**	**2002 Tasting**	**2004 Tasting[2]**	**2005 Tasting**	**2002 Tasting**	**2004 Tasting**	**2005 Tasting**	**2004 Tasting**	**2005 Tasting**	**2005 Tasting**	**Cumulative Average[7]**
Whites											
Bianca	9.7	9.0			9.0	9.4		4.3		5.3	
Bianca										7.1	
Bianca (dry)					9.2	8.8					8.4
Iskorka	11.1	9.9			3.1					2.6	10.5
Liza	15.0	8.5			5.4			8.4	9.4	7.6	9.1
Liza										4.1	
Malverina	12.7	10.4			10.9	12.4				10.1	
Malverina	11.2	6.4								4.6	10.6
Petra	12.8	10.2								6.6	9.9
Rani Riesling					10.5	12.5		9.7	9.1	7.2	9.8
Toldi	10.8	11.1						7.6	9.1	4.8	8.7
Toldi								4.0			
XIV-1-86	15.2									13.4	
XIV-1-86	9.4	7.6									
XIV-1-86	14.2	10.8			15.6	11.8					12.3
XX-15-51	13.0	10.4			2.8					6.6	
XX-15-51										6.9	9.2
34-4-49	11.6	11.9			14.1	12.2				3.5	12.5
Cayuga white (std) 3	8.8										
Vidal blanc (std)	14.8				10.4						12.6
Vidal/Seyvalblend (std)								10.7			
Traminette (std)								6.2			
Seyval (std)										11.0	
Reds											
Demetra										9.5	
I 31/67	8.6	3.2			9.3	10.4	10.7			6.0	9.0
II 70/20										13.8	
Kozma 55	8.8	12.2	12.1	10.5	12.5	10.1	11.6			9.0	10.9
Kozma 55 blended[4]								12.7	9.6		11.1
Kozma 525	11.2	10.5	11.0	6.3	13.0	11.3	9.1	9.7	5.1	12.0	10.5
Laurot	12.8	12.2	10.7	11.6	12.3	13.1	10.3	13.4	10.3	15.3	12.2
M 39-9/74	11.5	11.9	9.5		11.7	12.0	8.4	8.2	9.3	7.1	10.0
Nero										12.6	
Rubin Tairovski	11.2	10.2	8.7	7.6	9.5	7.7		4.6		0.5	
R. Tairovski										12.4	9.6
Rubin Tairovski (blended)[5]					9.8	8.8	8.3				9.0
XIV-11-57	10.4	7.2			11.5	7.7		10.2	9.1	0.6	9.4
Chambourcin (std.)	14.3				13.4			11.5			13.1
Norton (std)								14.9	15.6		15.3

[1] Where a variety is listed twice, it was either vinted by more than one winemaker in one year, or produced in more than one style. Cayuga white, Chambourcin, Norton, Traminette, Vidal/Seyval blend, and Vidal blanc were included as high quality American and French-American wine standards for comparison.

[2] Missing ratings are due to vintages being unsatisfactory and therefore not bottled; insufficient quantity of grapes to make wine; the 2000 whites were not rated in 2004 or 2005, due to their age. The 2001 whites were not rated in 2005, due to their age.

[3] All standard comparison wines were only evaluated once, with the exception of 2002 Norton.

[4] Blend of 50% Kosma 55 and 50% Laurot.

[5] The small Rubin Tairovski yield wasn't sufficient to make wine and thus was blended with Chambourcin.

[6] Rating scale: 0-5 = poor or objectionable, 6-8 = acceptable, 9-11 = pleasant, 12-14 = good, 15-17 = excellent, 18-20 = extraordinary.

[7] Cumulative average: Mean of all average ratings for a variety; however, very low ratings were not included in the cumulative average (i.e., where wine had obviously spoiled or where there was a winemaking problem).

Vinifera Grape Training Trial

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Introduction

Kentucky growers have planted extensive grape acreage for wine production over the last eight years. Roughly 37% of these grapes are *vinifera,* or European cultivars that are susceptible to extensive damage in very cold winters. Additionally, frequent exposure to critical winter temperatures make the European grapevines susceptible to crown gall (caused by the bacterium *Agrobacterium vitis*) infection through wounds due to trunk splitting. Crown gall severely weakens and can kill the vines. The objectives of this study were to compare survival, yield, and fruit quality between the vertically shoot positioned (VSP) and fan-trained grapevine varieties.

Materials and Methods

One-year-old, dormant, bare root vines of the *vinifera* cultivars 'Cabernet Franc clone No. 332' (fairly hardy), 'Chardonnay clone No. 76' (moderately hardy), 'Shiraz' (least hardy), and the French-American hybrid 'Vidal blanc' (very hardy) were planted in the spring of 2002 at the University of Kentucky Horticultural Research Farm in Lexington, Kentucky, on Murray silt-loam soil. All varieties were grafted onto the C-3309 rootstock except one treatment of Vidal blanc which was grown on its own roots. Vines were spaced 8 ft within the row and 12 ft (454 plants/A) between rows in a randomized block factorial design with six replications.

Half the vines were trained using the VSP system. With this system, vines are developed with two trunks, each becoming a cordon on the lowest wire (38 inches above ground). From these cordons, shoots are trained vertically between three sets of catch wires (spaced 12, 21, and 33 inches above the training wire). The remaining vines were fan trained, which consists of up to six canes radiating out from the vine base or graft union in a fan pattern and tied to the trellis. In 2005, metal trellis post extensions were installed to increase leaf area, bringing the exposed height of the trellis to six feet.

Vines were watered as needed until established, and weeds were controlled in a 3 ft wide herbicide-treated strip down the row beneath the vines. Mowed sod middles were maintained between rows. Graft unions were covered with soil annually in late fall to protect unions from freeze injury. Vines were trained during the first two seasons and balance pruned in 2004 and 2005 to adjust fruit load to pruning weight. Additional cluster and shoot thinning were performed on vines that had excessive crops and pruning weight, respectively. Insecticide, fungicide and herbicide applications were made in accordance with the *Midwest Commercial Small Fruit and Grape Spray Guide* (ID-94).

Vines bore fruit for the first time in 2004. Here we report results from the 2005 growing season. Pruning weight (referred to hereafter as "vine size"), yield, cluster weight, berry weight, total soluble solids, juice pH, and titratable acidity (TA) were measured.

Results and Discussion

There was very little interaction of the training system and the cultivar treatments in 2005. The vine size was not affected by training systems (Table 1). However, the cultivars had different vine sizes as affected by the 2004 yield. Even though 'Chardonnay' had the lowest yield in 2004, the vine size in 2005 was optimal (0.2-0.4 pounds per foot of row). The 'Shiraz' had the largest vine size in 2005 followed by 'Cabernet Franc.' The vine size reported for 'Shiraz,' 'Cabernet Franc,' and 'Vidal blanc' indicated excessive vigor regardless of training system. It is also possible that these cultivars were not correctly balanced in terms of vegetative growth and fruit production for a vineyard in the third leaf. The fan-trained grapevines had higher yields and carried more total clusters, marketable clusters, and had a higher cluster density per foot of row than the VSP system (Table1). However, there was no difference in number of culled clusters or cluster weight between the two training systems. The 'Vidal blanc' on its own roots outyielded the Vidal blanc/C3309 rootstock and had the highest yield of the cultivars in this trial. In

Table 1. Effect of training system and cultivar on yield components.

Cultivar	Harvest Date	Pruning Weight per Vine (lb)[1]	Pruning Weight per Foot of Row	Marketable Clusters/ Vine	Culled[2] Clusters/ Vine	Cluster Weight (g)	Marketable Weight/Vine (lb)	Tons/A[3]	Cluster Density[4]
Chardonnay	6 Sept.	2.7 c	0.33 c	57	4 ab	109 c	14.2 c	3.22 c	8
Cabernet Franc	15 Sept.	4.2 b	0.52 b	65	11 a	124 bc	17.8 bc	4.04 bc	9
Shiraz	21 Sept.	5.1 a	0.64 a	65	0 b	156 ab	22.0 b	4.99 b	8
Vidal blanc/own	23 Sept.	4.1 b	0.51 b	68	2 b	193 a	27.9 a	6.33 a	9
Vidal blanc/C3309	23 Sept.	3.7 b	0.47 b	53	11 a	157 ab	18.5 bc	4.19 bc	8
				ns					ns
Training system									
Fan		3.7	0.47	69 a	5	144	22.2 a	5.05 a	9 a
VSP		4.2	0.53	55.b	7	153	18.7 b	4.24 b	7 b
		ns	ns		ns	ns			

[1] Numbers in the same column that are followed by the same letter are not statistically different ($P < 0.05$); ns =not significant (no statistically significant difference within the column).
[2] Clusters that displayed >30% visual damage by fungal infection, bird damage, sunburn.
[3] Based on 454 vines/acre.
[4] Number of clusters/foot of row.

2005, 'Chardonnay' had the lowest marketable yield. 'Cabernet Franc' and 'Vidal blanc/C3309' had the greatest number of culled clusters, while 'Shiraz' and 'Vidal blanc' on its own roots had the lowest number of culled clusters.

Individual cluster weights for 'Vidal blanc' on its own roots and on C3309 and for 'Shiraz' were not different and were higher than for 'Cabernet Franc' and 'Chardonnay.' There were no differences between varieties in the number of total clusters, marketable clusters, or cluster density.

No differences were found between the fan- and VSP-trained grapevines in total soluble solids, juice pH, titratable acidity, or berry weight (Table 2); however, there were individual variety differences for all of these factors except berry weight. The two Vidal blanc treatments had the highest total soluble solids levels, while 'Cabernet franc' and 'Shiraz' had the lowest levels. Juice pH was highest for 'Cabernet Franc' and lowest for the two 'Vidal blanc' treatments. Titratable acidity was lowest for 'Cabernet Franc' and highest for the two 'Vidal blanc' treatments.

In 2005, the 'Vidal blanc/C3309' performed best in regards to balanced yield and optimum fruit composition (Tables 1 and 2), followed by 'Vidal blanc' on its own roots. The 'Chardonnay clone No.76' also performed well, with near optimum fruit composition values. However, mid-winter cold-hardiness data need to be collected for several seasons before recommendations can be made to Kentucky growers in regard to training system or cultivar and clone selection.

Table 2. Effect of training system and cultivar on fruit composition.

Cultivar	Total Clusters/ Vine	TSS[1,2]	Juice pH	TA[3]	Berry Weight (g)
Chardonnay	61	21.3 b	3.65 c	5.20 b	1.545
Cabernet Franc	76	19.5 c	3.88 a	3.49 c	1.563
Shiraz	64	19.8 c	3.75 b	4.73 b	1.796
Vidal blanc/own	70	22.2 ab	3.40 d	6.60 a	1.729
Vidal blanc/C3309	64	23.0 a	3.50 d	6.50 a	1.700
	ns				ns
Training System					
Fan	74 a[2]	20.9	3.64	5.36	1.65
VSP	62 b	21.5	3.61	5.49	1.68
		ns	ns	ns	ns

[1] TSS = Total soluble solids measured as degrees Brix in juice.
[2] Numbers in the same column that are followed by the same letter are not statistically different ($P< 0.05$); ns =not significant (no statistically significant difference within the column).
[3] Total acidity, measured as grams of tartaric acid/liter of juice.

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Fall Weed Control in Grapes

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Introduction

Fall-applied herbicides are an important component of a comprehensive weed control regimen, especially for control of perennials such as honeyvine milkweed, quackgrass, and johnsongrass. Growers are often busy in the fall with harvest and wine making and neglect weed control after harvest. In order to assist grape growers with their decision making, an experiment was conducted in spring of 2005 to determine the residual control and benefits of various herbicides applied in the spring and fall of 2005 on weed pressure in the spring of 2006.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a two-nozzle shielded boom calibrated to spray a 3 ft band at 30 psi at a 3 mph walking speed. The 11002-nozzles were set at 7 inches above ground to obtain good spray overlap and complete weed coverage. The spray boom was moved in and out in the row to avoid spraying the vine trunks. Therefore, weeds at the base of vine trunks were taller throughout the season and did not reflect the effectiveness of the applied herbicides. Plots were 6 ft wide x 108 ft long. The experimental design was a randomized complete block with three replications.

The preemergence (PRE) treatments were applied on 15 April 2005 when spring weeds were 3-4 inches tall, to grapevines at the 0.5-2 inch green tip stage. Since weeds had been growing since early March, Roundup WeatherMax 16 oz/A (0.68 lb ai/A) was included with all treatments. The postemergence (POST) treatments were applied on 15 June 2005. Roundup was also included with the POST treatments at same rate. All treatments were applied early in the morning when the average wind speed was 2.5 mph.

The fall treatments listed in the table below were applied in 2005 when soil temperatures were below 55°F but before soil freezing. Roundup was again included with all treatments for control of existing weeds.

Visual weed control ratings were made on 6 May and 15 June. The scale used in these ratings was 1-10, with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value.

Results and Discussion

Three weeks after PRE application, Karmex had the best control with about 90% of the weeds controlled (Table 1). Karmex was better than Princep on dandelion and clover and spring weeds such as chickweed and mustard, but was equal in marestail control. Both herbicides were better overall than Devrinol. Devrinol's lack of control of dandelion and clover is because they are perennial weeds not generally controlled by PRE herbicides. No new weed regrowth was observed on this date in any treated plots.

Two months after PRE applications, a new flush of annual grasses and broadleaves occurred together with clover which was already present (Table 2). Control of clover continued to improve with Princep and Karmex only. Karmex had the best overall weed control, except for redroot pigweed. In this field, clover is not considered a serious pest since it doesn't get tall enough to interfere with the grape canopy.

The final evaluation of this experiment will be conducted next spring when the residual benefit of the fall-applied herbicides will be evaluated. An updated report will be presented in next year's Research Report.

Table 1. Weed control ratings three weeks after spring herbicide treatments at UKREC, Princeton, Ky., 2005.

Trt No.	Treatment Name	Formula Conc. (%)	Formula Type	Rate/A	Growth Stage[1]	Weed Control Ratings and Dates of Ratings[2] DAND May 6	CLOVER May 6	MATA May 6
1	Princep	4	L	1.2 gal	PRE, POST	5	4	8
	Casoron	4	G	150 lb	Fall			
2	Karmex	80	DF	6 lb	PRE, POST	9	9	9
	Chateau	51	WG	12 oz	Fall			
3	Devrinol	50	DF	8 lb	PRE, POST	4	2	8
	Gallery	75	DF	21.3 oz	Fall			
1-3	Roundup WeatherMax	5.5	L	16 oz	ALL trts			
LSD (P = 0.05)						0	0	0

[1] Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts = applied with all treatments.
[2] DAND = dandelion; MATA = marestail.

Table 2. Weed control ratings two months after spring herbicide treatments at UKREC, Princeton, Ky., 2005.

Trt No.	Treatment Name	Formula Conc. (%)	Formula Type	Rate/A	Growth Stage[1]	Weed Control Ratings and Dates of Ratings[2] LACG Jun 15	CLOVER Jun 15	COPU Jun 15	RRPW Jun 15	SHPU Jun 15
1	Princep	4	L	1.2 gal	PRE, POST	1	9	3	6	8
	Casoron	4	G	150 lb	Fall					
2	Karmex	80	DF	6 lb	PRE, POST	9	10	10	6	10
	Chateau	51	WG	12 oz	Fall					
3	Devrinol	50	DF	8 lb	PRE, POST	9	1	10	9	9
	Gallery	75	DF	21.3 oz	Fall					
1-3	Roundup WeatherMax	5.5	L	16 oz	ALL trts					
LSD (P = 0.05)						2	0.8	4.2	7.9	2.9

[1] Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts = applied with all treatments.
[2] LACG = large crabgrass; COPU = common purslane; RRPW = redroot pigweed; SHPU = shepherdspurse.

Weed Control in Non-Bearing Grapes

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Introduction

Herbicides are an important component of a comprehensive weed control regimen, especially in newly established or non-bearing grapes. Growers are often so busy with canopy, disease, and insect management that they neglect weed control. In order to assist new growers or those considering planting a vineyard with their weed control options, six herbicide regimens were applied in the spring of 2005 to compare their residual control and benefits on weed pressure in the spring of 2006.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a two-nozzle shielded boom calibrated to spray a 3 ft band at 30 psi and 3 mph walking speed. The 11002-nozzles were set at 7 inches above ground to obtain good spray overlap and complete weed coverage. The spray boom was moved in and out of the vine row to avoid spraying vine trunks. Therefore, weeds at the bases of vines were taller throughout the season and did not reflect the effectiveness of the applied herbicides. Plots were 6 ft wide x 54 ft long. The experimental design was a randomized complete block with three replications.

The preemergence (PRE) treatments were applied on 15 April 2005 when weeds were 3-4 inches tall. Grapevines were at the 0.5-2 inch green tip stage. Since weeds had already germinated and had been growing since early March, Roundup WeatherMax at 16 oz/A (0.68 lb ai/A) was included with all treatments. The postemergence (POST) treatments were applied on 15 June 2005. Roundup was also included with the POST treatment at same rate. All treatments were applied early in the morning when the average wind speed was 2.5 mph.

Visual weed control ratings were collected at various dates. Ratings were on a 1-10 scale, with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value.

Results and Discussion

Three weeks after application, the PRE treatments 1-3 and 6 significantly reduced the regrowth of clover, whereas Snapshot and Kerb had no significant control on clover or the other weeds present (Table 1). Treatments 2 and 6 had the best overall weed control on both evaluation dates.

Two months later, Chateau at the high label rate of 12 oz still had excellent control of clover (Table 2). In general, all herbicides labeled for non-bearing grapes provided acceptable weed control on most annual broadleaves and grasses. Kerb and Snapshot provided a little weaker control on shepherdspurse and large crabgrass.

Table 1. Weed control ratings three weeks after spring herbicide treatments at UKREC, Princeton, Ky., 2005.

Trt No.	Treatment Name	Formula Conc. (%)	Formula Type	Rate/A	Weed Growth Stage[1]	Weed Control Ratings and Dates of Ratings[2] CLOVER May 6	PEWE May 6	SHPU May 6
1	Chateau	51	WG	6 oz	PRE, POST	6	6	9
2	Chateau	51	WG	12 oz	PRE, POST	7	8	10
3	Prowl	3.3	EC	4.8 pt	PRE	6	7	10
	Chateau	51	WG	6 oz	POST			
4	Snapshot	2.5	G	150 lb	PRE	2	2	3
	Chateau	51	WG	6 oz	POST			
5	Kerb	50	WP	6 lb	PRE	3	4	6
	Chateau	51	WG	6 oz	POST			
6	Surflan	4	AS	4 qt	PRE	6	7	10
	Chateau	51	WG	6 oz	POST			
1-6	Roundup	5.5	L	16 oz	ALL trts			
LSD (P = 0.05)						1.7	1.8	3.4

1 Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts = applied with all treatments.
2 PEWE = pepperweed; SHPU = shepherdspurse.

Table 2. Weed control ratings two months after spring herbicide treatments at UKREC, Princeton, KY, 2005.

Trt No.	Treatment Name	Formula Conc. (%)	Form Type	Rate/A	Weed Growth Stage[1]	Weed control ratings and dates of ratings[2] DAND Jun 15	CLOVER Jun 15	SHPU Jun 15	LACG Jun 15	HONE Jun 15
1	Chateau	51	WG	6 oz	PRE, POST	9	4	9	7	9
2	Chateau	51	WG	12 oz	PRE, POST	9	8	9	8	8
3	Prowl	3.3	EC	4.8 pt	PRE	9	4	8	7	10
	Chateau	51	WG	6 oz	POST					
4	Snapshot	2.5	G	150 lb	PRE	10	4	6	7	9
	Chateau	51	WG	6 oz	POST					
5	Kerb	50	WP	6 lb	PRE	9	5	6	8	10
	Chateau	51	WG	6 oz	POST					
6	Surflan	4	AS	4 qt	PRE	8	6	8	9	10
	Chateau	51	WG	6 oz	POST					
1-6	Roundup	5.5	L	16 oz	ALL trts					
LSD (P=.05)						1.3	2.9	3.1	2.4	3.3

1 Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts = applied with all treatments.
2 DAND = dandelion; LACG = large crabgrass; SHPU = shepherdspurse; HONE = horsenettle.

Phylogenetic Analysis of Kentucky Strains of *Xylella fastidiosa,* Cause of Grape Pierce's Disease

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Introduction

The phytopathogenic bacterium, *Xylella fastidiosa*, causes several economically important plant diseases, including Pierce's disease of grapes and bacterial leaf scorch of landscape trees. Pierce's disease is commonly found in vineyards of the southern U.S. and is currently causing significant losses in California vineyards. Pierce's disease of grape appeared only recently in a western Kentucky vineyard in 2001. In 2002, the disease was also found in a southern Indiana vineyard. These were the first two cases of Pierce's disease found in this region. At that time, *X. fastidiosa* from grape was isolated in culture, and the bacterial DNA was extracted. Through eradication of infected vines, the affected growers eliminated Pierce's disease from their vineyards, and no new cases have been found in Kentucky since then. In Kentucky, bacterial leaf scorch, also caused by *X. fastidiosa*, affects many oak and maple species, sycamore, hackberry, elm, sweetgum, and mulberry. Over the past 30 or more years, bacterial leaf scorch has caused tree mortality and tremendous losses, especially in oaks, along streets and in landscapes of many Kentucky cities. *X. fastidiosa* has recently been detected in several symptomless grasses, vines, shrubs, and weeds in the landscape. Diseases caused by *X. fastidiosa* are vectored by xylem-feeding leafhoppers.

Materials and Methods

It was the goal of this research to identify hosts of *X. fastidiosa* around Kentucky and use phylogenetic analysis (which determines how closely different organisms are related to one another) to compare DNA sequences of specific genes between the *X. fastidiosa* in different samples. The DNA of two genes was examined: the 16S rDNA (gene coding for bacterial ribosome structure and function[1]) and the gyrase B gene (*gyrB*, which codes for a bacterial DNA maintenance protein). In addition to the grape collections made in 2001 and 2002, landscape plant samples were collected in urban areas of Kentucky between 2002 and 2004 and tested for the presence of *X. fastidiosa* by enzyme-linked immunosorbant assay (ELISA) and polymerase-chain reaction (PCR). The ELISA test used detects proteins only found in *X. fastidiosa,* and the PCR test detects only *X. fastidiosa* DNA. Primer sets developed for *X. fastidiosa* were used to amplify part of the 16S rDNA and the *gyrB* genes from DNA extracted from plant tissue or from bacterial cultures. DNA base sequence data from these PCR products were assembled using computer programs that sort out complex DNA base sequence data. Phylogenetic analysis was then done with another computer program to show how closely the bacteria in the samples were related to one another. Comparisons with strains outside of Kentucky were also done using *X. fastidiosa* sequence data obtained from the National Center for Biotechnology Information.

This research tests the hypothesis that DNA base sequence comparison can determine if grape Pierce's disease and shade tree bacterial leaf scorch in Kentucky are caused by the same strain of *X. fastidiosa*. In addition, we tested the utility of DNA analysis in identifying asymptomatic hosts and vectors that could serve as a source of inoculum for pathogenic strains of *X. fastidiosa*.

Results and Discussion

Results indicate that the Kentucky Pierce's disease strain of *X. fastidiosa* is most likely a true Pierce's disease strain and not a bacterial leaf scorch strain that was transmitted from oaks or other hosts to infect grapevine because it fits into the same grouping with other strains isolated from grape elsewhere (1).

With few exceptions, *X. fastidiosa* sequences from oak samples fit into a group associated with bacterial leaf scorch of shade trees. According to the *gyrB* gene analysis, host of origin has a greater effect on the relationship between sequences than geography. For example, one group of related bacteria consists of strains from grape originating in California, Florida, Georgia, and Kentucky. Also, the sequences from oak samples group together despite the fact that they were collected in different parts of Kentucky and even different states. Results of phylogenetic analysis suggest that use of the gyrB gene is superior to the 16S rDNA for studying the relatedness of *X. fastidiosa* strains.

This research addressed the hypothesis that sequence comparison can be used to identify potential asymptomatic hosts and vectors for pathogenic strains of *X. fastidiosa*. The results of the collection and detection part of this study underscore the problems associating *X. fastidiosa* strains with a given host, particularly those that are asymptomatic. Isolation in culture proved to be difficult, if not impossible, for *X. fastidiosa* from most hosts, and ELISA is known to cross-react with plant sap of some hosts. PCR detection methods can bypass these problems to some extent, if the primer set used is specific for *X. fastidiosa* and if the DNA extraction method effectively eliminates PCR inhibitory compounds that may be in the plant tissue.

The main conclusion from this study is that the detection and comparison of strains of *X. fastidiosa* is dependent on reliable laboratory molecular methods. This requires the use of DNA extraction techniques that successfully access the DNA of *X. fastidiosa* in the plant xylem while minimizing the effect of PCR inhibitory compounds. It also requires the use of primers developed to specifically amplify *X. fastidiosa* DNA, and particularly to amplify meaningful genes or genomic regions that can be used in phylogenetic analysis.

Effective management of Pierce's disease, should it return to Kentucky, will depend on knowledge of sources and transmission of *X. fastidiosa*, which requires complex molecular studies. From this research, it is now known that the appearance of bacterial leaf scorch in Kentucky landscape trees does not represent a threat to grapes and vineyards growing nearby because the *X. fastidiosa* strain that attacks grapes is not found in landscape trees. The grape industry ultimately benefits from basic studies of host-pathogen interactions.

Literature Cited

1. Mundell, J.N. 2005. Phylogenetic analysis of Kentucky strains of *Xylella fastidiosa*. M.S. Thesis, Department of Plant Pathology, University of Kentucky, Lexington, Ky. 103 pp.

[1] *Ribosomes are needed for bacteria to make proteins.*

Establishment Costs for Sustainable Blueberry Production

Matt Ernst and Tim Woods, Department of Agricultural Economics

Introduction

In this study, we investigated economic feasibility of small-plot sustainable blueberry production on naturally low pH (4.9-5.0), highly erodible land in eastern Kentucky. This class of land is lower in cost, but may have substantial tradeoffs in yield, plant survival, and management costs. Cost estimates were generated using producer labor and sustainable materials data generated from observations over two years.

Materials and Methods

A ⅓-acre blueberry plot was established in Stanton (Powell County, Kentucky) in the spring of 2004. Labor times and materials used were recorded throughout 2004 and 2005. These data were used to generate labor times and material costs in an optimal sustainable production scenario. Hardwood sawdust and pine shavings, available locally, were used as mulch. The plot was evaluated for pH and fertility between mulch types through a 20-grid soil sample at the end of the two-year establishment period.

Results and Discussion

Establishment costs. Estimated establishment costs for conventional and sustainable 1/3-acre blueberry plots are reported in Table 1. Costs were estimated through an economic engineering model, drawing on inputs typically used in alternative fruit and vegetable production systems and input costs reported by local suppliers. These estimates show the sustainable system costing $402 more, in today's dollars, than a conventional blueberry plot. These additional costs are traced to: 1) more labor required for weed control (mulching, hoeing, etc.) in a sustainable plot and 2) greater fertilizer costs for bagged organic fertilizers.

Other observations. A grid soil sample taken at 20 locations in the plot at the end of the second growing season revealed no significant changes in pH throughout the field. There were no significant differences between pH, organic matter, and available nitrogen in areas where different mulches were used. The plot used in this project contained extremely low amounts of organic matter and was poorly drained, making it a challenging production site.

Recommendations

1. Pre-plant preparation is essential and economically viable. These establishment cost estimates include the cost of field preparation during the fall before planting. It is critical for the producer, especially one using marginal land, to spend the time and money on pre-plant preparation (subsoiling, organic matter incorporation, cover crop seeding). These pre-plant practices are relatively inexpensive and will increase the possibility for long-term blueberry profitability.

Table 1. Comparison of estimated establishment costs for 1/3-acre blueberry plot (to nearest dollar).

Inputs	Initial pH 6.0 Conventional Practices	Initial pH 4.9 Sustainable Practices
Fall Preplant		
Soil test	$20	$20
Sulfur	59	0
Herbicide	17	0
Grass seed	20	30
Fertilizer	24	0
Labor	21	80
Variable machine costs	10	10
Interest on variable costs	4	3
Total variable cost	175	143
Fixed machine cost	25	25
Total cost	200	168
Planting Year		
Herbicide	17	0
Plants	756	756
Peat moss	110	110
Fertilizer	8	95
Mulch	75	125
Herbicide at planting and mid-season	54	0
Insecticide	7	0
Seed grass	20	20
Fall herbicide	19	0
Planting and hoeing labor	80	140
Mulching labor	120	280
Irrigation	25	25
Variable machine costs	30	5
Other labor	80	80
Interest	53	62
Total variable costs	1454	1698
Fixed machine costs	35	5
Fixed irrigation costs	125	125
Total costs	1614	1828
Year after Planting		
Pesticide	8	0
Plants (Replanting)	53	105
Labor-mulching, compost	0	80
Fertilizer	8	100
Herbicide	40	0
Insecticide	7	0
Irrigation	25	25
Variable machine costs	30	5
Labor	80	170
Interest	10	19
Total variable costs	261	504
Fixed machine costs	30	5
Fixed irrigation costs	125	125
Total costs	416	634
Total variable establishment cost	1890	2345
Total fixed costs	340	285
	2230	2630

Raised beds are critical to minimize risks from poor soil drainage for blueberry production in Kentucky. Their use is essential on heavy, marginal soils. These establishment costs are generated using fixed and variable costs that a producer who already owns this equipment would incur, and this total cost is similar to that of custom hiring bed preparation.

2. Mulch type should be selected to minimize potential pH changes. While there were no significant pH increases in the field areas having hardwood versus softwood mulch, the areas with hardwood mulch did average 0.1 higher. Risk of any pH increase caused by hardwood mulch decomposition can be eliminated by using softwood (pine) products for weed control and moisture retention.

3. Factor in plant mortality. The single greatest cost for blueberry establishment is the purchase price of the plants, generally 40-50% of the planting year expense. Planting on marginal land increases the mortality rate for a planting, usually assumed at 5-10% for well-prepared fields. Replanting is expensive and also defers returns that can be realized from a mature plant. This cost estimate assumes a 20% mortality rate for a sustainable system, a value selected to be higher than most estimates but within the range of plant mortality observed in this plot.

4. Plant with marketing in mind. Producers should always factor marketing into their planting preparations. Planting a crop on marginal land may not be the best choice if producers are planning to market using u-pick or on-farm sales because of difficulty for consumer access and navigation over steeply sloping ground. Sustainable or organic products may easily command higher prices, and may more than compensate for a higher establishment cost, even if yields are less than those obtained with a conventional production system.

Acknowledgments

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Blueberry Cultivar Trial for Eastern Kentucky

Amanda Ferguson Sears, R. Terry Jones, and John C. Snyder, Department of Horticulture

Introduction

Although blueberries (*Vaccinium* spp.) are native fruits, Kentucky has limited commercial acreage. Blueberries have an excellent potential for local sales and u-pick operations. Recent research into the health benefits of small fruits, including blueberries, may help increase sales. Pharmaceutical companies are conducting more research on *Vaccinium*. Scientists attribute the blueberry's healing powers to the flavonoid compound anthocyanin. It is responsible for the blue color and is found only in the peel. Anthocyanins and other flavonoids could help limit cancer development, cardiovascular disease, glaucoma, and poor night vision. As consumers become more food-conscious, they may eat more blueberries.

The high start-up cost for blueberries, approximately $4,000/A, is mainly due to land preparation, plant, and labor costs. However, after the plants reach maturity in approximately five years, profits should steadily increase to as high as $6,000/A per year. The longevity of a properly managed blueberry field is similar to that of a well-managed apple orchard. Blueberries require acidic soils with a pH of 4.5 to 5.2, with good drainage and high organic matter. It is best to plant more than one cultivar to ensure good pollination and a continuous harvest. Harvest usually begins in early June and lasts well into July.

Materials and Methods

Two blueberry plantings were established in eastern Kentucky in the fall of 1996 at the University of Kentucky Robinson Station in Quicksand and at the Laurel Fork Demonstration Site. Cultivar growth, yield, and survival were compared between a normal silt loam site (Quicksand) and a disturbed mine site (Laurel Fork). The plantings consisted of 8 to12 rows of various cultivars in a randomized complete block design. Twenty-one cultivars at Quicksand and 19 at Laurel Fork were tested. Plants were 4 ft. apart in raised beds 14 ft. apart. Drip irrigation with point source emitters (2 gph/plant) was installed shortly after planting. Plants were fertilized beginning in the spring of 1997. In 2005, one application of 5-20-20 (5 lb/100 ft. row) was followed by two sidedressings of sulfur-coated urea (5 lb/50 ft. row) at bloom and three weeks later. Two applications of urea (0.2 lb/50 ft row) were applied in mid- and late July through the drip lines. Netting was used at both sites to prevent loss due to birds.

Results

Results are shown in Tables 1 and 2, respectively. This year there were no late freezes, but it was cool and windy throughout the bloom period and hot and dry during the growing season. For the fourth year in a row, blueberry plants at Laurel Fork out-yielded those at Quicksand, but the difference was smaller, and some of the North Carolina cultivars at Quicksand had very high yields. The Laurel Fork reclamation site is about 500 ft. higher in elevation than Quicksand and has much better air drainage. Apple tree bloom and plant development at Laurel Fork are usually about 7 to10 days behind Quicksand. The reason that the Laurel Fork blueberry site has out-yielded the Quicksand site is probably more complex than just an elevation difference. The soil pH of 5.1 at Laurel Fork is actually higher than that at Quicksand (pH of 4.4) so lime was added in January at Quicksand to bring the pH up to 5.4. Plant growth improved dramatically.

The five top yielding blueberry cultivars at Quicksand were NC1827, Sampson, NC1832, Ozark Blue, and Duke, while the five top yielders at Laurel Fork were Reka, Patriot, Sierra, Nelson, and Bluecrop. There were no common cultivars among the five best at either site. At Laurel Fork, Toro and Blueray produced the largest berries, while Spartan had the largest berries at Quicksand (Tables 1 and 2).

Table 1. Harvest measurements, berry measurements, and characteristics of blueberry cultivars, Quicksand, 2005.

Cultivar[1]	Fruit Yield (lb/bush)[2]	Berry Size (oz/berry)[2]	Berry Size Rating[3]	Taste[4]	Appearance[5]	First Harvest Date	% Harvested[6] (first two harvest dates)
NC1827*	20.5 A	0.016 B	S	S	A	6/27	0
Sampson*	20.14 A	0.039 AB	L	S	A	6/13	9
NC1832*	17.88 AB	0.017 B	S	S	A	6/27	0
OzarkBlue	11.03 B	0.033 AB	L	ST	A+	6/20	0
Duke	11.01 B	0.025 B	M	S	A+	6/8	31
Brigitta	11.01 B	0.032 AB	L	ST	A+	6/13	0.03
NC2852*	10.99 B	0.0289 B	ML	S	A	6/8	0.3
Blueray	10.18 BC	0.35 AB	L	SB	A	6/13	2
Jersey	9.34 BC	0.024 B	M	ST	A	6/8	5
Bluejay	9.28 BC	0.028 B	ML	S	A	6/8	1
O'Neal*	9.16 BC	0.039 AB	L	ST	A+	6/8	23
Reka	8.85 BC	0.028 B	ML	ST	A	6/8	40
Bluegold	8.63 BC	0.029 B	ML	S	A	6/13	13
Ornablue	7.61 BC	0.018 B	S	TB	A	6/13	16
Bluecrop	6.96 BC	0.027 B	M	ST	A+	6/13	5
Spartan	6.70 BC	0.063 A	VL	S	A	6/8	49
Patriot	6.34 BC	0.029 B	M	ST	A+	6/8	15
Nelson	5.28 BC	0.026 B	M	ST	A	6/13	0.06
Duplin*	5.10 BC	0.017 AB	S	S	A	6/13	2
Sierra	5.03 BC	0.027 B	M	ST	A	6/8	2
Toro	3.72 C	0.028 B	ML	ST	A	6/13	18
LSD[7]	6.59	0.033					

* These cultivars are one year younger than other ones in the trial. Cultivars were either furnished by Hartman's Plant Company, Lacota, MI, or purchased from Fall Creek Farm & Nursery Inc., Lowell, OR.
1 In descending order of yield.
2 Means, within a group, followed by the same letter are not significantly different, MSD (P = 0.05).
3 Size rated visually; S = small, M = medium, L = large, ML = medium large, VL = very large.
4 S = sweet, T = tart, B = bland.
5 A = average, A+ = above average.
6 Harvest dates were 6/8, 6/13, 6/20, 6/27, 7/5, 7/11, 7/18, 7/25 over a 47-day harvest season.
7 Least significant difference (P = 0.05).

Table 2. Harvest measurements, berry measurements, and characteristics of blueberry cultivars, Laurel Fork, 2005.

Cultivar[1]	Fruit Yield (lb/bush)[2]	Berry Size (oz/berry)[2]	Berry Size Rating[3]	Taste[4]	Appearance[5]	Date of First Harvest	% Harvested[6] (first two harvests)
Reka	13.45 A	0.0356 BCDEFG	ML	T	A	6/6	32%
Patriot	13.43 A	0.044 ABC	VL	ST	A+	6/6	16%
Sierra	12.28 AB	0.037 BCDEF	L	ST	A	6/9	0.1%
Nelson	12.16 AB	0.041 ABCD	L	ST	A	6/6	1%
Bluecrop	11.97 AB	0.051 AB	VL	S	A+	6/6	11%
Bluegold	11.96 AB	0.042 ABCD	L	ST	A	6/6	2%
Brigitta	11.28 ABC	0.039 ABCDE	L	ST	A+	6/14	0%
Bluejay	11.26 ABC	0.0351 BCDEFG	ML	S	A	6/6	3%
Blueray	10.5 ABCD	0.0558 A	VL	ST	A+	6/6	6%
Duke	10.48 ABCD	0.038 BCDE	L	S	A	6/6	65%
Toro	10.45 ABCD	0.0555 A	VL	T	A+	6/6	5%
Ornablue	7.88 BCD	0.0267 DEFG	S	T	A	6/6	12%
Sampson*	7.38 BCDE	0.035 BCDEFG	ML	S	A	6/9	8%
NC1832*	6.14 CDEF	0.019 GH	S	S	A	6/9	4%
Duplin*	5.67 DEF	0.05 AB	L	S	A	6/9	1%
NC2852*	5.42 DEF	0.0207 FGH	M	S	A	6/9	0.3%
O'Neal*	5.40 DEF	0.0327 CDEFG	ML	S	A	6/6	35%
NC1827*	2.14 EF	0.0192 GH	S	S	A	6/9	2%
Ozark Blue	1.17 F	0.0224 EFGH	M	S	A	6/22	0%
LSD[7]	5.24	0.017					

* These cultivars are one year younger than other ones in the trial. Cultivars were either furnished by Hartman's Plant Company, Lacota, MI, or purchased from Fall Creek Farm & Nursery Inc., Lowell, OR.
1 In descending order of yield.
2 Means, within a group, followed by the same letter are not significantly different, LSD (P = 0.05).
3 Size rated visually; S = small, M = medium, L = large, ML = medium large, VL = very large.
4 S = sweet, T = tart, B = bland.
5 A- = below average, A = average, A+ = above average.
6 Harvest dates were 6/6, 6/9, 6/14, 6/21, 6/28, 7/7, 7/12, 7/19 over a 44-day harvest season.
7 Least significant difference (P = 0.05).

The blueberries judged to be the most attractive at Quicksand were Duke, O' Neal, Brigitta, Ozarkblue, Bluecrop, and Patriot. The most attractive at Laurel Fork were Patriot, Toro, Blueray, Brigitta, and Bluecrop, (Tables 1 and 2). A variety's maturity is measured as the percent of the total season's yield that is harvested in the first two pickings. Spartan (49%), O'Neal (40%) and Duke (31%) were the earliest maturing cultivars at Quicksand. At Laurel Fork, Duke (65%), O'Neal (35%), and Reka (32%) were the earliest maturing cultivars.

The two North Carolina cultivars, NC1832 and NC1827, have small berries with a pleasant, but distinctive taste. NC1832 tends to flower in the fall. Plants of all five North Carolina selections continued to grow rapidly this summer and are now much larger than the earlier-planted highbush cultivars. Late-maturing Kentucky blueberries will require protective sprays to prevent Japanese beetle damage.

These results represent the sixth harvest of these cultivars after 7½ to 8½ years growth. Additional tests and observations will be directed toward improved harvesting techniques.

Survival of Blueberry Cultivars in Western Kentucky

Joseph G. Masabni, John Strang, and Dwight Wolfe, Department of Horticulture

Introduction

Blueberries are native to North America. They have recently been touted for their health benefits because of their high levels of antioxidants. Highbush blueberries have been a good supplemental crop for Kentucky growers who want to use rolling land not suitable for tillage. Kentucky has a small acreage of commercial blueberry production. Results from a previous highbush blueberry cultivar have been reported in previous issues of the Fruit and Vegetable Research Report (1). This study was initiated in order to further evaluate a number of highbush blueberry varieties and other types of blueberries for adaptability to Kentucky soils and climatic conditions.

Materials and Method

In the spring of 2004, two new blueberry cultivar trials were planted at UK Research and Education Center, Princeton, Kentucky. The first trial consisted of combination of 13 Northern and Southern Highbush cultivars randomized in a complete block design with six replications. These plants were spaced 4 ft apart within rows spaced 14 ft apart. The second trial consisted of nine Rabbiteye blueberry cultivars randomized in a complete block design with six replications. These plants were spaced 6 ft apart within rows 14 feet apart. Prior to planting each trial, the pH was reduced from above 6.0 to 5.4 with elemental sulfur. Both plantings were mulched in spring of 2005 with pine bark mulch and trickle-irrigated with 1/2 gallon/hour in-line emitters.

Results and Discussion

Temperatures during the summer of 2005 were above average and rainfall was below normal. Consequently, mortality was high, especially in the Northern and Southern Highbush trial. The cultivars in the two plantings and their survival rates as of October 25, 2005, are presented in Table 1.

Literature Cited

1. Masabni, J., G. R. Brown (Professor Emeritus), and D. Wolfe, 2004. Highbush Blueberry Cultivar Trial in Western Kentucky. 2004 Fruit and Vegetable Crops Report, PR-504:32-33.

Table 1. Survival of blueberry cultivars in recent plantings at UKREC, Princeton, Ky.

Blueberry Cultivars	Percent of Bushes Currently Surviving[1]
Northern Highbush Cultivars	
Bluecrop	67
Chandler	83
Echota	0
Spartan	33
NC-1871	100
NC-3129	100
Southern Highbush Cultivars	
Arlen	0
Duplin	0
Legacy	50
Lenoir	0
Misty	100
NC-2927	83
Ozarkblue	83
Pamlico	50
Sampson	17
Star	100
Rabbiteye Cultivars	
Climax	67
Columbus	33
Ira	83
NC-1827	67
Onslow	100
Powderblue	100
Tiffblue	50

[1] Six plants of each cultivar were originally planted.

Evaluation of Thornless Semi-Erect and Erect Blackberry Varieties and Training Systems

John Strang, April Satanek, Katie Bale, John Snyder, Courtney Hart, Chris Smigell, and Darrell Slone, Department of Horticulture

Introduction

Blackberries continue to be popular with Kentucky consumers, and most growers find that high quality blackberries are readily marketable. This study was initiated as part of the New Crops Opportunities Fruit Project at the Horticultural Research Farm in Lexington, Kentucky. One portion of the study has been designed to evaluate two cane training systems using a double-T four-wire trellis for three thornless, semi-erect blackberry varieties. The second portion of the study is to evaluate a plastic bailing twine trellis for cane stabilization versus no trellis for two thornless, erect blackberry varieties.

Materials and Methods

Semi-erect thornless blackberry plants were set in spring 2000 into black plastic-mulched beds with trickle irrigation. Each plot consisted of three plants of either the Hull Thornless, Triple Crown, or Chester varieties, spaced 8 ft apart in the row with 12 ft between rows. Each plot was replicated three times in a randomized block design. All plants were trained on a double-T four-wire trellis with the lower two wires 2 ft apart and the top two wires 4 ft apart. Two training systems were used: a conventional system and the minimal pruning system (referred to as the Oregon system in previous UK Research Reports). One plant of the three in each plot was harvested for yield.

In the conventional system, primocanes were tipped when they had extended one foot above the top of the trellis. Dead fruiting canes that had cropped were removed in the fall. During early spring dormant pruning, spindly canes and/or those that had red-necked cane borer swellings were removed. Lateral branches were pruned to 18 inches in length and those that were within 18 inches of the ground were removed completely.

In the minimal pruning system, primocanes were not summer tipped. In the spring, floricanes were not thinned, although those with red-necked cane borer swellings were removed. Low laterals, within 18 inches of the ground, were removed. Laterals above this were not cut back and were wound around, and sometimes loosely tied to the closest trellis wire, extending away from the plant.

Arapaho and Apache erect blackberry plants were set 3 ft apart in the guard rows on the north and south sides of the semi-erect blackberry plot. These were also set in black plastic with trickle irrigation. Trellising treatments (supported and unsupported) and varieties were each replicated three times in a completely randomized design. Plots consisted of three plants of the same variety, of which two plants were harvested for yield. Metal fence posts were set every 9 ft, and plastic bailer twine was run on both sides of the supported treatment at a height of 3.5 ft.

During the first (2000) growing season, canes were allowed to trail and grow as much as possible. In the spring of 2001, the erect blackberry floricanes were pruned severely to encourage development of more vigorous shoots for the following season. During the summers (2001-2003), primocanes were tipped at a height of about 3 ft. Spindly canes and those with red-necked cane borer swellings were removed in the spring. Laterals were cut back to 16 to 18 inches in length.

All plants were fertilized in February 2005 with calcium nitrate at the rate of 8 lb/100 ft row (44 lb N/A). Irrigation was necessary in 2005. Weeds were controlled with a preemergent application of Surflan, postemergence treatment with Poast, and hand weeding. Liquid lime sulfur at the half-inch growth stage and Cabrio and Nova during the season were used for disease control. Japanese and green June beetles were controlled with malathion. Raspberry crown borers were noted in a number of plants in 2004, and guthion was applied as a soil drench in October 2004. Bird pressure was severe early in 2002 and 2003 and moderate in 2004 and 2005. An avian alarm was used to reduce bird losses.

Plants were harvested each year from 2001 through 2005. Data were collected for yield, fruit size, and fruit soluble solids. The 2002 and 2005 seasons were hot and dry, while the 2003 and 2004 seasons were cool and wet. Data are shown for the 2005 season.

Results and Discussion

In 2005 the Chester semi-erect variety significantly out-yielded the Triple Crown variety (Table 1), while in 2004 Chester out-yielded both Hull Thornless and Triple Crown. In 2003 both Chester and Hull Thornless significantly out-yielded Triple Crown. Yields in 2005 were roughly 4,000 pounds less for all varieties as compared to 2004. This could be attributed to the extremely dry 2005 season and possible overproduction in 2004. Prior to 2005, yields had substantially increased annually for all three varieties. Triple Crown has consistently produced the largest berries for the last four years, and these had a higher soluble solids content than those of Chester, which had a higher soluble solids content than Hull Thornless berries.

As in all years except 2004, there was no difference in yield between the minimal pruning and the conventional training system (Table 2). In 2004 the minimal pruning system yielded more than the conventional system. Thus, the minimal pruning system may yield slightly more than the conventional system. However, average

Table 1. Thornless semi-erect blackberry variety yield, average berry weight, and soluble solids, 2005 harvest.

Variety	Yield[1] (lb/A)	Avg. Berry Wt.[1](oz)	Soluble Solids[1](%)
Chester	27,585 a	0.21 b	9.4 b
Hull Thornless	22,380 ab	0.21 b	8.5 c
Triple Crown	15,839 b	0.30 a	11.7 a

[1] Means within a column followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05).

berry weight was again smaller for the minimal pruning system, as in all previous years but 2002. When average berry weight is examined with respect to training system and variety, both Triple Crown and Hull Thornless produced their largest berries in the conventional training system in 2005, while there was no difference in berry size between the two systems for Chester (data not shown). The only other year in which a variety produced larger berries using a particular training system was in 2003 when Hull Thornless produced larger berries using the conventional system. There was no difference in berry soluble solids contents between training systems in 2005, while the minimal pruning system had slightly higher berry soluble solids levels in 2004.

For the thornless erect varieties, Apache far out-yielded Arapaho in 2005, as it had in 2003 and 2004 (Table 3). As with the thornless semi-erect varieties, yields were lower than in 2004. Apache has consistently produced larger berries than Arapaho, but there was no difference in soluble solids contents between the two varieties as there was in 2003 and 2004. Berry weight for Apache thornless erect berries averaged 0.26 oz, while that of Triple Crown, the largest of the semi-erect berries, averaged 0.30 oz.

There were no significant differences in yield, average berry weight, or soluble solids between the no-trellis and string trellis treatments for the erect thornless varieties (Table 4). This has been consistent throughout this study. The 2005 growing season was not a windy one, and there was very little cane breakage in the no-trellis plot. Apache had the more attractive fruit of the two varieties. The first, middle, and last harvest dates in 2005 for all the varieties can be found in Table 5.

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Table 2. Thornless semi-erect blackberry yield, average berry weight, and soluble solids based on training system, 2005 harvest.

Training System	Yield[1] (lb/A)	Avg. Berry Wt.[1] (oz)	Soluble Solids[1] (%)
Conventional	21,949 a	0.24 a	9.8 a
Minimal pruning	21,921 a	0.21 b	9.9 a

[1] Means within a column followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05).

Table 3. Thornless erect blackberry variety yield, average berry weight, and soluble solids, 2005 harvest.

Variety	Yield[1] (lb/A)	Avg. Berry Wt.[1] (oz)	Soluble Solids[1] (%)
Apache	6,330 a	0.25 a	11.5 a
Arapaho	607 b	0.12 b	11.0 a

[1] Means within a column followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05).

Table 4. Thornless erect blackberry yield, average berry weight, and soluble solids based on training system, 2005 harvest.

Training System	Yield[1] (lb/A)	Avg. Berry Wt.[1] (oz)	Soluble Solids[1] (%)
No trellis	3,481 a	0.24 a	11.2 a
String trellis	3,457 a	0.24 a	11.5 a

[1] Means within a column followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05).

Table 5. Harvest date data, 2005 harvest.

Variety	First Harvest	Mid-Point[1]	Last Harvest
Arapaho	June 24	July 9	July 29
Apache	July 8	July 24	Aug. 16
Triple Crown	July 8	July 23	Aug. 26
Hull Thornless	June 30	July 31	Sept. 2
Chester	July 12	Aug. 8	Sept. 6

[1] Date on which half of the berries were harvested, based on total yield weight.

Rootstock and Interstem Effects on Pome Fruit Trees

Joe Masabni and Dwight Wolfe, Department of Horticulture

Introduction

Apple is the principal tree fruit grown in Kentucky because of generally favorable weather and other growing conditions. Still, the hot and humid summers and heavy clay soils make apple production more difficult for Kentucky growers than for growers in neighboring apple-producing regions with more favorable conditions. The hot and humid summers are also a factor in high disease and insect pressure in Kentucky orchards.

In spite of these challenges, productive orchards are high per-acre income enterprises, suitable for rolling hills and upland soils. Furthermore, orchards in these sites have less soil erosion potential. Unfortunately, Kentucky imports more apples than it produces.

Identification of improved rootstocks and cultivars is fundamental for advancing the Kentucky apple industry. For this reason, Kentucky cooperates with 39 other states and three Canadian provinces in the Cooperative Regional NC-140 Project entitled, "Rootstocks and Interstem Effects on Pome Fruit."

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 1999 apple rootstock trial was designed to compare the adaptability of the slender-spindle and the French vertical-axe systems in orchards on Kentucky soils. In addition, the semi-dwarf rootstocks in the 1999 apple rootstock trial evaluate the rootstocks' abilities to support trees without a trellis. The 2002 apple rootstock trial provides information on performance differences among newly-released rootstock clones. The 2003 apple rootstock trial evaluates the adaptability of some new rootstocks to Kentucky climates and soils. The 2003 apple rootstock physiology trial primarily evaluates the relationship between different environments (sites), crop loads, and fruit size.

The NC-140 orchard trials are used as demonstration plots for visiting fruit growers, Extension personnel, and researchers. The data collected from these trials will help establish base-line production and economic records for the various orchard system/rootstock combinations that can be used later by Kentucky apple growers.

Materials and Methods

Scions of known cultivars on various rootstocks were produced by nurseries and distributed to cooperators for each planting. The University of Kentucky has three NC-140 rootstock plantings at the UK Research and Education Center (UKREC) at Princeton:

I. The 1999 dwarf and semi-dwarf apple rootstock trial consists of two groups (both have 'Fuji' as the scion cultivar):
   i) 11 dwarfing rootstocks with six replications per rootstock.Trees are planted on a 10 ft x 16 ft spacing.
   ii) six semi-dwarfing rootstocks with six replications per rootstock. Trees are planted on a 13 ft x 20 ft spacing.

Eight of the dwarfing and three of the semi-dwarfing rootstocks have not been tested previously at UKREC.

II. 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 ends of each row. A trellis was constructed and trickle irrigation installed a month after planting. Trees are spaced 8 ft apart within rows 15 ft apart.

III. The 2003 apple rootstock and 2003 apple physiology trials consist of two groups (both have 'Golden Delicious' as the scion cultivar):
   i) 11 rootstocks with four replications with two of each rootstock per replication. Trees are planted on an 8 ft x 15 ft spacing.
   ii) five rootstocks with six replications per rootstock. Trees are planted on an 8 ft x 15 ft spacing.

Table 1. 2005 results for the 1999 NC-140 dwarf and semi-dwarf apple rootstock trial, UKREC, Princeton, Ky.

Rootstock	Percent Survival (number of trees planted)	Cumulative Yield (lbs/tree)	2005 Yield (lbs/tree)	Fruit Weight (oz)	Trunk Cross-Sectional Area (sq. in.)	Number of Root Suckers
Dwarfing[1]						
CG.3041	50 (2)	474	274	6.3	8.2	0.0
CG.4013	100 (4)	457	108	5.8	14.2	12.3
G.16T	100 (5)	396	119	5.6	9.7	3.2
CG.5179	83 (6)	376	140	6.0	8.6	6.4
G.16N	100 (4)	370	138	5.2	9.5	2.5
CG.5202	80 (5)	317	51	5.8	9.0	6.3
M.9NAKBT337	83 (6)	302	48	6.3	8.1	7.2
Supporter 1	100 (6)	299	122	4.3	5.5	1.8
Supporter 2	100 (6)	295	88	5.0	6.9	0.2
Supporter 3	100 (6)	294	121	4.7	5.5	3.0
M.26 EMLA	83 (6)	232	32	2.9	7.7	2.4
Mean	91	332	101	5.1	8.2	4.1
LSD (5%)	NS	NS	NS	NS	2.3	7.3
Semi-Dwarfing[1]						
CG.30N	100 (2)	570	147	6.2	12.1	8.0
CG.7707	60 (5)	404	36	5.5	12.5	2.3
M.7 EMLA	100 (6)	296	49	5.9	10.5	26.3
CG.4814	80 (5)	294	28	6.0	10.0	9.3
M.26 EMLA	67 (6)	279	87	5.8	8.1	0.5
Supporter 4	17 (6)	106	61	6.2	2.1	7.0
Mean	67	327	61	5.9	10.0	11.4
LSD (5%)	53	148	NS	NS	NS	19.7

[1] Arranged in descending order of cumulative yield.

All trials were laid out as randomized block designs, except for the 2003 apple rootstock/physiology trial, which was laid out in a completely randomized design. Orchard floor management consisted of a 6.5 ft herbicide strip with mowed sod alleyways. Trees were fertilized and sprayed with pesticides according to local recommendations (1, 2). Yield, trunk circumference measurements, and number of root suckers were recorded for all of the rootstock trials. Fruit size was calculated as the average weight (oz) of 50 fruits.

Results and Discussion

The winter of 2005 was generally mild, in spite of a couple of cold snaps where temperatures dropped to 9.6°F on 18 January and 14.3°F on 23 January. A short wet spring was followed by a hot dry summer.

I. 1999 Dwarf and Semi-Dwarf Apple Rootstock Trial

At planting time, we received 90 trees of a possible 102 because 12 trees were not available (one each of G.16N, CG.4814, and CG.5202, two CG.4013, three CG.3041, and four CG.30N). Three trees among the dwarfing group never leafed out after planting (one G.16T, one G.16N, and one CG.3041), and one tree among the semi-dwarfing group on CG.7707 had the wrong scion for our trial.

The number of root suckers per tree varied significantly among both groups of rootstocks (Table 1). Trees on CG.3041 and CG.4013 had the least and most root suckers, respectively, among the dwarfing rootstocks. Trees on M.26 EMLA and M.7 EMLA had the least and most root suckers, respectively, among the semi-dwarfing rootstocks.

The trunk cross-sectional area varied significantly only among the dwarf rootstocks, while tree mortality and cumulative yield varied significantly only among the semi-dwarf group. Yields and average fruit weights did not vary significantly by rootstock for either the dwarf or semi-dwarf group in 2005. Trees on the Supporter Series of dwarf rootstocks (Supporter 1, 2, and 3) have all survived. Conversely, only 17% of the trees on Supporter 4 have survived in the free-standing, semi-dwarf trial.

II. 2002 Apple Rootstock Trial

Sixty-three trees of 'Buckeye Gala' were planted. 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 in 2005, fall trunk cross-sectional area, and number of root suckers, but no difference was observed in fruit size as measured by average fruit weight (Table 2). The combined yield over the past two years was greatest for trees on M.26 NAKB and M.9 Nic29. Scions on M.9 Burg 756 and M.9 Nic29 yielded the most fruit in 2005. P.14 and B.9 Europe rootstocks have produced the largest and smallest trees, respectively, in this trial.

Table 2. 2005 results for the 2002 NC-140 apple rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (number of trees planted)	Cumulative Yield (lbs/tree)	2005 Yield (lbs/tree)	Fruit Weight (oz)	Fall Trunk Cross-Sectional Area (sq. in.)	Number of Root Suckers
M.26 NAKB	86 (7)	91	56	5.5	4.5	0.0
M.9 Nic29	100 (7)	89	59	5.3	3.5	10.6
M.26 EMLA	57 (7)	82	50	5.3	4.2	0.3
M.9 Burg 756	71 (7)	81	61	6.2	4.5	2.8
M.9 T337	57 (7)	75	55	6.0	4.1	7.8
Supporter 4	86 (7)	74	48	5.5	4.4	5.2
P.14	71 (7)	66	51	5.9	7.2	0.6
B.9 Treco	86 (7)	61	34	5.3	2.2	3.3
B.9 Europe	86 (7)	38	19	4.2	1.4	3.5
Mean	78	73	48	5.4	3.9	4.0
LSD (5%)	NS	25	20	NS	1.3	4.9

[1] Arranged in descending order of cumulative yield.

Table 3. 2005 results for the 2003 NC-140 apple rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (number of trees planted)	2005 Yield (lbs/tree)	Fruit Weight (oz)	Fall Trunk Cross-Sectional Area (sq. in.)	Number of Root Suckers
CG.5935	63 (8)	47	6.4	3.3	0.3
Bud.62-3	100 (8)	31	7.1	3.2	0.4
CG.3041	88 (8)	30	6.5	2.4	1.6
J-TE-H	100 (8)	27	6.4	4.0	0.0
M.9T337	88 (8)	25	6.1	3.2	0.0
G.16	63 (8)	25	5.7	3.0	0.0
M.9Pajam	100 (8)	19	6.0	3.3	1.7
PiAu51-4	100 (7)	17	6.4	6.3	0.0
M.26	100 (8)	17	5.6	2.6	0.3
PiAu56-83	100 (8)	15	6.8	7.3	0.0
B.9	88 (8)	11	5.7	1.0	0.6
Mean	90	23	6.3	3.7	0.4
LSD (5%)	29	11	0.9	0.7	1.0

[1] Arranged in descending order of 2005 yield.

Table 4. 2005 results for the 2003 NC-140 apple physiology trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (number of trees planted)	2005 Yield (lbs/tree)	Average Fruit Wt (oz)	Average Number of Fruit Left After Thinning	Fall 2005 Trunk Cross-Sectional Area (sq. in.)	Number of Root Suckers
M.26	90 (10)	11.0	6.9	33	3.3	0.0
M.9 T337	100 (10)	10.9	6.8	31	2.9	0.5
G.16	90 (10)	10.7	5.3	34	2.9	0.0
Mean	93	10.9	6.4	33	3.0	0.2
LSD (5%)	NS	NS	1.3	NS	NS	NS

[1] Arranged in descending order of 2005 yield.

III. 2003 Apple Rootstock and Physiology Trials

Tree survival, yield, average fruit weight, trunk cross-sectional area, and number of root suckers all varied significantly among the trees in the 2003 apple rootstock trial (Table 3). Trees on CG.5935 yielded the most fruit in 2005. However, only 63% of the trees on this and the G.16 rootstocks have survived. Trees on PiAu56-83 are the biggest this trial.

For all trees in the physiology trials, the number of fruit left after the spring fruit thinning was adjusted to four per square centimeter of trunk cross-sectional area, for an average of 33 fruits per tree (Table 4). No significant differences were observed among the three rootstocks in mortality, yield, trunk cross-sectional area, or number of root suckers. However, fruit size (average weight per fruit) was significantly smaller for scions on G.16 rootstocks than it was for scions on either M.26 or M.9 rootstocks.

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Asian Pear, Apple, and Peach Variety Demonstrations

Joseph Masabni, Dwight Wolfe, June Johnston, and Hilda Rogers, Department of Horticulture

Introduction

One of the initial and most important decisions every fruit producer makes is the choice of cultivars. Although cultivar performance and fruit quality information is very useful, obtaining this information is time-consuming, due to the time required for fruit trees to start production. 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 potential of performing well in Kentucky.

Materials and Methods

In the spring of 1997, a training/pruning trial consisting of 36 trees per row was planted in the orchard of the UK Research and Education Center at Princeton, Kentucky (1). Guard rows of various apple cultivars (two trees per cultivar) were planted on the east and west sides of the trial. Four Asian pear cultivars (eight trees) were also included in the east side guard row. Spacing and cultural practices were the same as described previously for the optimal training trial (1).

In 2004 (2) and 2005, phenological stages were recorded in the spring and yield, fruit size (average weight of 50 fruits), flesh firmness, and the percent soluble solids (Brix) were recorded at harvest.

In 2004, a block of 37 peach cultivars was planted. This planting consists of two trees per variety spaced 6 ft apart within rows 18 ft apart.

Results and Discussion

Phenology, harvest, and fruit quality data for the apples and Asian pears are presented in Tables 1 and 2. Yield comparisons between any two varieties should not be used as evidence that one variety is a better yielder than the other. We will continue evaluating these varieties over a few years to determine how they perform over time.

The following comments reflect observations for the 2005 season only. The top three yielding apple varieties in 2005 were Crimson Crisp (Coop 39), Yataka, and Liberty, yielding 212, 130, and 121 lbs/tree, respectively. Phenology and trunk cross-sectional area (measured 12 in. above the soil line) of each peach cultivar are presented in Table 3. Peach cultivars without phenology data in Table 3 were planted in 2005.

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Table 1. Dates of phenological stages for apple and pear cultivars at Princeton, Ky., 2005.

Cultivars/Rootstock (Nursery)	Green Tip	Half-Inch Green	Tight Cluster	Pink	Bloom	Petal Fall	Fruit Set
Asian Pear							
Chojuro / OHxF97 (RM)	3/25	3/31	-	-	4/6	4/13	4/20
Korean Giant / OHxF97 (RM)	3/25	3/31	-	-	4/8	4/13	4/20
Niitaka / OHxF333 (RM)	3/25	3/31	-	-	4/8	4/13	4/20
Apple							
Jonagold De Coster / M.9 (ACN)	3/29	3/31	4/4	4/10	4/12	4/20	4/24
Rubinstar Jonagold / M.9 (Wafler's)	3/29	3/31	4/4	4/10	4/12	4/20	4/24
Morren's Jonagored / B.9 (Stark's)	3/29	3/31	4/4	4/10	4/12	4/21	4/24
Shizuka / B.9 (RM)	3/29	3/31	4/4	4/8	4/11	4/18	4/20
Florina / CG.10 (RM)	3/31	3/31	4/6	4/10	4/12	4/20	4/22
Enterprise 'PP9193' / CG.10 (RM)	3/29	3/31	4/4	4/8	4/11	4/20	4/22
Sun Fuji / M.9 (ACN)	3/29	4/4	4/6	4/8	4/11	4/20	4/22
Yataka / M.9 (Starks)	3/29	4/4	4/6	4/11	4/13	4/20	4/22
Senshu / M.9 (Starks)	3/29	4/4	4/6	4/11	4/13	4/20	4/22
GoldRush / M.9 (Starks)	3/29	3/31	4/6	4/8	4/11	4/21	4/24
Pristine 'PPAF' / M.9 (RM)	3/29	3/29	4/4	4/8	4/11	4/20	4/22
Monark / B.9 (RM)	3/25	3/29	4/4	4/6	4/8	4/16	4/20
William's Pride 'PP6268' / O.3 (RM)	3/29	3/31	4/4	4/6	4/11	4/18	4/22
Redfree 'PP4322' / CG.10 (RM)	3/31	4/4	4/6	4/11	4/13	4/20	4/22
Sansa 'PP 6519' / M.9 (ACN)	3/31	4/4	4/6	4/9	4/11	4/22	4/27
Rezista 'Gala' (Releika)	3/29	3/31	4/4	4/6	4/11	4/22	4/27
Crimson Crisp-Coop 39 / CG.10 (RM)	3/31	4/4	4/6	4/11	4/13	4/22	4/27
Big Red 'BJ 45' Gala / CG10 (RM)	3/29	3/31	4/4	4/8	4/11	4/19	4/22
6882 Pixie Crunch Dwarf / M.9	3/29	3/31	4/4	4/11	4/13	4/22	4/27
Liberty / M.9 (Starks)	3/31	4/4	4/6	4/8	4/11	4/20	4/24
Scarlet O'Hara-Coop25 / B9 (RM)	3/31	4/4	4/6	4/11	4/13	4/20	4/22

Table 2. Harvest data from the 1997 apple and pear cultivar trial at Princeton, Ky., 2005.

Cultivars/Rootstock (Nursery)	Harvest Date	2005 Yield (lbs/tree)	Fruit Weight (oz)	Flesh Firmness (lbs)	Brix (%)
Asian Pear					
Chojuro / OHxF97 (RM)	9/3	30	-	18.1	11.4
Korean Giant / OHxF97 (RM)	-	-	-	-	-
Niitaka / OHxF333 (RM)	-	-	-	-	-
Apple					
Jonagold De Coster / M.9 (ACN)	9/14	87	7.9	16.6	13.3
Rubinstar Jonagold / M.9 (Wafler's)	9/14	39	9.2	15.5	13.1
Morren's Jonagored / B.9 (Stark's)	9/26	70	9.0	10.0	14.1
Shizuka / B.9 (RM)	9/26	38	11.0	11.7	12.2
Florina / CG.10 (RM)	9/26	81	7.3	15.3	12.7
Enterprise 'PP9193' / CG.10 (RM)	10/3	91	7.8	18.5	12.3
Sun Fuji / M.9 (ACN)	10/18	44	6.0	17.8	15.8
Yataka / M.9 (Starks)	10/18	130	5.8	14.7	13.9
Senshu / M.9 (Starks)	-	-	-	-	-
GoldRush / M.9 (Starks)	-	-	-	-	-
Pristine 'PPAF' / M.9 (RM)	7/14	120	3.5	13.5	10.5
Monark / B.9 (RM)	7/14	49	5.1	13.7	11.5
William's Pride 'PP6268' / O.3 (RM)	7/26	41	3.1	11.8	11.6
Redfree 'PP4322' / CG.10 (RM)	7/26	94	5.9	17.6	11.9
Rezista 'Gala' (Releika)	8/19	12	3.5	18.4	13.7
Sansa 'PP 6519' / M.9 (ACN)	8/3	91	11.6	16.7	15.9
Crimson Crisp-Coop 39/CG.10 (RM)	8/3	212	9.8	25.0	11.6
Big Red 'BJ 45' Gala / CG10 (RM)	8/25	40	3.5	14.0	12.8
6882 Pixie Crunch Dwarf / M.9	8/19	4	3.7	22.4	13.3
Liberty / M.9 (Starks)	9/15	121	6.1	21.8	13.1
Scarlet O'Hara-Coop25 / B9 (RM)	8/19	50	6.1	25.1	13.6

Table 3. Dates of phenological stages for peach cultivars at Princeton, Ky., 2005.

Peach Cultivar	Swollen Bud	Half-Inch Green	Pink	Bloom	Petal Fall	Fruit Set	Trunk Cross-Sectional Area (sq. in.)
John Boy	3/21	3/25	3/31	4/4	4/8	4/13	1.6
White Lady	3/21	3/25	3/31	4/4	4/8	4/13	3.2
Redhaven	3/21	3/25	3/31	4/4	4/8	4/13	2.9
RedStar	3/21	3/31	4/2	4/4	4/8	4/13	5.3
Snow Brite	-	-	-	-	-	-	0.8
Sugar May	-	-	-	-	-	-	0.4
Spring Snow	-	-	-	-	-	-	0.4
Allstar	3/21	3/25	3/29	4/6	4/8	4/13	2.8
Contender	3/21	3/25	4/4	4/4	4/8	4/13	4.2
Coralstar	3/21	3/25	3/31	4/4	4/8	4/13	3.5
Sugar Giant	-	-	-	-	-	-	0.7
Klondike	3/21	3/29	3/31	4/4	4/8	4/13	2.6
NJ 275	-	-	-	-	-	-	0.4
John Boy II	3/21	3/25	3/29	4/4	4/8	4/13	3.8
Snow Giant	3/21	3/29	3/31	4/4	4/8	4/13	1.4
Laurol	3/21	3/25	3/31	4/4	4/8	4/13	2.2
Encore	3/21	3/25	3/31	4/4	4/8	4/16	1.6
Cresthaven	3/21	3/31	4/4	4/6	4/8	4/13	1.8
Glowinstar	3/21	3/31	4/4	4/6	4/8	4/13	4.4
Blushingstar	3/21	3/31	4/4	4/6	4/8	4/13	2.0
Summer Breeze	3/21	3/25	3/31	4/4	4/8	4/13	2.0
PF Lucky 21	3/21	3/25	3/29	4/4	4/8	4/13	2.3
PF 17	3/21	3/25	3/29	4/4	4/8	4/13	2.6
PF 15A	3/21	3/25	3/31	4/4	4/8	4/13	2.3
PF Lucky 13	3/21	3/25	3/29	3/31	4/8	4/13	3.5
PF 7	3/21	3/25	3/31	4/4	4/8	4/13	2.2
PF 5 B	3/21	3/25	3/31	4/4	4/8	4/13	3.4
PF 1	3/21	3/25	3/31	4/4	4/8	4/13	3.5
PF 35-007	3/21	3/25	3/31	4/4	4/8	4/13	1.2
Sweet-N-Up	-	-	-	-	-	-	0.4
Crimson Rocket	-	-	-	-	-	-	0.4
PF 27A	3/21	3/25	3/29	4/4	4/8	4/13	1.6
PF 25	3/21	3/25	3/31	4/4	4/8	4/13	2.0
PF 24C	3/21	3/31	4/4	4/6	4/8	4/13	1.6
PF 20-007	3/21	3/31	4/4	4/6	4/8	4/13	2.7
Galaxy	-	-	-	-	-	-	0.9
Flat Wonderful	-	-	-	-	-	-	0.9

Fall Weed Control in Apples and Peaches

Joseph Masabni, Department of Horticulture

Introduction

Fall-applied herbicides are an important component of a comprehensive weed control regimen, especially to control perennials such as honeyvine milkweed, quackgrass, and johnsongrass. Growers are often busy in the fall with harvest and fruit sales and neglect the importance of weed control after harvest. In order to assist fruit growers with their weed control options, two experiments, one in an eight-year old Golden Delicious apple orchard and the other in an 11-yr old Red Haven peach orchard, were conducted. The purpose of these experiments is to determine the residual control and benefits of various herbicides applied in the spring and fall of 2005 on weed pressure in spring of 2006.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a four-nozzle boom calibrated to spray a 5 ft band at 30 psi and 3 mph walking speed. The 8002-nozzles were set at 17 inches above ground to obtain good spray overlap and complete weed coverage. The spray boom was moved in and out of the tree row to avoid spraying tree trunks. Therefore, weeds at the bases of tree trunks were taller throughout the season and did not reflect the effectiveness of the applied herbicides. Plots were 10 ft x 66 ft long for peach and 10 ft x 27 ft long for apple. The experimental design consisted of a randomized complete block with three replications.

The preemergence (PRE) treatments were applied on 14 April 2005 when weeds were 3-4 inches tall. Peach and apple trees were at 100% and 50% full bloom, respectively. As weeds had been growing since early March, Roundup WeatherMax at 16 oz/A (0.68 lb ai/A) was included with all treatments. The postemergence (POST) treatments were applied on 15 June 2005 when peach fruits were 1 to 2 inches in diameter. Roundup at 16 oz/A was also included with the POST treatment. All treatments were applied early in the morning when the average wind speed was 2.5 mph.

In addition to currently labeled herbicides, this experiment also included non-labeled herbicides on apple and peach in an effort to support their possible registration. Chateau is labeled on non-bearing fruit trees with a one-year pre-harvest interval, and should not be used in bearing orchards. Readers are reminded that all experimental herbicides tested in this report would not be legal applications in commercial or residential settings, and UK does not recommend their use until they are labeled. The reason Chateau is listed here is because the intent of this experiment is to evaluate fall-applied herbicides on non-bearing fruit trees.

This experiment also evaluated the benefits of 'Attach,' an additive that improves preemergence weed control. PRE and POST applications of treatment 2 included Attach while those of treatment 3 did not.

The fall treatments listed in the tables were applied in 2005, when soil temperatures were below 55°F but before soil freezing. Roundup was included with all treatments for control of existing weeds.

Visual weed control ratings were made on 6 May and 15 June. Ratings were on a 1 to 10 scale, with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value.

Results and Discussion

In the peach experiment, three weeks after PRE treatments (6 May), all treatments resulted in desirable weed control on all weeds (rating of 7+) when compared to the Roundup-only control (Table 1). Princep was weakest on dandelion, with or without Attach. However, adding Attach to Princep improved control of purple deadnettle three weeks after treatment, but was weaker on clover and marestail. On 15 June (two months after treatment), Attach improved Princep activity on large crabgrass by about 10% and on shepherdspurse by about 30%. Chateau at 6 oz. controlled weeds better than Princep by the first evaluation date. However, its benefit was exhausted by 15 June, with best weed control achieved with treatment 2.

Treatments 4 and 5 had the best weed control but also caused obvious stunting to current season shoot growth. This is a currently available herbicide but not labeled for use on peaches. The observed stunting on peaches is obviously the reason why it is not labeled on this crop.

Similar results were observed with the apple experiment (Table 2). The addition of Attach improved weed control, even two months after PRE application for all herbicides tested (Princep, Karmex, and Devrinol). Chateau at the 6 oz. application rate (the low end of the labeled rate) gave better weed control initially but lost its effectiveness after two months. The experimental treatments (8, 9) gave good to excellent weed control but also resulted in stunting. With stunting observed on both peach and apple, it is doubtful that this herbicide will get registered in the near future.

The final evaluation of this experiment will be conducted next spring when the residual benefit of the fall-applied herbicides will be conducted. An updated report will be presented in next year's Research Report.

Table 1. Weed control ratings for herbicide treatments applied in peach orchard at UKREC, Princeton, Ky., 2005.

						Weed Control Ratings and Dates of Ratings[2]						
Trt No.	Product Name	Formula Conc. (%)	Formula Type	Rate/A	Growth[1] Stage	DAND May 6	CLOVER May 6	PUDN May 6	MATA May 6	DAND Jun 15	LACG Jun 15	SHPU Jun 15
1	Chateau	51	WG	6 oz	PRE,POST	7	9	10	9	1	3	1
	Chateau	51	WG	12 oz	FALL							
2	Princep	4	L	4.8 qt	PRE,POST	6	8	10	8	8	9	7
	Attach		L	1 pt	PRE,POST							
	Casoron	4	G	150 lb	FALL							
3	Princep	4	L	4.8 qt	PRE,POST	6	9	8	10	8	8	4
	Gallery	75	DF	21.3 oz	FALL							
4	Roundup	5.5	L	16 oz	PRE	1	1	1	1	3	1	1
	Attach		L	1 pt	PRE							
1-4	Roundup	5.5	L	16 oz	All trts.							
LSD (P = 0.05)						0	0	0	0	3.7	5	5.6

[1] Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts. = applied with all treatments.

[2] DAND = dandelion; PUDN = purple deadnettle, MATA = marestail; LACG = large crabgrass; SHPU = shepherdspurse; RRPW = redroot pigweed.

Table 2. Weed control ratings for herbicide treatments applied in apple orchard at UKREC, Princeton, Ky., 2005.

Trt No.	Treatment Name	Formula Conc. (%)	Formula Type	Rate/A	Growth Stage[1]	Weed Control Ratings and Dates of Ratings[2] DAND May 6	LACG May 6	CLOVER May 6	DAND Jun 15	LACG Jun 15	CLOVER Jun 15	RRPW Jun 15	SHPU Jun 15
1	Chateau	51	WG	6 oz	PRE,POST	10	9	9	6	5	6	10	6
	Chateau	51	WG	12 oz	FALL								
2	Princep	4	L	4.8 qt	PRE	8	4	8	8	8	10	10	6
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
	Casoron	4	G	150 lb	FALL								
3	Princep	4	L	4.8 qt	PRE	7	4	9	8	3	9	4	7
	Surflan	4	AS	6 qt	POST								
	Gallery	75	DF	21.3 oz	FALL								
4	Karmex	80	DF	4.8	PRE	10	8	10	7	9	10	10	10
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
	Casoron	4	G	150 lb	FALL								
5	Karmex	80	DF	4.8	PRE	9	8	9	6	6	10	10	10
	Surflan	4	AS	6 qt	POST								
	Gallery	75	DF	21.3 oz	FALL								
6	Devrinol	50	DF	8 lb	PRE	8	4	7	7	3	6	5	1
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
	Casoron	4	G	150 lb	FALL								
7	Devrinol	50	DF	8 lb	PRE	7	4	5	3	4	5	3	3
	Surflan	4	AS	6 qt	POST								
	Gallery	75	DF	21.3 oz	FALL								
8	Exp. A			16 oz	PRE	8	7	9	9	5	10	9	10
9	Exp. A			8 oz	PRE	8	8	9	9	3	9	9	9
10	Roundup	5.5	L	16 oz	PRE	5	5	4	1	1	1	1	1
	Attach		L	1 pt	PRE								
1-10	Roundup	5.5	L	16 oz	All trts.								
LSD (P = 0.05)						0	0	0	3.4	4.1	4	4.2	4.2

1 Time of herbicide application in relation to weed growth stage: PRE = preemergence, POST = postemergence, FALL = fall application, All trts. = applied with all treatments.

2 DAND = dandelion; PUDN = purple deadnettle, MATA = marestail; LACG = large crabgrass; SHPU = shepherdspurse; RRPW = redroot pigweed.

Fall Broccoli Cultivar Trial, Northwestern Kentucky

Nathan Howard and John C. Snyder, Department of Horticulture

Introduction

Broccoli has become a reliable fall vegetable crop in western Kentucky in a double cropping system. Many farmers are utilizing black plastic and drip irrigation lines that had been previously used for a summer crop such as peppers or squash. Others are using bare ground and planting broccoli after tobacco harvest. This allows farmers to grow two crops from the same piece of ground in one year. The West Kentucky Grower Cooperative in Owensboro is able to market this broccoli in the fall of the year. We wanted to conduct a cultivar trial with broccoli to determine quality and yield characteristics of new cultivars as well as those currently raised in this region.

Materials and Methods

The trial was conducted in cooperation with a vegetable grower in McLean County in the fall of 2004. The field had cucumbers that were raised in the summer, and they were sprayed with glyphosate as a burn-down before transplanting broccoli. Seed for eight broccoli varieties was obtained from Seedway and seeded in the greenhouse on 5 July. Plants were transplanted on 24 August by hand. The trial was arranged as a randomized complete block design with four replications. Each plot had 20 plants in 18-in.-wide double rows with 15 in. between plants within the rows. The grower applied 50 lbs. N/acre pre-plant through the drip system, and no P and K was applied; another 50 lbs. N/acre was side-dressed when broccoli heads developed. The field was scouted twice weekly and when unacceptable numbers of insects were found, insecticide was applied. One application of Pounce and one application of Capture were used for beet armyworm and cabbage looper control.

The broccoli trial was harvested whenever the majority of plants of each variety had acceptable heads for market. The plot was harvested four times between 20 October and 3 November. We determined and recorded maturity, percentage marketable yield, yield per acre, and percentage hollow stem.

The cooperative markets broccoli in two grades, bunch and crown cut. Bunch broccoli usually has a smaller head size and a lot of stem is left so it can be banded with another head. Fourteen bunches are boxed for direct sales in grocery stores. The crown cut does not have as much stem attached, and usually the head is larger. Crown cut is packaged loose, and usually around 30 heads are placed in a box for restaurant sales. Therefore, each variety was also graded on percentages of crown versus bunch cut at each harvest. All data were analyzed by analysis of variance.

Results and Discussion

The top yielding variety was Windsor, also the earliest maturing variety in the plot (Table 1). This variety has been used as the standard in this area for a few years. A high percentage of broccoli harvested from Windsor was graded as a crown cut. The color of this variety was purplish green at harvest, and it was also the variety with the highest number of small leaves extruding from the middle of the head. The grower would have to determine if the prospective buyer would object to the presence of these small leaves on Windsor. Gypsy yield was second to that of Windsor and was not significantly different from Windsor. Gypsy also had more crown than bunch cut. The marketable percentage for Gypsy was the lowest of all the cultivars because of head browning that was diagnosed as bacterial head rot. Another variety with bacterial head rot was Patron. Patron and Gypsy both had looser and flatter heads, and the wet season likely contributed to disease presence in these varieties. Green Magic, Diplomat, and Liberty all yielded more than 150 boxes/A, had high marketable percentages, good quality ratings, and were mid-season varieties. Coronado Crown had the lowest yield. This variety had more bunch cut broccoli than any other cultivar.

Table 1. Yield, maturity, and quality of eight broccoli cultivars grown in McLean County, 2004.

Variety (Source)	Yield[1,2] (boxes/A)	Crown Cut (%)	Bunch Cut (%)	Hollow Stem[2] (%)	Mkt. %	Net Income[3]	No. Days to Harvest[4]	Shape[5]	Color[6]	Bead Size[7]	Leafy[8]
Windsor (SW)	221 a	69	31	25 c	95	1042	57	4	4.5	1.5	1.5
Gypsy (SW)	217 a	65	35	36 abc	83	1034	61	3	4	2.5	0
Green Magic (SW)	188 ab	60	40	16 c	97	902	60	3.5	3.5	2.5	1
Diplomat (HR)	174 abc	55	45	29 bc	96	830	66	4	3.5	3.5	0
Liberty (SM)	158 abc	51	49	59 a	97	766	68	4	4	2.5	0
Patron (SW)	144 bc	49	51	30 bc	89	701	69	3	4	2.5	0
Belstar (SW)	112 c	51	49	58 ab	96	525	68	4.5	4.5	3.0	0
Coronado Crown (SW)	107 c	36	64	12 c	97	497	63	4	4	3.0	0

1 Sorted by total yield.
2 Means followed by the same letter are not significantly different as determined by Waller-Duncan LSD (P 0.05).
3 Net income returned to grower after co-op commission and charges and before production expenses.
4 Number of days from transplant to first harvest.
5 Head shape score: 1 = flat, 5 = high dome.
6 Head color score: 1-2 = yellow to light green, 3-4 = medium to dark green, 5 = purplish green.
7 Bead size score: 1 = very small and fine, 5 = very large and coarse.
8 Score for extrusion of small leaves through the head: 1 = no leaves, 5 = very leafy.

Hollow stem was seen in some varieties in the plot (Table 1). This condition occurs during very rapid growth periods. High temperatures and high levels of nitrogen also are thought to contribute to this condition. The cultivars Liberty and Belstar had very large stems, and a high percentage of hollow stem was present in these two cultivars.

In conclusion, this trial provides evidence that yields of Windsor and Gypsy were the best of the tested cultivars. The quality of Gypsy was less than desirable, but Windsor was solid in this category except for the leaf protrusion. Therefore, Windsor seems to be a good early variety. For the mid-season, Green Magic and Diplomat seem to be good cultivars with decent yield and good quality. Growers need to use caution in trying new varieties in the field. Always grow small amounts the first year and compare them to your standard variety.

Bell Pepper Evaluations for Yield and Quality in Eastern Kentucky

R. Terry Jones, Amanda Ferguson Sears, and John C. Snyder, Department of Horticulture

Introduction

As a result of several multi-year studies evaluating bell pepper cultivars for resistance to bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria* or Xcv) and fruit quality, nearly 100% of Kentucky's pepper acreage is planted with resistant bell pepper cultivars with high fruit quality, like Aristotle. As new pepper cultivars are released, we try to test them for leaf spot resistance, as well as for fruit yield and quality under Kentucky conditions. Because Kentucky farmers are planting more vegetable crop acreage, new disease problems like Phytophthora blight (*Phytophthora capsici*) and tomato spotted wilt virus (TSWV) are becoming more prevalent. Past studies have shown that pepper cultivars with leaf spot resistance to at least three races of Xcv (races 1, 2, and 3) perform better under high disease pressure. Several of the cultivars in this study also contain resistance or tolerance to TSWV or Phytophthora blight in addition to bacterial spot resistance.

The bell pepper cultivars were tested in replicated trials at two Kentucky locations in 2005 (central and eastern). See the report for central Kentucky elsewhere in this publication.

Materials and Methods

Eleven new bell pepper cultivars with the Bs2 gene for bacterial spot resistance were compared with a main season and early season control varieties, Aristotle and King Arthur, respectively (Table 3). Mature green fruit were harvested two times from late June to mid-August. Fruit were graded and weighed according to class size (U.S. No. 1 extra large, large, medium, chopper and cull). Yields in each class size were multiplied by their respective wholesale market prices to determine gross returns (income) for each cultivar. Wholesale prices for 2005 were used to calculate incomes for the different varieties. The income variable has been a good indicator of a cultivar's overall performance, taking into account time of harvest as well as yields of the different size classes and their price differentials.

The 13 bell peppers were seeded in 72-cell trays in the greenhouse at the Robinson Station on 18 March and were transplanted to the field on 12 May.

Based on the soil test results shown in Table 2, 50 pounds of actual nitrogen along with 60 pounds of P_2O_5 and 60 pounds of K_2O/A were applied the day before planting. Ninety additional pounds of nitrogen/A were applied to the peppers during the growing season for a total of 140 lb actual N/A.

Each plot contained 14 plants in a double row with 7 plants/row. The in-row spacing was 14 in. with 20 in. between rows. One empty space/row was left between plots. Plots were replicated four times in a randomized complete block design. Dual II Magnum 1.3 pt/A was applied to the bare ground between plastic strips to control weeds.

Fruit appearance ratings. All pepper cultivars harvested on (7/18) were laid out on the ground and evaluated for fruit appearance. Overall appearance ratings were the result of several factors listed in order of

Table 1. Seed company descriptions of bell cultivars tested at Quicksand and Lexington, 2005.

Cultivar	Source	Days to Maturity	Comments
Aristotle (X3R)	SW	72	Very large green to red, BLS 1,2,3 and PVY, TMV
Socrates	SW	64	Very early, blocky, green to red, sturdy-medium size plants BLS 1, 2, 3
PS 9915776	SI		5 race BLS resistance, Phytophthora tolerant
Revolution (HMX 1660)	HM	72	Large to ex lg blocky fruit, tall plants. BLS 1,2,3,5, CMV & Phytophthora tolerant. Cool tolerant
Heritage	HM	75	Green to red fruit, tall plant, TSWV resistant, BLS 1, 2, 3, 5
Alliance (HMX2643)	HM	73	Blocky, green to red fruit; BLS 1, 2, 3, 5, "intermediate resistance" to Phytophthora, PVY, PepMoV, CMV.
Patriot	HM	70	Early red, blocky concentrated fruit, BLS 1, 2, 3, 5, and PVY
Double-up	SW	69-80	Early to mid-season. Resistant to BLS 1, 2, 3 and Tobamo virus
Excursion II	RU	75	Large blocky fruit; BLS 1, 2, 3, TSWV, PVY, and TMV
Mahi	EN		large, high-yielding green to red blocky pepper
E41.8338	EN		
Telestar	HZ	Early	Resistant to PVY, TMV, BLS
King Arthur	SI	65-70	BLS susceptible

Table 2. Soil test results for pepper trial plot at Quicksand, Ky., 2005.

pH	Buf-pH	P	K	Ca	Mg	Zn
6.8	6.95	65	339	3236	392	6.6

decreasing importance: overall attractiveness, shape, smoothness, degree of flattening, color, and uniformity of shape.

Results and Discussion

Total marketable yields, gross incomes, and fruit quality characteristics are shown in Table 3. Total marketable yields based on two harvests ranged from 12.8 to 21.2 tons/acre. The growing season was very dry and temperatures were warm-hot with clear skies. Incomes were lower than in previous years and ranged from around $3175 to $5178 per acre. Heritage had the highest marketable yield and the highest number of pounds of extra large fruit. The total marketable yield of nine other pepper cultivars was not significantly different from Heritage (Table 3.).

Heritage produced significantly more pounds of extra large peppers than nine of the other cultivars (Aristotle, Socrates, Revolution, Alliance, Patriot, Excursion II, Mahi, E41.8338, and King Arthur). Only three other pepper cultivars had similar yields of extra large fruit (PS9915776, Double-up, and Telestar (Table 3.).

Fruit quality ratings showed that Aristotle, PS9915776, Patriot and Heritage and Excursion II fruit had the best overall appearance ratings at Quicksand. Socrates and King Arthur had the lowest overall fruit quality ratings. Nine cultivars (Aristotle, PS9915776, Heritage, Alliance, Patriot, Excursion II, Mahi, E41.8338, and Telestar) had commercially acceptable fruit at both Lexington and Quicksand (Table 4).

Growers should also see results from a similar trial in 2005 from central Kentucky found elsewhere in this publication. Results of previous Kentucky research on pepper cultivars can be viewed on the Web at: htttp://www.uky.edu/Ag/Horticulture/comveggie.html.

Table 3. Yields, gross returns, and appearance ratings of bell pepper cultivars in Quicksand, Ky.

Cultivar	Seed Source[1]	Tot. Mkt. Yield[2] (tons/A)	Pounds XL Fruit/A[3]	% XL + Large[4]	Income ($/acre)[5]	Overall Appearance[6]	No. Lobes	Fruit Color	Comments
Aristotle	SW	18.8 AB	14,040 BC	64 BCD	$4,564 ab	6	4-3	Dk green	Good yield.
Socrates	SW	15.9 ABC	11,982 C	52 E	$4,131 abc	4.5	4-3	Pale med. green	Some misshapen fruit distorted lobes.
PS9915776	S	19.2 AB	16,725 ABC	71 AB	$4,571 ab	6	4-3	Dk green	Good shape, little distortion.
Revolution	HM	14.2 BC	13,525 BC	68 ABC	$3,486 bc	5	4-3	Med. green	A lot of pumpkin-shaped fruit.
Heritage	HM	21.2 A	21,250 A	73 A	$5,178 a	6	3-4	Variable green	Slightly irregular shape.
Alliance	HM	12.8 C	11,468 C	65 ABCD	$3,176 c	6	3-4	Variable pale-med green	About 1/3 flattened misshapen fruit.
Patriot	HM	17.5 ABC	13,239 BC	56 DE	$4,130 abc	7	4-3	Mostly dk green	About 1/4-1/3 flattened fruit.
Double-up	HM	17.5 ABC	18,288 AB	67 ABC	$4,318 abc	4.5	3-4-5	Dk green	About 1/4-1/3 flattened fruit. Ugly blossom end.
Excursion II	RU	16.2 ABC	13,297 BC	64 ABCD	$3,738 bc	7	4-3	Dk green	A lot of pumpkin-shaped fruit.
Mahi	EZ	14.0 BC	12,203 C	63 ABCD	$3,281 bc	5	4-3	Med. green	About 1/4 fruit pumpkin-shaped.
E41.8338	EZ	16.8 ABC	14,763 BC	62 BCD	$3,955 abc	5	4-3		A lot of fruit pumpkin-shaped.
Telestar	HZ	17.8 ABC	15,802 ABC	60 CDE	$4,192 abc	5	4-3		
King Arthur	S	17.1 ABC	14,059 BC	62 BCD	$4,206 abc	4	4-3		
Waller-Duncan MSD (P<0.05)		5.64	5,513	9.1	1,311				

1 Seed source identification and address information are listed in Appendix A of this publication.
2 Total marketable yield includes the yields of U.S. Fancy and No. 1 fruits of medium (>2.5 in. diameter) size and larger plus misshapen but sound fruit that could be sold as choppers to foodservice buyers.
3 Pounds of extra large peppers (>3.5 in. diameter).
4 Percentage of total yield that was extra large (>3.5 in. diameter) and large (>3 in. diameter but ≤3.5 in. diameter).
5 Income + gross returns per acre: average 2005 season local wholesale prices were multiplied by yields from the different size/grade categories: $0.17-0.19/lb for extra large; $0.09-0.14/lb for large and mediums, and $0.05-0.11/lb for "choppers," i.e., misshapen fruits.
6 Visual rating: 1-9 scale where 1 = worst, 9 = best, taking into account overall attractiveness, shape, smoothness, degree of flattening, color, and shape uniformity; all fruit from two separate replications were observed on 7/18. A rating of 5 was considered commercially acceptable.

Table 4. Appearance ratings of fresh market bell peppers, Quicksand and Lexington, 2005.

Cultivar	Overall Appearance[1] (QSD)	(LEX)	(Avg)	Number of Lobes (QSD)	No. Lobes (LEX)	Fruit Color (QSD)	Color (LEX)	Comments (QSD)	Comments (LEX)
Aristotle	6	6.5	6.25	4/3	Mostly 4	Dark green on shaded side, light green	Med-dk	High yielder	
Socrates	4.5	4.5	4.5	4/3	Mostly 4	Light green	Lt.-med.	Deep distorted lobes	50% flattened; pumpkin-shaped
PS 9915776	6	6	6.0	4/3	3-4	Dark green, light green on side	Med.	Good shape	Very few flattened; some misshapen
Revolution	5	4.5	4.75	4/3	Mostly 4	Light/dark green	Med-dk.	Pumpkin shape, large ones	50% flattened; otherwise ok
Heritage	6	5.75	5.88	3/4	Mostly 4	Variable green	Med.	Changes color just a little bit	No flattening; shapes somewhat irreg.
Alliance	6	5.5	5.75	3/4	Mostly 4	Variable green	Med-dk.	Shaded side a lighter green	1/3 flattened, otherwise nice
Patriot	7	5	6	4/3	Mostly 4	Mostly dark green	Med-dk.		1/4 to 1/3 flattened.
Double-up	4.5	5	4.75	3/4/5	3-4	Dark green	Med.	Ugly blossom end	1/4 to 1/3 flattened, many 3-lobed
Excursion II	7	5	6.0	4/3	3-4	Dark green, some light	Med.-dk.	A lot of pumpkin-shaped fruits	1/3 flattened; some 3-lobed, nice color
Mahi	6.0	5.5	5.75	4/3	Mostly 4	Dark green, some light	Med.-dk.		1/4 flattened, otherwise nice
E41.8338	5	5.5	5.25	4/3	Mostly 4	Uniform green	Lt-med. Med-dk.	A lot of pumpkin-shaped fruits	<25% flattened
Telestar	5	6	5.5	4/3	3-4	Good green	Med.	A lot of misshapen lobes, deep lobes	Many 3-lobed; some flat and long
King Arthur	4	na	4.0	4/3	na	Medium green	na	A lot of culls, choppers, pumpkin-shaped fruits	Not grown in LEX

[1] Visual rating: 1-9 scale where 1 = worst, 9 = best, taking into account overall attractiveness, shape, smoothness, degree of flattening, color, and shape uniformity; a rating of 5 or above is considered commercially acceptable. QSD = Quicksand, Kentucky; LEX = Lexington, Kentucky.

Table 5. Dates and prices (in dollars) of the grades of bell peppers, 2005.

Date	Jumbo and Extra Large	Large and Medium	Chopper
June 26	$0.21	$0.15	$0.12
July 3	0.21	0.15	0.12
July 10	0.17	0.12	0.05
July 17	0.19	0.11	0.10
July 24	0.19	0.10	0.07
July 31	0.09	0.09	0.06
August 7	0.17	0.09	0.10
August 14	0.17	0.14	0.11
August 21	0.17	0.08	0.05
August 28	0.09	0.08	0.05
September 4	0.09	0.08	0.05
September 11	0.09	0.08	0.05

Bell Pepper Cultivar Evaluations for Yield and Quality in Central Kentucky

Brent Rowell, April Satanek, and John C. Snyder, Department of Horticulture

Introduction

After completing a two-year (2000-01) evaluation of bell pepper cultivars under induced bacterial spot infection (*Xanthomonas campestris* pv. *vesicatoria* or *Xcv*) and in a bacterial spot-free environment, we began a new series of trials in 2003 to compare new cultivars with a previously recommended, highly resistant cultivar with very attractive fruits (Aristotle). While nearly 100% of the pepper acreage in the state is planted with spot-resistant cultivars having the *Bs2* gene (resistance to *Xcv* races 1, 2, and 3), many new resistant cultivars have been released since 2001. Three of the cultivars in this trial (Revolution, Alliance, and PS9915776 (hereafter referred to as "PS...5776"), reportedly have some tolerance to *Phytophthora capsici*, which is becoming more of a problem in the state. Two cultivars (Heritage and Excursion II) reportedly have resistance to tomato spotted wilt virus (TSWV). This thrips-transmitted disease has become economically important in Illinois and in some southern states in the last few years. All varieties tested have resistance to bacterial spot races 1, 2, and 3, but many have not been tested under epidemic conditions in Kentucky.

Bell cultivars were tested in replicated trials at two locations in 2005 (central Kentucky at Lexington and eastern Kentucky at Quicksand). See also the trial report for the same varieties grown in eastern Kentucky.

Materials and Methods

This trial was planted at the Horticultural Crops Research Station in Lexington. All 12 cultivars were seeded on 21 March. Seedlings were grown in 72-cell plastic trays and transplanted to the field on 13 May.

The trial field received 57 lb N/acre prior to planting, supplemented by an additional 54 lb N/acre divided into 13 weekly fertigations (111 lb N/acre season total). Potassium was applied prior to planting according to soil test recommendations. Plots consisted of 20 plants in double rows with four replications in a randomized complete block design. All were planted on raised beds with black plastic mulch and drip irrigation. Plants of all cultivars were spaced 12 in. apart in the row with 15 in. between the two rows on each bed. Beds were 6 ft apart from center to center. A tank mix of maneb plus fixed copper was applied biweekly until mid-August for bacterial spot protection. Three applications of synthetic pyrethroid insecticides and one application of spinosad were made for European corn borer control.

Eleven new bell cultivars with the *Bs2* gene were compared with main season control Aristotle (Table 1); six of these were also tested in 2004. Mature green fruits were harvested only three times from 11 July to 10 Aug. Marketable fruits were graded and weighed according to size class (U.S. No. 1 extra large, large, medium). We also weighed misshapen fruits that could be marketed to foodservice as "choppers."

Incomes. Yields in each size class were multiplied by their respective wholesale market prices to determine gross returns (income) for each cultivar. Weekly wholesale prices from Cumberland Farm Products Cooperative for 2004 were used to calculate incomes from the different cultivars. The income variable has been a good indicator of a cultivar's overall performance, taking into account yields of the different size classes and their price differentials. Earlier maturity usually results in higher prices and incomes.

Fruit appearance ratings. All pepper fruits harvested from two replications at the second harvest (26 July) were laid out on tables for careful examination and quality ratings on July 28. Overall appearance ratings took several things into account including, in order of importance: overall attractiveness, shape, smoothness, degree of "flattening," color, and uniformity of shape.

Results and Discussion

Total marketable yields, gross incomes, and fruit quality characteristics are shown in Table 1. The 2005 growing season was unusually hot and dry, and total marketable yields were low, ranging from 9 to 16 tons/acre (600 to 1066 boxes/acre). Consequently, incomes were also lower than in previous years ranging from $2131 to $3703/acre. The group of highest yielding and highest income varieties included Double-up, Socrates, Heritage, Aristotle, and PS...5776 (Table 1). Unlike 2004, yields of Revolution were very low in 2005—perhaps a result of a large percentage of culls due to flattening of fruits in response to hot weather.

Fruit quality characteristics for bell cultivars are also shown in Table 1. The hot weather resulted in flattening of a large percentage of fruits in some varieties (see "Comments" in Table 1) which resulted in lower appearance scores. Aristotle, with no flattening, received the highest appearance rating while PS...5776, Heritage, and Telestar had little flattening and high appearance scores. Other

Table 1. Yields, gross returns, and appearance scores of bell pepper cultivars in Lexington, Ky.; yield and income data are means of four replications.

Cultivar	Seed Source	Total Mkt. Yield[1] (tons/A)	% XL + Large[2]	Income[3] ($/acre)	Shape Unif.[4]	Overall Appearance[5]	No. Lobes[6]	Fruit Color	Comments
Double-up	SW	16.1	76	3703	3.2	5.0	3-4	Med	25% flattened; many 3-lobed
Socrates	S	15.7	63	3586	2.5	4.5	4	Lt-med	50% flattened, pumpkin-shaped
Heritage	HM	15.3	72	3843	3.5	5.8	4	Med	Very few flattened
Aristotle	S	14.5	67	3323	3.7	6.5	4	Med-dk	No flattening
PS...5776	S	14.4	67	3142	3.5	6.0	3-4	Med	Very few flattened
Excursion II	AC	13.6	69	3063	3.2	5.0	3-4	Med-dk	33% flattened; some 3-lobed; nice color
Patriot	HM	12.7	67	2777	3.2	5.0	4	Med-dk	25-33% flattened
Alliance	HM	12.1	62	2775	3.0	5.5	4	Med-dk	33% flattened, otherwise nice
Telestar	HA	11.7	62	2581	3.7	6.0	3-4	Med	Many 3-lobed; few flattened
E41.8338	E	11.1	74	2670	3.0	5.5	4	Lt-med	10-25% flattened
Mahi	E	10.1	64	2131	2.5	5.5	4	Med	25% flattened, otherwise nice
Revolution	HM	9.0	56	2131	2.5	4.5	4	Med-dk	33-50% flattened
Waller-Duncan LSD (P = 0.05)		2.9		777					

1 Total marketable yields of U.S. Fancy and No. 1 fruits of medium (>2.5 in. diameter) size and larger plus misshapen, but sound fruit that could be sold as "choppers" to foodservice buyers.
2 Percentage of total yield that was extra-large (>3.5 in. diameter) and large (>3 in. diameter but ≤3.5 in. diameter).
3 Income = gross returns per acre; average 2004 season local wholesale prices were multiplied by yields from different size/grade categories: $0.17-0.19/lb for extra-large, $0.09-0.14/lb for large and mediums, and $0.05-0.11/lb for "choppers," i.e., misshapen fruits.
4 Average visual uniformity of fruit shape where 1 = least uniform, 5 = completely uniform.
5 Visual fruit appearance rating where 1 = worst, 9 = best, taking into account overall attractiveness, shape, smoothness, degree of flattening, color, and shape uniformity; all fruits from two replications observed at the 2nd harvest (26 July).
6 3-4 = about half and half 3- and 4-lobed; 3 = mostly 3-lobed; 4 = mostly 4-lobed.

cultivars that received acceptable ratings of 5.0 or better included Double-up, Excursion II, Patriot, Alliance, E41.8338, and Mahi; one-fourth to one-third of the fruits of these varieties were flattened. Socrates and Revolution appeared to be most susceptible to flattening (up to 50%) and received the worst appearance scores (Table 1). While heat-related flattening will not be a problem every year, growers should be aware that some varieties are much more susceptible to this problem than others.

Cultivars that had the highest yields, incomes, *and* acceptable or better fruit quality ratings were Aristotle, Double-up (but many 3-lobed fruits), Heritage, and PS...5776. Aristotle and Heritage fruits were mostly 4-lobed and appeared to tolerate heat without flattening; Telestar and PS...5776 were also heat tolerant but had larger percentages of 3-lobed fruit. Growers should consider these results together with those reported in 2004 and from the sister trial in eastern Kentucky in 2005.

Acknowledgment

The authors would especially like to thank Darrell Slone and the farm crew for their hard work and generous assistance with this trial.

Effect of Transplant Size on Yields and Returns of Bell Peppers

Nathan Howard, Brent Rowell, and John C. Snyder, Department of Horticulture

Introduction

Bell peppers have been a major vegetable crop for farmers in western Kentucky for the past five years. Growers have successfully marketed fresh market green bell peppers through wholesale buyers and the West Kentucky Grower Cooperative in Owensboro. In 2005, more than 150 acres of bell peppers were sold on the fresh wholesale market in northwestern Kentucky. Growers are using intense management techniques including drip irrigation and black plastic mulch. Yields in the area have consistently exceeded 1000 boxes per acre. Growers continue to adjust fertility, disease management, and cultivar selection to attain yields closer to 2000 boxes/acre.

The best bell pepper producers in central Kentucky around the Georgetown cooperative are using similar management techniques and are producing on similar soil types but consistently obtain closer to 1800 boxes/acre. The only obvious difference in their production practices is the size of their transplants. Central Kentucky growers are using 128-cell Styrofoam trays for transplants while western Kentucky growers are using 242-cell trays.

Larger cell sizes result in larger transplants which should better withstand stresses at planting and should subsequently produce earlier peppers. The purpose of this research was to determine if a larger cell/transplant size results in a yield increase and/or higher early yields (usually associated with higher market prices). Secondly, we wanted to know if these yield differences justified the higher cost of transplant production associated with using a larger cell size.

Materials and Methods

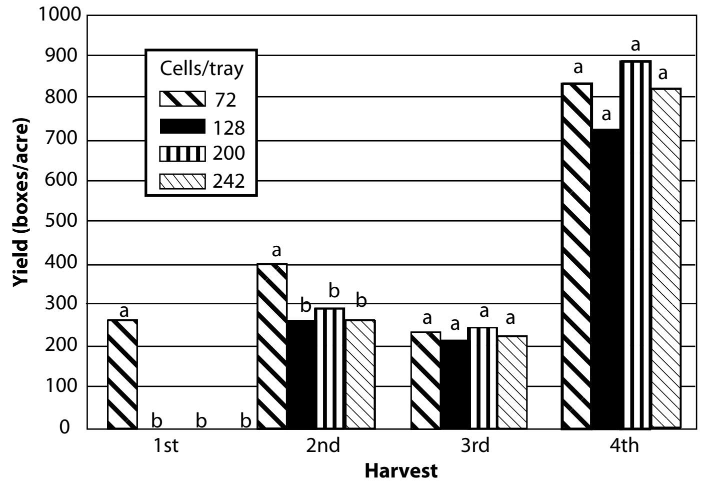
The trial was conducted in cooperation with a bell pepper grower in Henderson County. Four cell sizes were used for transplant production: 72-, 128-, 200-, and the standard 242-cell tray. The variety used was Alliance donated by Rupp Seed Company. Each treatment was seeded in the greenhouse on 7 March. The plants were taken outside the greenhouse on 2 May and hardened off for three days. On 5 May the plants were transplanted into raised beds with black plastic mulch with drip irrigation (Figure 1). Each treatment had 20 plants in double rows that were 18 in. apart on the bed with 15 in. between plants in the rows. Beds were spaced 66 inches apart from center to center resulting in a plant population of 12,672 plants per acre.

Figure 1. Photograph of transplants when taken to the field: from left to right, plants from 72-, 128-, 200-, and 242-cell trays. Notice difference in size of the plants.

The grower managed the trial plot in the same manner as the rest of his field. Phosphorus and potassium were applied pre-plant according to soil test results and current University of Kentucky recommendations. Nitrogen was applied at the rate of 60 lb/acre prior to planting with an additional 140 lb/acre sidedressed (fertigated) through the irrigation system. Fungicides (maneb and copper) were applied on a weekly basis for disease prevention. Mustang Max and Orthene insecticides were applied as needed when insect populations reached unacceptable thresholds. The trial was arranged in a randomized complete block design with four replications.

The 2005 growing season was very good for peppers in Kentucky. Warm weather and low disease and insect pressure persisted throughout. The trial plot was harvested four times between 29 June and 20 July. Peppers were harvested according to cooperative standards, making sure each pepper had a solid wall regardless of size. Harvested peppers were graded according to USDA standards, counted, and weighed. Grades for peppers included jumbo, extra large, large, medium, and "chopper" (misshapen fruit). Data were then analyzed for statistical differences.

Figure 2. Effects of transplant cell size (no. cells/tray) on early and late bell pepper yields at four harvest dates, 2005; data are means of four replications. Columns for a harvest, labeled with the same letter are not significantly different as determined by the Duncan-Waller LSD (P = 0.05).



Results and Discussion

Only the 72-cell treatment had fruits ready for harvest 29 June (first harvest, Figure 2). We expected an earlier pepper with a larger cell/transplant size, and this proved to be the case. The price for peppers the last week of June was well above average (Table 1); higher prices are typical for peppers harvested in Kentucky before the Fourth of July. The 72-cell plants also yielded significantly more than the other three treatments during the second week of harvest (Figure 2). There were no significant differences in total yields among treatments for the last two harvests (Figure 2).

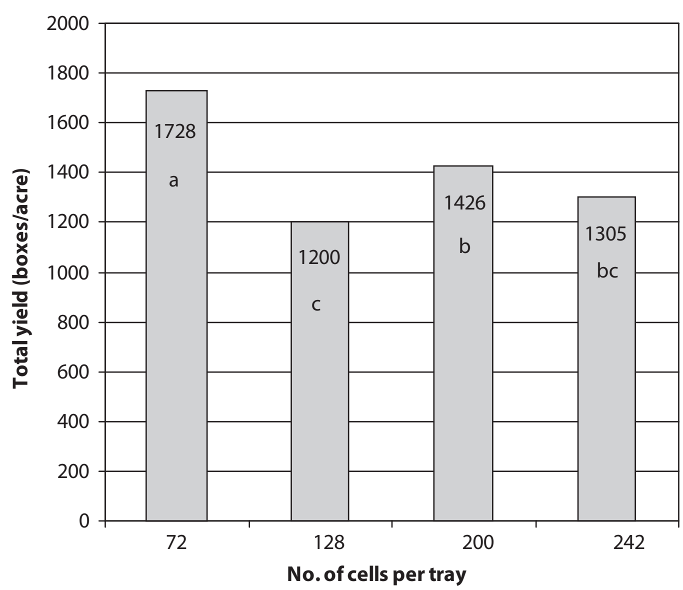
The total yields were somewhat surprising (Figure 3). As expected the larger cell size produced earlier peppers and a higher yield that was significantly different from the yield produced by the smaller transplants. The 72-cell treatment out-yielded the standard 242-cell treatment by 421 boxes an acre (Table 2). Although we had expected that the 128-cell treatment would be the next highest yielding, this was not the case as this treatment was the lowest yielding treatment overall (Figure 3). This was unexpected and is difficult to explain. The other two treatments yielded as expected, between 1300 and 1450 boxes per acre.

Transplant production costs were determined by the local vegetable transplant producer and are listed in Table 2. To pay for the largest cell size (72-cell trays), the net return to the grower would have to be $1330/acre. After net income was calculated, the grower could have paid for the larger cell size and would have made an additional $2024/acre. This was also a surprise because we had thought that the largest cell size wouldn't pay for itself. Switching a grower from a 242- to a 128-cell size was thought to be easier to justify because the grower only needed to make an extra $750/acre to pay for it; however, the results indicated that growers would lose $707/acre by switching to this cell size (Table 2). The 200-cell size generated another 120 boxes an acre, and the grower needed to earn $167/acre to pay for that switch; this was believed to be attainable and does pay for itself, generating another $473/acre.

Table 1. Average weekly wholesale prices (per 32-lb box) for bell peppers from June 29 to July 20, 2005, at West Kentucky Grower Cooperative.

Harvest Date	Jumbo	X Large	Large	Medium	Chopper
June 29	$13.39	$12.05	$10.25	$5.51	$6.65
July 6	9.59	10.82	9.62	6.89	6.13
July 11	7.72	7.83	7.19	5.78	3.79
July 20	7.03	7.36	6.08	4.81	2.86

Figure 3. Effects of transplant cell size (no. cells/tray) on total marketable yields of bell peppers in 2005. Data are means of four replications; means followed by the same letter are not significantly different as determined by Waller-Duncan LSD (P = 0.05).



In conclusion, the results of this study were surprising. It was expected that there would be a significant difference in yield per acre from the 72-cell size, but it was questioned whether the grower could pay for this. The results proved that it could. It was expected that there would be an opportunity for growers to switch to128-cell trays, but yields were inexplicably lower with that treatment. It was predicted that the 200-cell treatment would yield more than the 242 and pay for itself, which proved to be the case. This study clearly shows the advantage of taking a larger transplant to the field in bell pepper production. Similar studies with crops such as tomatoes and eggplant may yield similar results. The benefit of having a larger root ball (Figure 1) and a larger, stronger transplant will have a direct positive impact on yields. This trial will be repeated in 2006.

Table 2. Costs per acre, based on a plant population of 12672/A, per acre yield differences, breakeven point, and per acre income for four transplant cell sizes.

Cell Size	Cost per Acre	Yield Difference from 242-Cell	Income Needed To Break Even	Income Difference from 242-Cell
72	$2331	+421 boxes	$1330	+ $3354
128	$1751	-106 boxes	$ 750	- $ 707
200	$1168	+120 boxes	$167	+ $ 473
242	$1001	--	--	--

Field Observations on Jalapeño Pepper Cultivars in South-Central Kentucky

Beth Wilson, Pulaski County Cooperative Extension

Introduction

Kentucky farmers have been growing bell peppers successfully for some time. Many types of hot and specialty peppers can be successfully grown in Kentucky using the same management practices as bell peppers. Wholesale market outlets for these peppers are often not conveniently located. However, non-box store outlets can be found south of Kentucky and in many cases, peppers are not required to be cooled. Jalapeños and other hot specialty peppers are profitable crops.

Materials and Methods

Nine jalapeño cultivars were planted in Pulaski County in a non-replicated observation trial. Transplants were planted 15 in. apart in double rows on black plastic with trickle irrigation on May 24, 2005. Plants were not staked; however, jalapeño plants can grow up to 4 feet tall and could require staking, depending on the cultivar.

Cultivars compared in this trial were Agriset 4002, Agriset 4108, Agriset 4109, El Rey, Grande, Ixtapa X3R, Perfecto, Tula, and VTR 56. Only Ixtapa and El Rey have bacterial leaf spot resistance. Plants were watered and fertigated through the drip system according to University of Kentucky recommendations for bell peppers. Glyphosate was applied in row middles as a directed, shielded spray for weed control.

Results and Discussion

Three harvests were made over the course of the trial, although at least two or three more could have easily been made.

Total yield. The best yielding cultivar was Agriset 4002, followed by El Rey, Agriset 4109, VTR 56, and Perfecto (Table 1). Agriset 4109 consistently produced round, ball-like fruits. This would make it unmarketable. Lowest yielding was Agriset 4108.

Weight and color. Large, dark green jalapeño fruits are more marketable than small or light green fruits. The largest peppers in the trial were from Agriset 4002; however, these fruits were very light green. The next largest peppers with a nice green color were from VTR 56 and Ixtapa X3R. Fruit of Agriset 4002 were not straight; this was especially noticeable from the second and third harvests. They tended to curve more toward the blossom end and were somewhat blocky.

Cracking. Jalapeños tend to develop longitudinal cracks, or "checking", the longer they remain on the plant. Box stores want jalapeños with no checking, while other markets demand jalapeños with checking. Perfecto fruits seemed to check more than the others, especially fruit harvested the second and third time. Ixtapa X3R

Table 1. Yields and observations from three harvests of single plots of jalapeño pepper varieties grown in Nancy, Ky., 2005.

Cultivar	Seed Source	Pounds/ Plant	Pounds/ Acre[a]	Comments
Agriset 4002	S	1.95	19550	Big, but light green fruits
El Rey	SW	1.85	18537	Medium, light green fruits
Agriset 4109	S	1.73	17347	Roundish fruits, not very marketable
VTR 56	SW	1.69	16909	Excellent, dk green large fruits, staking required
Perfecto	S	1.59	15976	Nice color fruits, plants are small, many checked fruits
Ixtapa X3R	SW	1.57	15771	Excellent quality fruits, staking required, susceptible to ozone injury
Tula	S	1.48	14846	Small to med fruits, very smooth fruits with little checking, pretty fruits
Grande	S	1.45	14546	Large plants, easy to pick, good quality fruits
Agriset 4108	S	0.93	9343	Large fruits with good color

[a] Based on plastic mulched beds on 6 ft centers with drive rows every sixth row (10,020 plants per acre).

also checks a little more than others. Agriset 4108, Agriset 4109, Tula, and VTR 56 did not produce many fruits that checked and therefore might be better choices for box store markets.

Overall. The highest yielding jalapeño, Agriset 4002, is probably not the best choice for planting. Kentucky's standard jalapeño, bacterial spot-resistant Ixtapa X3R, still proved itself worthy. It produced dark green, medium to large fruit that were very marketable. One problem with Ixtapa that has been encountered the last two years in Pulaski County is its susceptibility to serious injury by ozone. Ozone-damaged plants eventually lost leaves in the upper canopy causing fruit to become sunburned.

VTR 56 shows some promise. Yields were high, and fruits were large and dark green. However, VTR 56 lacks resistance to bacterial leaf spot, a major concern in some years. Staking is recommended for both VTR 56 and Ixtapa.

Acknowledgments

Thank you to David Phillips of Seminis and Kevin Hosey of Seedway for supplying seed for this trial.

Weed Control in Bell Peppers

Joseph Masabni, Joe Williams, and Nathan Howard, Department of Horticulture

Introduction

An experiment was conducted in 2005 on row middles of transplanted peppers to quantify the effectiveness of labeled and non-labeled herbicides, which are commercially available but not for use on pepper yet. The latter were evaluated as part of our effort to support their future registration. Sandea, one of the tested herbicides, is currently labeled on row middles in pepper. Readers are strongly reminded that an experimental herbicide's inclusion in this report is not a legal application in a commercial or residential setting, and UK does not recommend its use until labeled. The reason for listing the experimental herbicides here is because the intent of this experiment is their evaluation in the hope of future registration.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a 2-nozzle shielded boom calibrated to spray a 3 ft band at 30 psi and 3 mph walking speed. The 11002 nozzles were set 7 in. above ground level to obtain good spray overlap and complete soil coverage.

Plots were 3 ft x 15 ft long. Both sides of each treatment bed were sprayed with the same treatment. Peppers were harvested from the treatment beds only. The beds that had different treatments applied on each side were not harvested as they were not part of this experiment. The experimental design consisted of a randomized complete block with three replications.

The preemergence (PRE) treatments were applied on 4 May 2005 immediately after transplanting. Weed pressure was minimal this year due to early spring rains followed by dry weather that crusted the soil surface and acted as a barrier against weed germination. Therefore, no weeds were present at time of PRE treatment application. The postemergence (POST) treatments were applied on 10 June 2005 when peppers were in flower and plants were 1-1.5 ft tall. All treatments were applied early in the morning; average wind speed was 2.5 mph. Gramoxone 5L (0.8 pt/A) was included with all POST treatments to control germinated weeds.

Visual weed control ratings were collected on 27 May and 10 June. The scale used in these ratings was 1-10, with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value. Peppers were harvested twice. No harvest occurred after 14 July because the grower decided to stop due to dropping prices. The grower applied ethylene to ripen the fruits and obtain uniformly red peppers.

The following is the full name of the weed codes used in the tables: LACG = large crabgrass; RRPW = redroot pigweed; COLQ = common lambsquarters; BYGR = barnyardgrass. The two non-labeled herbicides were experimental herbicide A (treatment 4 POST, and treatment 9 PRE+POST) and experimental herbicide B (treatments 7 and 8 POST).

Table 1. Weed control ratings for nine herbicide treatments in pepper.

	Treatment		Growth	27 May			10 June		
Trt No.	Name	Rate/A	Stage	LACG	RRPW	COLQ	COLQ	RRPW	BYGR
1	Sandea	0.5 oz	PRE,POST	6	9	9	10	10	6
2	Sandea	1 oz	PRE,POST	3	9	9	8	5	5
3	Sandea	1 oz	PRE	5	9	10	8	10	7
	Treflan	20 fl.oz.	POST						
4	Sandea	1 oz	PRE	5	10	10	10	10	6
	Expt. A	0.53 qt	POST						
5	Sandea	0.5 oz	PRE	3	9	9	9	9	2
	Dual Magnum	2 pt	POST						
6	Sandea	1 oz	PRE	5	10	10	8	10	6
	Dual Magnum	2 pt	POST						
7	Dual Magnum	2 pt	PRE	10	10	10	10	10	10
	Command	0.7 pt	PRE						
	Expt. B	1 oz	POST						
8	Dual Magnum	2 pt	PRE	8	9	9	7	10	8
	Command	1.3 pt	PRE						
	Expt. B	1 oz	POST						
9	Expt. A	0.53 qt	PRE,POST	9	10	10	10	10	9
LSD (P = 0.05)				*3.9*	*1.9*	*2.1*	*3.9*	*2.7*	*3.7*

Results

Three weeks after PRE treatment, pepper plants were 6-8 in. tall with 12-14 leaves and flower buds forming. In terms of overall herbicide weed control ratings, Treatment no. 8 (T8) and T9 were the cleanest with no weeds present, followed by T7 and T2, followed by T1 (Table 1).

None of the treatments applied had any effect on the plant stand (Table 2). Visual observation also didn't indicate any herbicide injury to the plants. There were no significant differences in pepper numbers or yield/plot on either harvest date. The general consensus after discussions with the grower was that this was not a typical year for weed germination and growth. The soil surface was hard and crusted for the whole duration of this experiment. This was due to excess spring rain followed by two weeks of hot sunny days that baked the ground into a hard surface.

Table 2. Number of plants (plant stand) and pepper yields as affected by nine herbicide treatments.

				7 July			14 July	
Trt No.	Treatment Name	Rate/A	Growth Stage	Plants No./Plot	Yield No./Plot	Yield Lb/Plot	Yield No./Plot	Yield Lb/Plot
1	Sandea	0.5 oz	PRE, POST	25	40	19.2	92	35.7
2	Sandea	1 oz	PRE, POST	25	61	26.0	121	40.7
3	Sandea	1 oz	PRE	25	43	19.6	81	33.1
	Treflan	20 fl.oz.	POST					
4	Sandea	1 oz	PRE	26	58	26.0	119	44.1
	Expt. A	0.53 qt	POST					
5	Sandea	0.5 oz	PRE	25	48	20.9	124	45.2
	Dual Magnum	2 pt	POST					
6	Sandea	1 oz	PRE	25	59	24.5	97	37.0
	Dual Magnum	2 pt	POST					
7	Dual Magnum	2 pt	PRE	26	54	22.9	136	49.4
	Command	0.7 pt	PRE					
	Expt. B	1 oz	POST					
8	Dual Magnum	2 pt	PRE	26	72	28.7	88	31.7
	Command	1.3 pt	PRE					
	Expt. B	1 oz	POST					
9	Expt. A	0.53 qt	PRE, POST	26	68	26.5	114	39.2
LSD (P = 0.05)				*1.9*	*23*	*8.4*	*67*	*26.9*

The two experimental herbicides show promise for use in pepper grown on plastic. Neither treatment showed any visual injury on the pepper plants or an effect on the harvested yields. Weed control was slightly better on most weeds, except for large crabgrass and barnyardgrass.

This was not a year with heavy weed pressure. All treatments gave acceptable weed control with clean plots throughout the growing season. The only weed escapes that regrew were large crabgrass and barnyardgrass. Control of these two weeds is easily managed with grass-specific herbicides such as Poast or Select that will not harm pepper. In our case, weed pressure was not sufficient to require additional sprays.

Gourmet Potato Production Using Plasticulture

April Satanek, Brent Rowell, and Darrell Slone, Department of Horticulture

Introduction

Trials conducted in 2003 and 2004 identified several varieties that appeared suitable for early harvest as "gourmet" potatoes. Gourmet potatoes should have some unique characteristic(s) like red skin, unique taste, or yellow flesh and yield a fairly large percentage of smaller tubers. Such varieties can command high prices in both local and wholesale markets. Four promising varieties, Red Gold, Butte, Corola, and Dark Red Norland, were planted in black plastic-covered, raised beds in 2005. We wished to become more familiar with this planting method and to observe any advantages or limitations with this production system compared with drip-irrigated potatoes grown at traditional spacings on bare ground.

Materials and Methods

Potatoes were cut for seed on 23 March. Approximately 200 seed pieces were cut for the four potato varieties, plus border rows. Potato seed were planted on 7 April using a waterwheel setter; seed pieces were placed in holes created by the waterwheels on raised beds with black plastic and drip irrigation. In this process, planting holes were watered with starter solution from the setter and covered by hand. Each bed was planted with two (double) rows with 18 inches between rows and 12 inches between plants. In order to use our cultivator, beds were spaced 8 feet from center to center. Each variety was planted in a single 100 ft-long bed (no replication). The two 100 ft border (guard) rows consisted of drip-irrigated, bare ground raised beds with Dark Red Norland and Kennebec planted at traditional spacings.

Fertilizer was applied preplant at a rate of 114 lbs of actual nitrogen per acre as 19-19-19. On 2 June, the potatoes were sidedressed by fertigation with ammonium nitrate at a rate of 34 pounds of actual nitrogen per acre. The herbicide Dual Magnum was applied on 20 April over the plastic and between beds. Sprays of Permethrin and Baythroid were applied to control Colorado potato beetle.

In order to kill vines (and therefore develop skin on tubers), two sprays of the dessicant Diquat were applied on 22 and 27 June, about 75 days after planting. Potatoes were harvested on 6 July by undercutting plants with a commercial plastic lifter/undercutter after which the plastic mulch was removed. A potato digger was used to expose the tubers which were gathered by hand. The potato digger was used a second time to expose any tubers that remained buried.

Potatoes were washed, graded and weighed. The grades, based on tuber diameter, were large (>2¼ in. dia.), medium (1¾ in. to 2¼ in.), small or creamers (1 in. to 1¾ in.), and culls (unmarketable). We used these market grades which are not equivalent to USDA grades. Representative samples of tubers of each variety were laid out on tables to rate them for appearance and other quality characteristics.

Results and Discussion

When the potato shoots broke through the soil, some stems had to be manually lifted out from under the plastic. In addition, we used wider than necessary spacings between beds, and 5-6 ft between bed centers would have been adequate. Also, since potatoes grown on black plastic did not receive much water from rainfall, they required much more irrigation than those grown on bare ground. Water demands were especially high just prior to harvest when the plants were fully developed.

Tuber characteristics, size distributions, and yields are shown in Tables 1 and 2. Fungal rot was observed in seed tubers of Red Gold, and seed sprouting was very low for that variety (Table 1). Only about 55 seed pieces sprouted which resulted in more widely spaced plants in the field; 55% of Red Gold tubers were very large, preventing a fair comparison with the other varieties. This variety had looked good and performed well in previous trials. Corola had the largest percentage of culls (13%) due to decayed spots on the tubers (Table 2).

The variety Butte had very thick vines that required a second desiccant spray (for vine killing). Even after this second spray, Butte still had some green vines at harvest, causing some skinning of tubers. Most of the Butte culls were misshapen.

When Dark Red Norland and Kennebec tubers grown under plastic were compared with tubers of the same varieties grown on bare ground, there were no differences in tuber appearance or shape uniformity (data not shown). Tubers were larger when grown under plastic compared with bare ground in 2005. Unfortunately, valid yield comparisons could not be made between varieties grown on plastic and those in the guard rows on bare ground in 2005; however, it appeared that yields were higher and tubers were larger in 2005 using plasticulture compared with bare ground plantings in 2003 and 2004 (Table 3).

More comparative trials are needed to investigate how quality and yield are affected when potatoes are grown under plastic. Planting at higher plant densities (closer spacings) should result in a larger number of small tubers. For spacings, varieties, and other cultural practices recommended for plasticulture potato production, see the potato chapter in the new (2006-07) edition of the *Vegetable Production Guide for Commercial Growers* (UK Extension Publication ID-36).

Table 1. Number of plants harvested and tuber characteristics of four "gourmet" potato varieties grown using plasticulture in 2005, Lexington, Ky.

Variety	No. Plants Harvested	Interior Color	Skin Color	Shape
Red Gold	54	yellow	light red	oval
Butte	175	white	brown	oblong
Corola	124	yellow	yellow	oval
Dark Red Norland	197	white	bright red	oblong

Table 2. Yield and tuber sizes of four "gourmet" potato varieties grown using plasticulture in 2005, Lexington, Ky.[1]

Variety	Total Mkt. Yield Lbs. (cwt)	% Small	% Medium	% Large	% Culls
Red Gold	333	8	28	55	9
Butte	193	20	49	22	9
Corola	187	20	49	18	13
Dk Red Norland	179	11	43	43	4

[1] Yields were extrapolated to represent the yield of 200 plants.

Table 3. Yields and percentages of small tubers from four "gourmet" potato varieties in 2003 (bare ground), 2004 (bare ground), and 2005 (plasticulture). Yields are in pounds per 200 plants.

	Total Mkt. Yields			Bare Ground	Bare Ground	Plasticulture
Variety	2003[1]	2004[2]	2005 Plasticulture	2003 % Small	2004 % Small[2]	2005 % Small
Red Gold	216	239	333	23	14	8
Butte	130	197	193	80	40	20
Corola	150	190	187	54	35	20
Dk Red Norland	68	133	179	37	10	11

[1] Unreplicated observation trial, harvested after 70 days with plants spaced 9 in. within row.
[2] Replicated trial, harvested after 77 days; plants spaced 9 in. within row.

Weed Control in No-Till Pumpkins

Joseph Masabni and Joe Williams, Department of Horticulture

Introduction

The acreage of pumpkin has recently increased in Kentucky. Many growers double crop their fields by planting pumpkins after winter wheat. They not only gain two crops in one season, but also benefit from the wheat stubble left after harvest, which serves as a natural weed barrier. Stubble is so effective that some growers are sacrificing fall-planted rye or wheat with an herbicide kill, pushing the dead straw down and no-till planting pumpkins in the heavy stubble. One obvious advantage to this practice is that expensive herbicides have to be used only in the planting strip instead of on the whole field. The objective of this study was to evaluate effectiveness of herbicides in a no-till transplanted pumpkin crop.

Material and Methods

In fall 2004 winter wheat was drilled at about 90 lb/A. The wheat was killed with Gramoxone on 1 June 2005 and was later rolled down to provide a thick cover. Herbicides were applied using a CO_2-pressurized backpack sprayer with a 4-nozzle boom calibrated to spray a 5 ft band at 30 psi and 3 mph walking speed. The 8002 nozzles were set 17 in. above ground level to obtain good spray overlap and complete weed coverage. Plots were 10 ft x 35 ft. The experimental design consisted of a randomized complete block with three replications. Each plot was sprayed with two passes of the boom to cover the 10 ft. plot width.

Two varieties of small-fruited pumpkins were planted in each plot; Cotton Candy (white) and Hybrid Pam (orange). These varieties were used instead of the traditional Jack-O-Lantern pumpkins because of increasing interest in smaller fruits suitable for kids to carry. Herbicide treatments were applied on 17 June 2005, one week after transplanting pumpkins. All herbicides were applied early in the morning and average wind speed at the time of application was 2.5 mph.

Visual weed control ratings were collected at 28 June and 18 July. The scale used in these ratings was 1-10 with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value. Vine injury was also rated visually on these dates on a scale of 1-10 with 1 indicating no injury, and 10 indicating crop death.

Results

Few grasses and broadleaves were present in the field. Therefore, no specific evaluation of each individual species was conducted. Instead, weeds were evaluated as either broadleaves (BL) or grasses (GRASS).

Treatments 1 (T1) and 2 (T2) are currently labeled herbicides on pumpkins. T1 was sprayed at a 2X rate to determine if any injury is possible with a high rate of Sandea (labeled rate is 0.5-0.67 oz/A, with 2 oz/A maximum per crop). Treatments 3-10 are not labeled herbicides and must not be used by growers under any situation. I remind growers that the use of non-labeled herbicides is against the law. The herbicides are listed here so that growers can observe the severe injury possible with these herbicides.

A final but important point to consider when reviewing the results is that the treatments were applied one week post-transplanting (POST-TR) the two pumpkin cultivars. Plants were about 4 inches tall with 1-3 true leaves at time of transplanting. This experiment was designed specifically to determine the worst-case scenario when testing potential new herbicides for use on pumpkins. The logic behind this design is that if a new or non-labeled herbicide was safe when applied POST-TR, then chances are high that it would be safe if applied preemergence (PRE).

Eleven days after herbicide application (Table 1), Spartan (T5+T6), Chateau, and Matrix had excellent grass and broadleaf weed control, but significantly injured both cultivars (60-90% injury). By 30 days after treatment (Table 2), the overall weed control rating for the treatments ranged between 58-95%. The weediest plots were observed with T3 and the cleanest with T6. In general, weed control improved between 11 and 30 days for most treatments, except for a slight drop for T1 (Sandea) and a significant drop for T10 (Matrix).

Based on yield, the white pumpkin Cotton Candy was more sensitive to herbicides than the orange Hybrid Pam (Table 3). The high rate (2X) of Sandea (treatment 1) significantly reduced number and weight of Cotton Candy pumpkins but had no effect on Hybrid Pam. Treatments 6, 9, and10 significantly reduced both number and weight of fruits per plot. Outlook and Define at low and high rates didn't show any significant decrease in yield. However, actual yield values decreased by 13% and 18% for Outlook T3 and T4, respectively, and by 25% and 30% for Define T7 and T8, when compared to the control plot, T2. Therefore, even if Outlook

Table 1. Visual injury rating of pumpkin vines and visual weed control ratings of grasses and broadleaves taken 11 days after treatment.

Trt No.	Treatment Name	Form Conc	Form Type	Rate/A	Growth Stage	Pumpkin C. Candy Injury Jun 28	Pumpkin H. Pam Injury Jun 28	Grass Rating Jun 28	BL Rating Jun 28
1	Sandea	75	DF	2 oz	POST-TR	3.0	3.2	7.7	9.7
2	Strategy	2	EC	3 qt	POST-TR	2.7	2.5	8.8	9.2
3	Outlook	6	EC	14 fl.oz.	POST-TR	2.7	1.7	8.0	9.0
4	Outlook	6	EC	28 fl.oz.	POST-TR	2.3	1.8	9.0	9.7
5	Spartan	4	F	0.19 qt	POST-TR	8.2	5.7	8.3	9.7
6	Spartan	4	F	0.38 qt	POST-TR	9.3	8.3	8.3	10.0
7	Define	4	SC	0.53 qt	POST-TR	2.7	2.3	7.7	9.7
8	Define	4	SC	0.69 qt	POST-TR	2.5	2.0	9.0	9.5
9	Chateau	51	WG	6 oz	POST-TR	7.7	5.0	8.3	9.3
10	Matrix	25	DF	1 oz	POST-TR	5.0	5.7	8.7	9.3
LSD (P = 0.05)						*1*	*0.98*	*2.1*	*1.0*

Table 2. Visual injury rating of pumpkin vines and visual weed control ratings of grasses and broadleaves taken 1 month after treatment.

Trt No.	Treatment Name	Form Conc	Form Type	Rate/A	Growth Stage	Pumpkin C. Candy Injury Jul 18	Pumpkin H. Pam Injury Jul 18	Overall Weed Rating Jul 18
1	Sandea	75	DF	2 oz	POST-TR	2.8	2.0	7.7
2	Strategy	2	EC	3 qt	POST-TR	3.0	2.0	7.3
3	Outlook	6	EC	14 fl.oz.	POST-TR	2.7	1.8	5.8
4	Outlook	6	EC	28 fl.oz.	POST-TR	1.8	1.7	9.0
5	Spartan	4	F	0.19 qt	POST-TR	8.3	6.5	7.3
6	Spartan	4	F	0.38 qt	POST-TR	9.2	9.0	9.5
7	Define	4	SC	0.53 qt	POST-TR	3.7	2.0	7.5
8	Define	4	SC	0.69 qt	POST-TR	2.0	1.0	8.7
9	Chateau	51	WG	6 oz	POST-TR	9.5	9.3	8.7
10	Matrix	25	DF	1 oz	POST-TR	7.8	7.0	6.7
LSD (P = 0.05)						*1.7*	*1.4*	*3.2*

and Define appear to be safe on the two pumpkin cultivars tested in terms of foliage growth and coverage of the plot, a considerable yield decrease was observed. This was a dry year in Kentucky; growers are encouraged to consider the potentially higher injury levels that might occur with normal rainfall.

Fruit weight did not differ significantly among all treatments (Table 3), except for Chateau that seriously injured plant growth, vigor, and yield. For Cotton Candy, Chateau, Spartan (high rate), and Matrix had significant injury on plant growth and on fruit set and size. The same plots were the cleanest in terms of weed ratings one month after application with 70-100% weed control.

On Hybrid Pam, only Spartan (high rate) significantly reduced both number and weight per plot. Sandea at the 2X rate (T1) didn't appear to negatively affect Hybrid Pam or reduce its yield compared to plots treated with the labeled herbicide Strategy (T2). Plots treated with Spartan (low rate, T5) and Define (high rate, T8) had higher number and yield of pumpkins, but absolute values were not significantly different from T2, the control. No significant differences were observed for fruit size with any treatment. Hybrid Pam grew out of Spartan (low rate, T5) initial injury (11 days after treatment). However, the high rate of Spartan (T6) resulted in significant season-long injury, based on its yield reduction.

The purpose of this experiment was to investigate potential new herbicides for use on no-till pumpkins and to determine the benefits of applying herbicide after transplanting. The results indicated that the risk of testing new non-labeled herbicides can be substantial. Growers are not encouraged to experiment on their own but should use the results of this report as an example of possible injury. Even if some herbicides appear to be safe and have little or no effect on plant growth and yield, growers are strongly encouraged not to take this as confirmation of their safety in general. This experiment will be repeated next year in order to confirm the results. A high rate of Sandea, above the label limits, can be injurious, even though it is a labeled herbicide for pumpkin. Finally, Strategy, a pre-mix combination of Curbit and Command, has proven its safety and provides excellent weed control in no-till pumpkin.

Table 3. Yield for two pumpkin varieties (fruits/plot, total yield/plot, and average fruit weight). Harvest, September 22, was conducted 97 days after treatment.

Trt	Treatment	Form	Form		Growth	C. Candy			H. Pam		
No.	Name	Conc	Type	Rate/A	Stage	No./Plot	Lb./Plot	Lb./Fruit	No./Plot	Lb./Plot	Lb./Fruit
1	Sandea	75	DF	2 oz	POST-TR	4	6.4	1.8	16	50.4	3.1
2	Strategy	2	EC	3 qt	POST-TR	9	34.9	3.9	17	54.6	3.3
3	Outlook	6	EC	14 fl.oz.	POST-TR	10	29.4	2.9	15	45.9	2.9
4	Outlook	6	EC	28 fl.oz.	POST-TR	8	27.7	2.2	17	57.9	3.5
5	Spartan	4	F	0.19 qt	POST-TR	6	6.6	1.9	21	73.7	3.5
6	Spartan	4	F	0.38 qt	POST-TR	3	9.5	3.5	5	18.7	3.5
7	Define	4	SC	0.53 qt	POST-TR	8	25.3	3.3	12	33.4	2.9
8	Define	4	SC	0.69 qt	POST-TR	8	23.5	2.6	20	71.1	3.7
9	Chateau	51	WG	6 oz	POST-TR	1	3.9	0.9	10	34.8	3.9
10	Matrix	25	DF	1 oz	POST-TR	3	9.0	3.5	15	68.9	3.3
LSD (P = 0.05)						*5.7*	*9.4*	*1.0*	*12.4*	*18.3*	*0.4*

Evaluation of Fungicides and Cultivars for Management of Powdery Mildew on Yellow Squash

Kenny Seebold and Ed Dixon, Department of Plant Pathology

Introduction

Powdery mildew, caused by *Podosphaera xanthii*, continues to be a serious constraint to cucurbit production in Kentucky and can be especially difficult to deal with in fall-planted squash. 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 powdery mildew. 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 yellow squash commonly planted in Kentucky have varying levels of resistance to powdery mildew, and planting resistant varieties can reduce the need for fungicides to control the disease. However, when conditions favor powdery mildew (often the case in fall-planted crops), fungicides are often required to achieve acceptable suppression of disease.

Generally, a fungicide program should be in place to prevent diseases, including powdery mildew, from becoming established in a crop. Relatively inexpensive protectant materials (multi-site 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 multi-site inhibitors when conditions are highly favorable for disease, but these products are also more expensive. Examples of these types of fungicides include DMI products such as myclobutanil (Nova) and triflumizole (Procure), or strobilurins (Amistar, Quadris, Flint, Pristine). Pristine is actually a combination product that contains azoxystrobin (strobilurin) and boscalid (carboxamide). Each of these products affects a broad spectrum of plant pathogens and is effective against powdery mildew. Along with high cost, DMI fungicides and strobilurins are more likely to lead to fungicide resistance in pathogen populations than multi-site inhibitors.

Growers must balance costs against expected benefits and returns when choosing fungicides to use in a disease management program. In dry years or when conditions are unfavorable to disease development, it is possible to use less expensive protectants at long (10-14 day) intervals to suppress most pathogens. However, shorter spray intervals and higher-priced products are generally required in wet years or when the environment is conducive to disease. Planting disease-resistant cultivars may allow the use of fungicides at reduced rates or longer spray intervals; however, in the case of yellow squash, cultivars vary widely in their resistance to important diseases like powdery mildew which affects fungicide requirements. This report describes an experiment designed to evaluate several fungicides on three cultivars of yellow squash, each with a different level of resistance to powdery mildew, to determine if host resistance could be used to reduce or eliminate the need for high-cost fungicides with specific modes of action.

Materials and Methods

The experiment was conducted at the Horticultural Crops Research Station (South Farm) in Lexington. The cultivars of yellow squash planted in the trial were Lioness (straight-neck, Harris-Moran), Sunray (straight-neck, Seminis), and Prelude II (crookneck, Seminis). Previous reports indicated that Lioness was more susceptible to powdery mildew than Sunray or Prelude II (Rowell *et al.*, 2002). Squash were seeded into 72-cell plastic trays and maintained in the greenhouse until transplanting on 15 August. Seedlings were transplanted into raised, plastic-mulched (white-on-black) beds that were spaced 6 ft. apart; plant spacing was 18 in. Plot size was 10 plants with a 3-ft. buffer separating each plot. A single-row border surrounded the plots. The experimental design was a split-plot randomized complete-block. Main effects were squash cultivar (3), and sub-plot effects were fungicide (7, including an untreated control). A list of fungicides used in the trial can be found in Table 1. Irrigation was supplied as needed through a single drip line installed in each bed, and all management practices (weed and insect control, fertility) were made according to recommendations of the UK Cooperative Extension Service.

Fungicides were applied on 7 September and 19 September, beginning prior to disease development; all sprays were discontinued following the appearance of severe downy mildew during the week of 26 September. Applications were made with a CO_2-powered backpack sprayer equipped with a 3-nozzle hand boom fitted with TX-18 hollow-cone nozzles (20-in. spacing). Application volume was 30 GPA, and sprayer pressure was 40 psi.

A single evaluation of disease was made on 30 September. Powdery mildew was rated on upper and lower leaf surfaces using a 0-10 scale where 0 = no symptoms detected and 10 = 100% of leaf area affected by powdery mildew. Downy mildew was also evaluated at this time using a 0-5 scale, where 0 = no symptoms and 5 = 100% of leaf area affected. Yields were not taken; fruit were left on plants to induce plant stress and favor development of powdery mildew.

Results and Discussion

Rainfall was below normal for the Lexington area during August and September; therefore, conditions were highly conducive for development and spread of powdery mildew. Symptoms of powdery mildew were first observed in plots around 23 September. Sudden and severe symptoms of downy mildew appeared during the week of 26 September; therefore, a single evaluation of disease was made on 30 September. Further applications of fungicide and evaluations were not made beyond 30 September because of the rapid decline of plants due to downy mildew.

Cultivars differed significantly in their susceptibility to powdery mildew, with Lioness being the most susceptible and Sunray being the least susceptible (Table 1). Lioness was the cultivar most susceptible to downy mildew.

Fungicides, when averaged across all cultivars, significantly reduced the severity of powdery mildew compared to the untreated check (Table 1). Among fungicide treatments, Procure 480SC alone or alternated with Pristine (12.5 oz/A) gave significantly better control of powdery mildew than protectants such as Bravo WeatherStik or Microthiol Disperss[1].

Table 1. Effect of cultivar and fungicides on the severity of downy and powdery mildew on summer squash, 2005, Lexington, Ky. Data are presented as averages across whole-plot effects and fungicide.

Treatment	Application Rate / A	Application Timing[1]	DM Severity[2, 3]	PM Severity[3,4]
Sub-Plot Effect (Fungicide)				
Untreated check		ABCD	3.7 a	5.2 a
Procure 50WS	6 oz	ABCD	2.8 b	1.7 bc
Procure 480SC	6 fl oz	ABCD	3.0 b	1.2 cd
Procure 480SC/	6 fl oz	AC	2.7 b	0.7 d
Pristine 38WG	12.5 oz	BD		
Bravo WeatherStik	2 pt	ABCD	1.8 d	1.9 b
Microthiol Disperss[1]	5 lb	ABCD	2.6 bc	1.9 b
Bravo WeatherStik+	2 pt	AC	2.2 cd	1.5 bc
Procure 480SC/	6 fl oz	AC		
Quadris	11 fl oz	BD		
Whole-Plot Effect (Cultivar)				
Lioness	--	--	2.1 b	2.9 a
Prelude II	--	--	1.8 c	2.0 b
Sunray	--	--	4.1 a	1.2 c

1 Application dates: A = 7 September; B = 19 September; C, D not made due to onset of downy mildew.
2 DM severity: severity of downy mildew rated on a 0-5 scale where 0 = no symptoms and 5 = 100% of leaf area affected.
3 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).
4 PM severity: severity of powdery mildew on upper and lower leaf surfaces rated on a 0-10 scale where 0 = no symptoms and 10 = 100% of leaf area affected.

1 Microthiol Disperss is a sulfur product. Approval for organic vegetable production (OMRI listing) is expected but could not be confirmed at the time of this writing (11/2005).

The effect of fungicides was greatest on the powdery mildew-susceptible variety Lioness (Table 2). Procure 480SC and Procure + Bravo WeatherStik alternated with Quadris (11 fl oz/A) gave better control of powdery mildew than Microthiol Disperss and Bravo WeatherStik alone. No differences were observed between any fungicide treatment on Prelude II; however, all fungicides significantly reduced disease compared to the untreated check (Table 3). On the powdery mildew-resistant Sunray, only Procure 480SC alternated with Pristine had less disease than the untreated check (Table 4). In general, the liquid formulation of Procure performed as well (or slightly better) than the 50WP formulation.

Results from the trial indicate that it is possible to manage powdery mildew with relatively inexpensive fungicides such as Bravo WeatherStik or Microthiol Disperss (sulfur) when cultivars with moderate to high levels of resistance to powdery mildew (Prelude II or Sunray in this trial) are planted. Bravo WeatherStik also provides broad-spectrum protection against other diseases, including downy mildew; however, sulfur is primarily effective against powdery mildew and may also cause severe burning on foliage if applied when air temperatures are greater then 90°F. Strobilurins or DMI fungicides, or combinations of these materials in rotation with chlorothalonil or mancozeb, will be required to provide adequate suppression of powdery mildew if a susceptible cultivar is used. *When using a DMI fungicide such as* Procure *or* Nova*, we recommend that these materials be tank-mixed with a protectant fungicide to expand the spectrum of activity beyond powdery mildew.* All fungicides that have a specific mode of action should be rotated with protectant fungicides to reduce the risk of resistance development in pathogen populations.

Table 2. Effect of fungicides on the severity of downy and powdery mildew on 'Lioness' summer squash, 2005, Lexington, Ky.

Treatment	Application Rate/A	Application Timing[1]	DM Severity [2,3]	PM Severity[3,4]
Untreated check		ABCD	3.3 a	7.8 a
Procure 50WS	6 oz	ABCD	2.3 bc	2.3 bcd
Procure 480SC	6 fl oz	ABCD	2.8 ab	1.8 cd
Procure 480SC/	6 fl oz	AC	2.0 bcd	1.0 d
Pristine 38WG	12.5 oz	BD		
Bravo WeatherStik	2 pt	ABCD	1.5 cd	2.8 bc
Microthiol Disperss	5 lb	ABCD	1.8 cd	3.3 b
Bravo WeatherStik+	2 pt	AC	1.3 d	1.3 d
Procure 480SC/	6 fl oz	AC		
Quadris	11 fl oz	BD		

1 Application dates: A = 7 September; B = 19 September; C, D not made due to onset of downy mildew.
2 DM severity: severity of downy mildew rated on a 0-5 scale where 0 = no symptoms and 5 = 100% of leaf area affected.
3 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).
4 PM severity: severity of powdery mildew on upper and lower leaf surfaces rated on a 0-10 scale where 0 = no symptoms and 10 = 100% of leaf area affected.

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Table 3. Effect of fungicides on the severity of downy and powdery mildew on 'Prelude II' summer squash, 2005, Lexington, Ky.

Treatment	Application Rate/A	Application Timing[1]	DM Severity[2,3]	PM Severity[3,4]
Untreated check		ABCD	2.8 a	6.0 a
Procure 50WS	6 oz	ABCD	1.5 bc	1.8 b
Procure 480SC	6 fl oz	ABCD	2.0 b	1.0 b
Procure 480SC/	6 fl oz	AC	1.8 bc	1.0 b
Pristine 38WG	12.5 oz	BD		
Bravo WeatherStik	2 pt	ABCD	1.3 c	1.3 b
Microthiol Disperss	5 lb	ABCD	1.8 bc	1.3 b
Bravo WeatherStik+	2 pt	AC	1.5 bc	1.5 b
Procure 480SC/	6 fl oz	AC		
Quadris	11 fl oz	BD		

1 Application dates: A = 7 September; B = 19 September; C, D not made due to onset of downy mildew.
2 DM severity: severity of downy mildew rated on a 0-5 scale where 0 = no symptoms and 5 = 100% of leaf area affected.
3 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).
4 PM severity: severity of powdery mildew on upper and lower leaf surfaces rated on a 0-10 scale where 0 = no symptoms and 10 = 100% of leaf area affected.

Table 4. Effect of fungicides on the severity of downy and powdery mildew on 'Sunray' summer squash, 2005, Lexington, Ky.

Treatment	Application Rate/A	Application Timing[1]	DM Severity[2,3]	PM Severity[3,4]
Untreated check		ABCD	5.0 a	1.8 a
Procure 50WS	6 oz	ABCD	4.8 ab	1.0 ab
Procure 480SC	6 fl oz	ABCD	4.3 bc	0.8 ab
Procure 480SC/	6 fl oz	AC	4.3 bc	0.0 b
Pristine 38WG	12.5 oz	BD		
Bravo WeatherStik	2 pt	ABCD	2.8 d	1.8 a
Microthiol Disperss	5 lb	ABCD	4.3 bc	1.3 a
Bravo WeatherStik+	2 pt	AC	3.8 c	1.8 a
Procure 480SC/	6 fl oz	AC		
Quadris	11 fl oz	BD		

1 Application dates: A = 7 September; B = 19 September; C, D not made due to onset of downy mildew.
2 DM severity: severity of downy mildew rated on a 0-5 scale where 0 = no symptoms and 5 = 100% of leaf area affected.
3 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).
4 PM severity: severity of powdery mildew on upper and lower leaf surfaces rated on a 0-10 scale where 0 = no symptoms and 10 = 100% of leaf area affected.

Synergistic Sweet Corn Evaluations in Eastern Kentucky

Terry Jones and Amanda Ferguson Sears, 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 synergistic sweet corn varieties that might be suitable for production in eastern Kentucky.

Methods

Sixteen synergistic sweet corn cultivars were planted by hand on May 17, 2005. Plots consisted of a row 20 feet long of each cultivar replicated four times in a randomized block design. Rows were spaced 3 feet apart and 100 seeds were planted for each plot of a cultivar. One day after planting 1.7 pts. of Dual Magnum II was applied pre emergence to control weeds.

Soil test results (Table 1) showed that additional phosphorus and potassium were needed. Therefore 50 lb N, 50 lb P_2O_5 and 50 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 needed. Warrior T was applied every 5 days during silking to reduce worm problems.

In evaluating and ranking cultivars, points were awarded based on yield, plant stand, husk coverage, tip fill, and commercial acceptability. Disease tolerance was measured but not used in the equation in 2005 because there was so little disease present at the time of harvest.

Table 1. 2005 sweet corn cultivar trial soil test results.

pH	Buffer pH	P	K	Ca	Mg	Zn
6.55	6.8	48	237	2965	149	6.6

Results

This was a good year to evaluate sweet corn cultivars for pollination and ear fill under extremely warm and dry weather. We experienced hot dry weather during most of the 2005 growing season. Quicksand received 10.8 inches of rain between May 1 and August 31.

Despite hot dry conditions, the 2005 sweet corn crop did very well. Harvest for these cultivars occurred between July 26 and Aug. 5. Unlike 2004, Northern Corn Leaf Blight, Southern Corn Leaf Blight, Yellow Leaf Spot and Gray Leaf Spot were not very severe during the summer of 2005, so we were not able to determine which cultivars had good disease tolerance and thus were better suited for late-season production in disease-prone areas. Polka showed the highest level of leaf disease (slight-moderate) in 2005.

Sugar Ace and Honey Treat were rated as the two top yielding, best quality yellow sweet corn cultivars (Table 2). Sugar Ace was a high yielding, disease-resistant cultivar in the 2004 corn trials. 2004 was one of the coolest, wettest years on record, whereas 2005 was a very warm dry year.

Nantasket and Providence were the best bicolor sweet corns and were the two top rated cultivars overall (Table 2). BC 0805 was also a very nice bicolor and did well in 2004 trials.

Avalon, Misquamicut, and Argent were the three best white cultivars, giving commercially acceptable yields of attractive, high quality ears (Table 2). Avalon and Argent were also outstanding in 2004.

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

Table 2. 2005 synergistic sweet corn plant characteristics and yield components, Robinson Station, Quicksand, Ky.

Cultivar Name[1]	Seed Source	Plant Stand[2]	Husk Coverage[3]	Tip Fill[4,7]	Disease Rating[5]	Commercial Acceptability[6,7]	Dozen Ears/Acre	Cultivar Points[8]	Rank Based on Points
Nantasket (BC)	H	73	10	9.6	1	5	1936	3386	1
Providence (BC)	H, SW	73	9.9	9.6	1	5	1815	3359	2
Sugar Ace (Y)	H	83	10	9.5	1	4	1769	3354	3
Honey Treat (Y)	SY	80	10	8.5	1	5	1981	3351	4
Avalon (W)	SW	84	10	9.5	1	4	1618	3349	5
Misquamicut (W)	H, SW	79	9.6	9.4	1	5	1467	3339	6
BC 0805 (BC)	SW	69	10	9.6	1	4	1603	3213	7
Argent (W)	H, SW	80	10	8.5	1	3.5	1891	3194	8
BC1136 (BC)	SY	75	9.6	8.6	1	3.5	1860	3109	9
Sweet Satin (W)	H	79	10	7.8	1	3.5	1936	3106	10
Sweet Ice (W)	H	80	10	7.4	1	3	2027	3040	11
Cinderella (BC)	SW	70	9.6	8.8	1	4	1059	3048	12
Honey Select	SW	69	10	7.5	1	4	1860	3028	13
Polka (BC)	HM, SW	62	10	9.5	2	2.5	1316	2949	14
Cameo (BC)	H, SW	71	8.6	7.5	1	3	1997	2813	15
Frisky (BC)	SW	73	8.4	6.8	1	2	1089	2554	16

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 = mild, 2 = slight-moderate (infected to just below ear level), 3 = moderate (infected above ear level, 4 = moderate-severe (infected to flag leaf), 5 = severe (plant dead).
6 Commercial acceptability: 1 = poor, 5 = excellent.
7 Based on 10 ears of corn.
8 Points obtained (Rank) = (10 x Stand) + (100 x Husk Coverage) + (100 x Tip Fill) + (100 x Commercial Acceptability) + (Yield/10)- (disease rating x 100). Disease rating was not included in 2005 point ranking.

Synergistic Sweet Corn Evaluations in Central Kentucky

John Strang, April Satanek, Katie Bale, Chris Smigell, Darrell Slone, and John Snyder, Department of Horticulture

Introduction

Locally produced sweet corn is a high demand item at Kentucky retail markets. This trial was designed to evaluate synergistic sweet corn varieties that do not require isolation from sugar enhanced (*se*) varieties.

Materials and Methods

Fifteen synergistic hybrid and one sugar enhanced sweet corn varieties were planted by hand on 11 May 2005. Plots consisted of a 20 ft long row of each cultivar, replicated four times. Rows were spaced 3.5 ft apart, and 100 seeds were planted in each 20 ft row. Plants were thinned to a distance of 8 inches apart on June 10.

Prior to planting, 100 lb of actual N per acre was applied as ammonium nitrate and tilled in. Plants were sidedressed with 50 lb of actual N per acre as ammonium nitrate.

Bicep II Magnum at the rate of 1.6 qt per acre was applied on 10 May 2005 for weed control. Pounce and Warrior were used for insect control.

Results and Discussion

Variety evaluation results can be found in Tables 1 through 3.

Sugar Ace, a synergistic variety that has been available for a number of years was the best performing yellow variety. This has been a top variety in previous trials and was placed in this trial for comparative purposes. The poor plant stand for this variety in Table 1 is attributed to the use of two-year old seed. All other seed in the trial was produced in 2004.

Misquamicut and Sweet Ice were the best white varieties. Argent, the white check *se* variety did very well. Attribute BC0805 and Providence were the best bicolor varieties.

The dry season accentuated husk coverage and tip fill problems and led to some husk sunburning.

Table 1. Plant characteristics and yield of synergistic sweet corn cultivars, Lexington, Ky., 2005.

Cultivar	Seed Source[1]	Days to Maturity	Plant Stand[2] (%)	SSe Seedling Vigor[3] (1-5)	Height to First Harvested Ear (in.)	Ease of Ear Harvest[4] (1-5)	Yield (dozen ears per acre)
Argent[5]	SI	83	85	4.4	16.2	2.8	2100
Attribute BC0805	SY/RG	82	85	3.3	16.2	2.6	1997
Sweet Satin	HM	77	86	4.5	18.4	4.0	1984
Sugar Ace	HR	85	28	1.4	16.3	3.0	1906
Avalon	ST/SW	82	92	3.6	9.4	3.7	1737
Honey Select	SW	79	87	3.0	14.1	2.9	1737
Cameo	SW/HR	84	81	3.6	20.5	3.6	1698
Misquamicut	SI	78	88	3.9	17.9	4.2	1672
Sweet Ice	HM	74	90	4.0	21.6	3.8	1647
Providence	ST/SW	80	87	2.3	18.5	2.9	1634
Nantasket	ST	73	81	2.8	14.3	4.3	1595
Polka	ST	59-66	80	3.1	7.8	3.0	1582
Frisky	ST	58-69	90	3.4	5.7	3.6	1530
Honey Treat	SY/RG	76	90	4.6	11.4	2.6	1465
BC1136	SY/RG	75	78	3.1	13.9	2.8	1387
Cinderella	ST	80	90	2.6	8.0	3.0	1361
Waller-Duncan LSD (P = 0.5)							862

1 See Appendix for seed company addresses.
2 Plant stand is percentage emergence based on planting 100 seeds.
3 1 = poor; 5 = excellent.
4 Ease of harvest 1 = hard; 5 = easy.
5 Sugar enhanced check variety.

Table 2. Ear characteristics of synergistic sweet corn, Lexington, Ky., 2005.

Cultivar	Husk Coverage[1] (1-10)	Ear Length (in)	Ear Width (in)	Tip Fill[2] (1-10)	Kernel Color[3]	Row Straightness[4] (1-10)
Argent[5]	9.3	8.4	1.9	8.3	W	8.8
Attribute BC0805	9.8	9.0	1.9	8.5	BC	8.6
Sweet Satin	7.3	8.4	1.9	6.3	W	7.3
Sugar Ace	9.5	7.8	1.9	9.8	Y	8.5
Avalon	7.3	8.7	1.9	9.5	W	8.6
Honey Select	6.3	8.6	1.9	1.0	Y	7.8
Cameo	7.8	8.4	1.9	4.0	BC	7.5
Misquamicut	8.8	8.1	2.0	8.8	W	6.9
Sweet Ice	9.8	7.5	1.8	8.0	W	6.5
Providence	8.0	9.0	1.8	8.0	BC	8.0
Nantasket	8.5	7.5	2.0	5.0	BC	6.5
Polka	9.5	7.3	1.7	4.0	BC	5.0
Frisky	6.0	7.2	1.6	8.3	BC	7.5
Honey Treat	8.0	8.8	1.8	3.5	Y	9.3
BC1136	6.8	8.6	1.8	6.3	BC	7.6
Cinderella	8.8	7.8	1.8	6.3	W	7.5

1 Number of ears out of 10 that had tight husk coverage over the ear tip.
2 Number of ears out of 10 that had good tip fill.
3 Y = yellow; W = white; BC = bicolor.
4 Number of ears out of 10 that had straight rows of kernels.
5 Sugar enhanced check variety.

Acknowledgments

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Table 3. Ear quality characteristics of synergistic sweet corn varieties, Lexington, Ky., 2005.

	Cooked Corn			
Cultivar	Pericarp Tenderness[1] (1-4)	Kernel Tenderness[2] (1-4)	Sweetness[3] (1-4)	Comments
Argent[4]	4.0	4.0	3.0	Attractive ear and husk. Husks with sunburned ends.
Attribute BC0805	-[5]	-	3.0	Attractive husk and ear, easy to shuck.
Sweet Satin	2.0	2.0	2.0	Attractive ear and husk, large flags.
Sugar Ace	3.0	3.5	3.4	Attractive husk and ear, some with small tassels, hard to husk, long flags.
Avalon	1.5	3.0	2.0	Attractive ear, some with ear tassels. Husks easily, some with sunburn.
Honey Select	-	-	-	Attractive husk. Easy to shuck, but poor tip fill.
Cameo	1.5	2.5	3.3	Attractive ear and husk. Microwaved corn tended to be gummy.
Misquamicut	4.0	4.0	1.0	Attractive ear and husk, excellent tip fill, husks easily. Blunt ear, some sunburning of husk.
Sweet Ice	2.3	3.0	3.0	Attractive ear and husk, a few with ear tassels.
Providence	-	-	3.0	Attractive ear and husk, large ears.
Nantasket	-	-	-	Attractive husk and ear, small ears, some butt end blanking.
Polka	2.8	3.5	3.3	Small ears, not attractive, excessively sunburned shuck.
Frisky	3.0	4.0	3.3	Ears very low to ground.
Honey Treat	4.0	4.0	3.3	Attractive ear and husk, very tender, husk snaps off ear easily, some butt end blanking.
BC1136	2.0	2.0	2.0	
Cinderella	4.0	4.0	3.0	Attractive ear and husk, shucks very easily, some ears with tassels, raccoon feeding.

[1] 1 = tough; 4 = tender.
[2] 1 = crisp; 4 = creamy and tender.
[3] 1 = starchy; 4 = very sweet; ratings are based on two microwaved ears.
[4] Sugar enhanced check variety.
[5] - = Misplaced data.

Ornamental Corn Evaluation in Eastern Kentucky

Amanda F. Sears and Terry Jones, Department of Horticulture

Introduction

Fall decorating has increased in popularity. Currently the average American household spends $45 annually; only Christmas sales are greater. Consumer demand for pumpkins, gourds, corn shocks, straw bales, and ornamental corn is providing growers with new market opportunities. Hosting harvest festivals and family outings to the pumpkin patch as well as producing and selling fall decorations have become a significant part of some farms' incomes. This research was done to evaluate large-eared, ornamental corn varieties that might be appropriate for commercial growers in Kentucky.

Methods

Seven ornamental corn varieties and one type of broom corn were observed in the summer of 2005 at Robinson Station. The eight varieties were planted by hand on May 31. Plots consisted of 20 foot rows with each cultivar replicated four times in a randomized block. Rows were 3 feet apart, and 40 seeds were dropped in each row. Dual Magnum II (1.5 pints/acre) was applied two days after planting to control weeds.

The soil tests results are shown in Table 1. The ornamental corn plot received 50 lb N/A in the form of ammonium nitrate. Additionally, on June 20 and July 23, the plot was sidedressed at 50 N/A rate for a total of 150 lb N/A (NH_4NO_3) for the season.

In evaluation of these cultivars, ear color, husk color, ear size, tip fill, lodging, height to first ear, yield, and commercial acceptability were considered in their ranking.

Table 1. Soil test results for 2005 ornamental corn cultivar trial.

pH	Buffer pH	P	K	Ca	Mg	Zn
6.25	6.82	85	329	2236	115	8.8

Results

This was a good year to evaluate ornamental corn varieties for pollination and ear fill under extremely warm and dry weather. Many open pollinated corn cultivars do not do well under hot dry conditions in Kentucky We experienced hot, dry weather during most of the 2005 growing season. Quicksand received 10.8 inches of rain between May 1 and August 31.

The ornamental corn was harvested from September 20 to 30. Lodging was a major problem in many cultivars due to various stalk rots. The cultivar having the least amount of stalk rot and lodging was Indian Art 104 (Table 2).

Indian Art 104 and Autumn Splendor had the highest yield and best quality ears of the seven ornamental corn cultivars tested. However, due to superior stalk strength and well-developed ears, the only tested ornamental corn cultivar suitable for recommendation is Indian Art 104.

The broom corn cultivar was very tall with a well-developed head containing red seeds. It did not have lodging problems despite its height and could be used in dried floral arrangements.

Table 2. 2005 ornamental corn plant characteristics and yield, Robinson Station, Quicksand, Ky.

Cultivar Name	Seed Source	Ear Color	Husk Color[1]	Ear Size (in.)	Tip Fill[2]	Lodging[3]	Height to First Ear (in.)	Yield (dz/ acre)	Commercial Acceptablitity[2]
Indian Ornamental Corn	HM	mixed	YW/P	7 x 1.5	6.8	95%	36	790	5.5
Earth Tones Dent	HM	mixed	YW	7.5 x 1.5	8.0	64%	36	1011	6.2
Wilda's Pride	HM	mixed	YW/P	7.5 x 1.5	6.5	85%	37	726	3.2
Indian Art 104	RU	mixed	YW/P	10 x 1.5	7.9	27%	36	1465	8.2
Autumn Explosion	SW	mixed	YW/P	9.5 x 1.5	6.0	39%	38	1361	7.2
Big Chief	SW	mixed	YW	10.8 x 2.0	6.8	48%	51	1231	7.2
Autumn Splendor	RU	mixed	YW/P	9.5 x 1.5	6.7	36%	38	1465	8.0

[1] YW = yellow white husk, P = purple husk.
[2] Tip fill and commercial acceptability: 1 = poor, 10 = excellent.
[3] Lodging = percentage based on amount of corn on ground.

Yield, Income, and Quality of Staked Tomato Cultivars in Eastern Kentucky

R. Terry Jones, Amanda Ferguson Sears, and John C. Snyder, Department of Horticulture

Introduction

Kentucky growers produce approximately 1200 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 a premium tomato with resistance to a potentially serious virus problem (Tomato Spotted Wilt Virus, TSWV). Cultivars were evaluated for yield, appearance, and potential return to growers. We wanted to see if new tomato cultivars with resistance to TSWV would produce attractive fruit, acceptable to the industry.

Materials and Methods

Sixteen fresh market, red-fruited tomato cultivars were evaluated at Quicksand, Kentucky (Table 1). According to soil test results (Table 2), the plot received 59 lb P_2O_5, 118 lb of K_2O, and 59 lb N/A preplant. An additional 75 lb of N/A was applied through the drip irrigation lines during the growing season. Pest control was based on recommendations from ID-36, *Vegetable Production Guide for Commercial Growers*. Fungicides were applied weekly and insecticides, as needed.

Trays were seeded in the greenhouse at Quicksand on 29 March. Black plastic mulch and drip tape were laid on May 9 and tomatoes were transplanted the same day. Cultivars were replicated four times with eight plants per replication. Plants were spaced 18 in. within rows. Rows (bed centers) were 7 ft. apart to allow the sprayer to be driven between beds.

Eight harvests were made during this trial. The tomato cultivars were harvested when the fruit was at the breaker stage. Data collected included: grade, weight, and count for extra large (>3.5 in.), large (>2.5, <3.5 in.), No. 2, small (<2.5, >2.0 in), and cull tomatoes. Reasons for culling included catfacing, concentric or radial cracks, disease, scars, blossom end rot, and uneven ripening. Incomes were calculated based on the prices received by growers for staked tomatoes in 2003 (Table 3).

Table 1. Tomato cultivars, descriptions and reported disease resistance, grown at Quicksand and Lexington, Ky., 2005.

Variety Name (Company)	Comments/Description[1]
Amelia VR (HM)	Determinate, red, 80 days, resistant to 1,2,3,12
BHN444 (B)	Determinate, red, 80 days, resistant to 1,2,3,12
Crista [NC 0256] (HM)	Determinate, red, 75 days, resistant to 1,2,3,4,9,12
SunGuard (S)	Determinate, red, 77 days, resistant to 1,2,3,6,7,9
SunShine (S)	Determinate, red, 67 days, resistant to 1,2,3,6,7
Mt. Spring (RG)	Determinate, red, 72 days, resistant to 1,2,3
Mt. Fresh Plus (HM)	Determinate, red, 78 days, resistant to 1, 2, 3, 13.
Mt. Crest (SU)	Determinate, red, 75 days, crack resistant, resistant to 1,2,3
Applause (S)	Determinate, red, 67 days, unknown resistance
Quincy (S)	Determinate, red, 80 days, early to midseason, resistant to 12
Debut (S)	Determinate, red, 66 days, resistant to 1,2,3,6
Soraya (S)	Determinate, red, 80 days, resistant to 1,2,3,7,9
Biltmore VFF (RG)	Determinate, red, 77 days, resistance to 1,2,3,6,7
RTF 6153 (RG)	Determinate, red, 77 days, resistant to 1,2,3,7
Indy (RG)	Determinate, red, 75 days, resistant to 1,2,3,7
BHN 543 (B)	Determinate, red, 72 days, resistant to 1,2,3,4

[1] 1-Verticillium Wilt, 2-Fusarium Wilt R1, 3-Fusarium Wilt R2, 4-Nematode tolerant, 6-Alternaria Stem Canker Tolerant, 7-Stemphylium Tolerant, 9-Fusarium Wilt R3, 12- Tomato Spotted Wilt Virus, 13-Early Blight Tolerant.

Results and Discussion

The 2005 growing season was drier and warmer than normal. Rainfall totals for May through August were: 3.76, 2.86, 4.14, and 0.0 inches for a total of 10.76 inches. Extreme heat caused the tomatoes to stop fruiting in mid-August. Bloom returned in September when lower temperatures returned. Due to dry weather,

Table 2. Results from soil test at Quicksand, Ky., 2005.

pH	Buffer pH	P	K	Ca	Mg	Zn
6.6	7.02	75	245	2906	210	3.5

Table 3. Prices used to calculate incomes—actual farm gate prices paid by Cumberland Farm Products Cooperative in 2003.[1]

Week	No. 1 Jumbo & X-Large	No. 1 Large	No. 2s
	Price per Pound		
7/12	$0.34	$0.21	$0.21
7/19	0.34	0.21	0.22
7/26	0.30	0.17	0.22
8/2	0.29	0.15	0.19
8/9	0.20	0.11	0.09
8/16	0.12	0.09	0.08

[1] Yields of each size class/grade were multiplied by these prices for the appropriate harvest dates to calculate "income per acre" for each cultivar.

Table 4. 2005 fresh market tomato full season yields at Quicksand, Ky., 2005. Data are means of four replications.

Cultivar	Jumbo & Extra Large (boxes/acre)[3]		% Jumbo & Extra Large[3]		Total Marketable Yield (lbs)[1, 3]		Income ($)	Pounds No. 2 Tomatoes[3]		Percent Culls[2,3]	
BHN 543	3126	A	95	ABC	82,349	AB	$9,114	8012	ABC	14	AB
Crista	3062	A	93	ABC	83,273	A	$9,668	3293	F	6	B
Quincy	3048	A	95	ABC	79,951	ABC	$8,453	7571	ABCDE	10	B
BHN 444	2889	AB	92	ABC	79,069	ABC	$8,227	9490	A	9	B
SunGuard	2871	AB	94	ABC	76,424	ABCD	$8,672	5121	BCDEF	8	B
Amelia	2858	AB	96	AB	74,181	ABCD	$9,201	4693	BCDEF	9	B
Mt. Fresh Plus	2754	AB	90	BC	76,346	ABCD	$8,660	4958	DEF	7	B
Indy	2724	AB	89	C	75,828	ABCD	$8,727	3850	EF	8	B
Mt Spring	2711	AB	95	ABC	71,446	ABCD	$8,003	5147	BCDEF	8	B
Mt Crest	2672	AB	91	BC	73,559	ABCD	$7,938	4900	BCDEF	10	B
Soraya	2552	AB	96	AB	66,312	ABCD	$6,429	3967	DEF	12	AB
Biltmore VFF	2530	AB	98	A	64,536	ABCD	$7,480	4408	CDEF	19	A
RFT 6153	2417	AB	94	ABC	63,810	ABCD	$7,106	5523	BCDEF	12	AB
SunShine	2092	B	89	C	58,715	BCD	$7,392	7856	ABCD	12	AB
Debut	2090	B	92	ABC	56,991	CD	$7,091	8505	AB	13	AB
Applause	2006	B	94	ABC	53,102	D	$6,826	4849	BCDEF	10	B
Duncan-Waller LSD (5%)	925		6.6		24,894		ns	3948		8.5	

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

the appearance of tomato fruit harvested was better than it was in 2003 and 2004.

Crista had the highest full season total marketable yield, but it was not significantly different from the yields of 12 of the other 15 large-fruited cultivars (Table 4). BHN543, Crista and Quincy had significantly more boxes of jumbo and extra large tomatoes than Sunshine, Debut, and Applause. Biltmore had the highest percentage (19%) of cull tomatoes which was significantly higher than 10 of the other cultivars. Cash returns ranged from $6429 to $9429 per acre but did not differ significantly among the 16 cultivars. Crista, Amelia, and BHN543 had the highest cash returns, but did not differ significantly from the other 13 cultivars. The major reason there were no significant differences can be seen in Table 5. Most of the lower yielding cultivars (Applause, Debut, Sunshine) produced over 70% of their fruit early and received higher prices. Higher yielding cultivars BHN543, Crista, and Quincy produced higher percentages (22-48%) of fruit later in the growing season when prices were lower. A good yield and a high percentage of early fruit helped Amelia finish second in total returns while being eighth in total marketable fruit for the season.

There was a significant difference in the percentage of jumbo/extra large tomatoes. Mountain Fresh Plus, Indy, Mtn. Crest, and Sunshine had significantly lower percentages than three of the other cultivars.

Tomatoes were rated for visual appearance at both Lexington and Quicksand. Based on visual ratings of the 16 cultivars (Table 6), Sunshine, Applause, and Debut did not produce commercially acceptable fruit. The best-looking tomato cultivars were Mtn. Spring followed by Mtn. Fresh Plus, Crista and Mtn. Crest.

Growers should use caution when selecting any vegetable cultivar based on one year's results at a single location. See also the trial report for the same varieties tested at Lexington.

Table 5. 2005 tomato early and late income by cultivar, Quicksand, Ky., 2005. Data are means of four replications.

Cultivar	Early Income[1]	Late Income[1]	Total Income	% Early Income
Crista	$4,674	$4,995	$9,668	48%
Amelia	$5,089	$4,112	$9,201	55%
BHN 543	$3,183	$5,931	$9,114	35%
Indy	$3,883	$4,844	$8,727	44%
Sunguard	$3,110	$5,562	$8,672	36%
Mt. Fresh Plus	$2,589	$6,072	$8,660	30%
Quincy	$1,882	$6,571	$8,453	22%
BHN 444	$3,081	$5,146	$8,227	37%
Mt. Spring	$3,705	$4,298	$8,003	46%
Mt. Crest	$2,387	$5,551	$7,938	30%
Biltmore	$2,670	$4,811	$7,480	36%
Sunshine	$5,812	$1,580	$7,392	79%
RTF6153	$2,019	$5,087	$7,106	28%
Debut	$5,058	$2,033	$7,091	71%
Applause	$5,349	$1,477	$6,826	78%
Soraya	$2,075	$4,354	$6,429	32%

[1] Early income was that earned with tomatoes harvested prior to July 30, and late income was income earned after this date.

Table 6. Tomato fruit appearance ratings from Lexington and Quicksand, Ky., 2005.

Cultivar	Visual Rating[1] Lexington	Quicksand	Average	Comments (Quicksand Only)
Mt. Spring	8	6	7.0	Blotchy ripening/yellow shoulder disorder (slight at 1 picking)
Mt. Fresh Plus	7	6	6.5	
Mt. Crest	6	7	6.5	BR/YSD[2] (slight 1 picking)
Amelia	7	5	6.0	BR/YSD (slight 1 picking)
SunGuard	7	7	7.0	
Crista	7	6	6.5	
BHN 444	7	5	6.0	
BHN 543	6	6	6.0	BR/YSD (slight 1 picking)
SunShine	4	4	4.0	Ugly, late in the season
Applause	4	2	3.0	Ugly
Quincy	5	6	5.5	Ugly later in the year.
Debut	4	3	3.5	Ugly! Many times during the year
Indy	5	5	5.0	
Soraya	4	6	5.0	Ugly
Biltmore VFF	4	6	5.0	
RTF 6153	6	6	6.0	

[1] 1 = worst, 9 = excellent; 5 is minimum acceptable for commercial sales.
[2] BR/YSD = Blotchy ripening or yellow shoulder disorder.

Yield, Income, and Quality of Staked Tomato Cultivars in Central Kentucky

Brent Rowell, April Satanek, Katie Bale, and John C. Snyder, Department of Horticulture

Kentucky growers currently produce about 1200 acres of staked, vine-ripe tomatoes for local and national markets. Kentucky tomatoes have an excellent quality reputation among buyers in several midwestern states. We continue to test new and existing commercial fresh market tomato cultivars to support the existing industry and to identify any cultivars that might be featured in supermarkets as a premium "Kentucky Tomato." We evaluated cultivars for yield, appearance, firmness, and taste and compared them with well-established cultivars like Mountain Spring and Mountain Fresh. We were looking specifically for the following characteristics in the "Kentucky Tomato":

1. large slicer that tastes good
2. ships reasonably well (firm, but not necessarily the most firm among cultivars)
3. high yields of extra-large and jumbo size classes
4. low frequency of fruit defects.

Some of the varieties identified as superior in 1998-99 trials were again evaluated for these traits (except for taste) in 2004 and 2005. Three varieties included in the 2005 trial (Quincy, Amelia, and BHN 444) claim to have resistance to tomato spotted wilt virus (TSWV), which has become a major problem in some neighboring states. See the tomato cultivar trial report from eastern Kentucky for more detailed descriptions of the varieties tested.

Materials and Methods

A carefully selected group of 14 determinate tomato varieties from several seed companies was evaluated at Lexington in central Kentucky and at Quicksand in eastern Kentucky (see separate report). Two popular cultivars, Mountain Spring and Mountain Fresh Plus, were included for comparison with new cultivars. Mountain Fresh Plus is essentially the same variety as the old Mountain Fresh but with the addition of root knot nematode resistance. All trial entries were seeded in the greenhouse at the Horticultural Research Farm in Lexington on 23 March and subsequently transferred to 72-cell plastic trays. Cultivars were transplanted to the field on 12 May. Cultivars were planted in a randomized complete block design with four replications. Plots consisted of eight plants spaced 18 in. apart in single rows on 6-in. high raised beds spaced 6 ft. apart with black plastic mulch and drip irrigation.

Drip irrigation was applied as needed according to tensiometers used to monitor soil moisture. Plants were staked and tied using the Florida weave system and pruned to two main stems except for SunShine which was not pruned. Sixty pounds/acre of nitrogen, no phosphorus, and 103 lbs/acre of potassium (K_2O) were applied prior to bed formation. A total of 122 lbs/acre of supplemental N (from ammonium nitrate) was fertigated in 11 applications during the season; an additional 40 lbs/acre of potassium (from potassium nitrate) was fertigated in a single application. Plots were sprayed weekly with protectant fungicides (fixed copper plus Maneb, alternated with copper plus either Bravo or Quadris). Four insecticide sprays (Pounce, Baythroid, or SpinTor) were required during the season for Colorado potato beetle and tobacco hornworm control.

Ten harvests were made from 11 July until 22 Aug. Fruit were graded into the following size classes prior to counting and weighing: Jumbo (>3.5 in. diameter), extra-large (>3 in. but ≤3.5 in.), large (>2.5 in. but ≤3 in.), medium and small (≤2.5 in.), and cull. Fruits were also sorted according to U.S. No. 1 or U.S. No. 2 grades. In order to approximate the present marketing situation in Kentucky, "marketable yield" included only the "large" and above size classes. Yields of the "medium" size class are reported together with the small class as they are not considered worth marketing by most grower/shippers in the state. All yields reported are of U.S. No. 1 fruit unless otherwise indicated. Yields of No. 2 fruits, although marketable in most years, were not included in "marketable yield" and are reported in separate columns in the tables. Means of all variables were compared using Waller-Duncan's K-ratio T-test (P = 0.05).

Income per acre. In addition to reporting yields in pounds or cartons per acre, variety performance is also expressed as income per acre. We used 2003 wholesale prices received by Cumberland Farm Products Cooperative (Table 1) which were similar to those from 1999-2002. These weekly market prices were multiplied by yields from the different size classes for each variety. Higher prices used for the first three weeks of harvests favor earlier-maturing varieties. Higher prices were also obtained for the "extra large/jumbo" size class. Yields of No. 2 fruits were also used in these calculations but usually with lower prices than No. 1 fruits. We consider the incomes per acre together with fruit quality observations to provide

Table 1. Actual farm gate prices paid by Cumberland Farm Products Cooperative in 2003. Yields of each size class/grade were multiplied by these prices for the appropriate harvest dates to calculate "income per acre" for each cultivar.

Week Ending	#1 Jumbo & X-Large	#1 Large	#2's (Jumbo, X-Lg, Lg, Med)
	Price per Pound		
22 July	$0.34	$0.21	$0.22
29 July	0.30	0.17	0.22
5 Aug	0.29	0.15	0.19
12 Aug	0.20	0.11	0.09
19 Aug	0.12	0.09	0.08
20 Aug-28 Sept[z]	0.10	0.05	0.06

[z] Cumberland Farm Products Cooperative discontinued packing on 19 August. We used prices slightly lower than their 19 Aug prices for income calculations for all trial harvests after that date.

the best indication of overall variety performance.

Fruit quality ratings. All ripe fruits of each variety harvested on 22 Aug. (final harvest) were laid out on tables for careful examination and quality ratings on 23 Aug. All cultivars were rated for smoothness, blossom scar size, extent of cracking, firmness, and internal color. The overall appearance rating took most of these factors into account.

Table 2. Yields, fruit size, and income from staked tomato cultivars at Lexington, Ky., 2005; all data are means of four replications.

Entry (Seed Co.)	#1 Jumbo + XL[1] (boxes/acre)	(%)	Total Mkt.[2] (thousand lbs/acre)	#2's[3] (thousand lbs/acre)	Culls[4] (%)	Avg. Fruit Wt. (oz.)	Income ($/acre)
Sunshine (S)	1446	63	57.4	12.4	23	10.2	6000
Min. Fresh Plus (HM)	1333	73	46.8	8.5	21	11.3	3491
Biltmore (S)	1233	90	34.8	7.1	34	13.7	2682
Quincy (S) TSWV	1128	74	37.6	6.0	29	11.7	3401
Soraya (RG)	1032	79	32.6	5.0	31	11.4	2725
Debut (S)	999	82	30.0	13.1	33	12.1	3831
Amelia (HM)	986	83	29.2	12.2	32	12.4	3018
Crista (HM)	975	83	29.3	4.9	37	12.5	2963
Mtn. Spring (HM?)	927	82	28.0	8.8	37	12.3	3056
Sunguard (S)	856	69	30.4	6.9	29	10.7	3108
Indy (RG)	839	63	33.1	14.0	27	10.4	3179
Mtn. Crest (HM)	791	78	25.2	8.3	40	11.3	2552
Applause (S)	647	80	20.2	11.0	48	11.9	2479
BHN 543	612	67	22.6	8.0	48	10.7	1730
RFT 6153 (RG)	546	60	23.0	5.0	42	9.8	1525
BHN 444	512	71	18.6	12.4	53	10.5	1756
Waller-Duncan LSD (P = 0.05)	288		9.0	4.0	11	1.1	805

1 Yields of USDA No. 1 fruit of jumbo (>3.5 in. diameter) plus extra large (>2.75 in. but ≤3.5 in.) size classes: boxes/acre = number of 25 lb cartons per acre: "%" = percentage of the total of these two size classes of the total marketable yield.
2 Total marketable yield = yield of No. 1 fruit of jumbo + extra large + large size classes; mediums not included.
3 Yield of USDA No. 2 fruit from all size classes.
4 Percentage of culled fruit in total yield.
5 Average fruit weight; includes jumbo, extra large, and large only.

Results and Discussion

The 2005 growing season was abnormally hot and dry. Very cool night temperatures occurred just after transplanting which led to relatively low fruit appearance ratings and a greater than normal amount of cull fruit (21-53%) due to catfacing and other defects from the earlier harvests. Late harvests were affected by bacterial canker (*Clavibacter michiganensis*) which had spread to almost all plots in the field by mid-August. The occurrence of this disease late in the season probably resulted in lower than expected yields from some of the main season and later-maturing varieties.

Yields and incomes. Yields and incomes per acre were low this year because of the impact of bacterial canker resulting in fewer harvests. Because of the effects of this disease, no firm conclusions should be drawn using these data. Under these conditions, the highest yielding and highest income cultivar by far was the very early-maturing SunShine (Table 2). This variety escaped most of the yield loss due to canker, and its early yields obtained the highest market prices. Debut was also very early, resulting in the second highest income per acre. The main season variety Mountain Spring Plus had the second highest yields of jumbo and extra large fruits and was third highest in income. Incomes ranged from $6000/acre for SunShine to $1525/acre for RFT 6153 (Table 2).

Fruit quality. Among the group of varieties with the highest incomes, Sunguard, Mtn. Fresh Plus, and Quincy had the highest

Table 3. Fruit quality characteristics; observations from all fruits harvested from four replications on 22 August 2005. Cultivars ranked in order of yield of #1 Jumbo + Extra Large fruits.

Cultivar (Seed Co.)	Shape[1]	Blossom Scar[2]	Smoothness[3]	Cracking[4]	Appearance[5]	Firmness[6]	Internal Color[7]	Comments
SunShine (S)	do	s	2	--	--	--	4	sample size too small at late harvest
Mtn. Fresh Plus (HM)	g	s-m	3	2	6	m	5	
Baltimore (S)	do-g	s	3	2.5	6	m	4	
Quincy (S)	dg	m	3	1.5	6	m	3	
Soraya (RG)	g	s	2	1.5	6	f	3	some weather checking on shoulders
Debut (S)	o	s-m	3	4	3	m	4	badly cracked at this harvest
Amelia (HM)	do	m	3	2	5	f	3	
Crista (HM)	do	s	3	2	6	f	3	
Mtn. Spring (RG)	do	s	3	2	6	m	3	
SunGuard (S)	dg	s	2	1	7	m	3.5	
Indy (RG)	dg	s	3	2	5	m	3	
Mtn. Crest (SU)	g	s	2	1	7	f	4	
Applause (S)	o	s-m	4	4	2	s	3	badly cracked and catfaced
BHN 543 (B)	dg	s	2	3	6	m	3	
RFT 6153 (RG)	g	s-m	3	2	6	m	4	
BHN 444 (B)	dg	s	2	3	5	m	3	

1 Fruit shape: 0 = oblate; do = deep oblate (diameter somewhat greater than height); g = globe (spherical); dg = deep globe.
2 Blossom scar size: s = small (<1/8 in. diameter), m = medium (1/8 to 1/4 in.), lg = large (5/16 to 7/16 in.).
3 Smoothness of fruit shoulders: 1 = smooth, 5 = rough (ribbed on top of fruit).
4 Fruit cracking: 1 = none, 5 = severe.
5 Overall fruit appearance rating: 1 = worst, 9 = best.
6 Fruit firmness by feel: s = soft, m = medium firm, f = very firm.
7 Internal fruit color: 1 = whitish (worst), 5 = uniformly deep red (best).

fruit appearance scores (Table 3). SunShine could not be rated for appearance since too few fruits were available late in the season when the varieties were evaluated. Debut, while in a high income group, had a very low appearance score at this late harvest. Poor quality late in the season has been noted in other trials for other very early varieties including SunShine and SunStart. Other varieties with high appearance scores of 6 or above were SunGuard, Biltmore, Soraya, Crista, Mtn. Spring, Mtn. Crest, BHN 543, and RFT 6153. SunGuard and Mtn. Crest had the best overall appearance scores, while Applause and Debut had the worst (Table 3).

All things considered. Given the problem with bacterial canker that affected most varieties, it is difficult to come to any firm conclusions regarding variety performance from the yield and income data in this trial. As has been shown in previous trials, very early varieties like SunShine, SunStart, and Debut can produce high returns per acre when early season prices are high; however, fruit quality deteriorates rapidly as the season progresses. Debut should be compared with SunShine and other varieties for fruit appearance early in the season in 2006. Most of the varieties tested in 2005 look promising and will be tried again in 2006. As for fruit appearance and quality, SunGuard was again one of the best cultivars in this trial and in trials conducted in 2003 and 2004 (see 2003 and 2004 Research Reports). Mountain Crest, a new variety with extended shelf life and dark red internal color, also rated highest for fruit appearance in 2004 and 2005.

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Specialty Melon Variety Evaluations

John Strang, April Satanek, Katie Bale, John Snyder, and Chris Smigell, Department of Horticulture

Introduction

Seventeen specialty melon varieties were evaluated in a replicated trial and six in an observation trial for their performance under Kentucky conditions. These included Asian, canary, cantaloupe, casaba, charentais, crenshaw, galia, gourmet, heirloom, and honeydew melons.

Materials and Methods

Varieties were seeded on 29 April into Styrofoam plug trays (72 cells per tray) at the Horticulture Research Farm in Lexington. Plug trays were set on a mist bench with bottom heat until seeds germinated, then moved to a drier, cooler bench in the greenhouse, where the seedlings were thinned to one per cell. Plants were set into black plastic-mulched, raised beds using a waterwheel setter on 1 June. Each plot was 21 feet long, with 7 plants set 3 feet apart within the row and 6 feet between rows. Each replicated treatment was replicated 4 times in a randomized complete block design. Observation treatments were replicated twice randomly throughout the replicated planting. Drip irrigation was used to provide water and fertilizer as needed.

Forty-two pounds of N/A as ammonium nitrate and 75 lb K/A as potassium chloride were applied and incorporated into the field prior to bed shaping and planting. The plot was fertigated with a total of 42 lbs N/A as ammonium nitrate divided into seven applications over the season. Epsom salts foliar sprays were applied twice. The systemic insecticide Admire 2F was applied by hand as a drench to the base of each plant after planting, using the maximum rate of 24 fl oz/A. Foliar insecticide applications included Sevin, Pounce, and Capture. Weekly foliar fungicide applications included Bravo, Quadris, and Nova. Curbit preemergent herbicide was applied and incorporated between the rows, just as the vines began to grow off the plastic mulch. One fruit from each replication was measured and evaluated for flavor, soluble solids, interior color, rind color, and net type.

Results

The growing season was dry and hot; consequently, disease pressure was minimal. No virus was observed. Vine cover was thick, with no plant death. Magnesium deficiency became apparent on most of the galia melon plants later in the season despite foliar magnesium applications.

Fruit were generally harvested twice a week. Melon sugar contents were high. Harvest and evaluation data for the replicated trial are in Tables 1 and 2, while the observation trial results can be found in Tables 3 and 4. Most melon varieties evaluated previously performed well.

Replicated Trial

Crenshaw. Bolero is a high yielding, excellent-tasting large melon that appeared to hold up well after harvest. Flesh was thick and attractive, and the variety was superior to others of this type evaluated in previous years. However, the dark rind sunburned severely during this hot season.

Casaba. Honey I Dew performed very well in this trial. Flavor was outstanding and the sugar content was very high. Its bright golden rind was attractive, although it sometimes developed dark surface spots. Honey I Dew was very similar in appearance to canary melons.

Canary. Golden Beauty again performed exceptionally well, producing high yields of high quality, attractive melons with no culls.

Honeydew. Neither of the honeydews were exceptional. Honey Orange did not have as good a flavor and exterior appearance as in the previous two seasons.

Galia. HSR4278 and Vicar performed exceptionally well. Both had excellent yield, superior taste, and sugar content with few culls.

Specialty melons. Sunrise and Napoli do not seem to fit any melon class. They resemble small tightly netted cantaloupes on the exterior, but they do not have the musky flavor of cantaloupes,

Table 1. Specialty melon variety trial yield and fruit characteristics, Lexington, Ky., 2005.

								Outside Measurements		Flesh	Seed Cavity	
Variety	**Melon Type[1]**	**Seed Source**	**Days to Harvest**	**Yield (cwt/A)[2]**	**Avg. No. Melons/A**	**Avg. Wt./Fruit (lbs.)**	**Culls (%)**	**Length (in.)**	**Width (in.)**	**Thickness (in.)**	**Length (in.)**	**Width (in.)**
Bolero	CR	SI	95-100	955 a	9853	9.8	0.0	8.0	7.5	2.0	5.6	3.5
Honey I Dew	CS	GU	84	853 ab	12100	7.1	0.0	9.1	6.7	1.7	5.9	3.1
Golden Beauty	CA	JS	80	851 ab	13224	6.5	0.0	9.4	7.0	1.7	6.3	3.5
Amarillo Oro	CA	BC	100	455 ef	7606	6.0	0.0	10.8	6.7	1.8	7.7	3.2
Honey Ace	HD	SI	75	848 ab	13915	6.1	3.2	7.4	7.2	2.0	4.0	2.9
Honey Orange	HD	JS	80	400 fg	8989	4.5	1.0	7.7	6.4	1.7	5.0	3.0
HSR4278	GA	HL	75	787 bc	16479	4.8	1.8	7.4	6.3	2.0	4.2	2.1
Vicar	GA	SY/RG	86	773 bc	19101	4.1	0.5	6.1	6.4	2.0	3.5	2.5
Visa	GA	SW	78	702 c	16854	4.2	0.0	7.1	6.2	2.0	4.0	2.2
Sunrise	SP	EV	72	696 c	19706	3.5	0.0	5.6	5.6	1.5	3.6	2.5
Napoli	SP	EV	72	549 de	18409	3.0	0.5	5.0	5.0	1.5	3.3	2.3
Sensation	GO	HL	80	658 cd	13569	4.9	2.6	7.0	6.2	1.8	3.5	2.8
Jenny Lind	HE	BC	80	403 fg	15816	2.5	1.1	5.4	6.0	1.4	3.6	3.3
Prescott Fond Blanc	HE	BC	95	395 fg	7519	5.3	0.0	5.1	7.6	1.4	2.8	3.9
Noir de Carmes	HE	BC	75	322 fg	18150	1.8	2.2	4.8	5.2	1.2	3.0	3.2
Yellow Star	AS	SI	70	298 g	25410	1.2	0.0	5.5	3.1	0.7	4.2	1.6
Golden Liner	AS	EV	65	290 g	27830	1.0	0.0	5.5	3.0	0.7	4.3	1.6

[1] Melon type: AS = Asian melon, CA = canary, CR = crenshaw, CS = casaba, GA = galia, GO = gourmet, HD = honeydew, HE = heirloom, SP = specialty type.
[2] Numbers followed by the same letter are not significantly different (Waller-Duncan LSD P = 0.05). Cwt/A = hundredweights (100 lb. units) per acre.

and Napoli has light green flesh. Melon flavor and flesh texture are excellent, fruit are very uniform in size and have a relatively long harvest period. These varieties have the potential to be developed into a specialty niche market.

Gourmet. Sensation is an outstanding melon in terms of flavor, sugar content, and its relatively long harvest period for this type of melon. It was also observed to hold fairly well in refrigerated storage.

Heirloom. Jenny Lind, Prescott Fond Blanc, and Noir de Carmes performed very poorly in this trial. All were unattractive, had low yields, and became overmature very rapidly. Melon flavor was very poor in comparison to the other melons evaluated. The Jenny Lind evaluated this year had a green flesh, very apparent buttons at the blossom end of the fruit, and green flesh as described in the literature for this variety. The Jenny Lind evaluated last season from Johnny's Seeds had an orange flesh and was far superior to this Jenny Lind.

Table 2. Specialty melon trial fruit characteristics, Lexington, Ky., 2005.

Variety	**Flavor (1-5)[1]**	**Sugar (%)**	**Interior Color[2]**	**Rind Color[3]**	**Fruit Shape**	**Cracking (1-4)[4]**	**Net Type[5]**	**Comments**
Bolero	4.6	13.9	or	gr and yl	oval	1.0	none	Dark rind sunburns, pick at slip when rind starts to turn yellow, coarse checking, melon size variable.
Honey I Dew	4.5	14.3	lg	gd	almond	1.0	none	Develops small brown spots at harvest sometimes.
Golden Beauty	4.1	13.5	cry lg	gd	almond	1.0	none	Excellent, harvest when rind is golden yellow.
Amarillo Oro	3.6	12.0	cry lg	gd	almond	1.0	none	Harvest when rind is golden yellow.
Honey Ace	4.2	14.4	lg	lg	round	3.2	none	Very sweet, some surface checking, harvest when exterior and ground spot turn a cream color.
Honey Orange	4.0	12.8	or	lg	oval	1.0	none	Considerable rind checking, harvest when exterior and ground spot turn a cream color.
HSR4278	5.0	12.7	lg	str yl	oval	1.0	med	Very nice, small seed cavity, pick at early slip.
Vicar	4.4	14.0	lg	str yl	round	1.0	lt	Musky flavor, harvest at first sign of yellow.
Visa	4.1	12.5	lg	str yl	oval	2.0	lt	Attractive interior, harvest at first sign of yellow.
Sunrise	4.2	12.8	or	str	round	1.0	lt	Dense, small fruit, good taste, harvest at first sign of yellow, long period for optimum harvest.
Napoli	4.7	15.7	lg	str lg	round	1.2	lt	Sweet mild flavored flesh, harvest at first slip.
Sensation	4.7	13.6	cry lg	str lg	oval	1.0	med	Attractive, tastes good even when overripe, slight rind checking pick at slip, longer period for optimum harvest.
Jenny Lind	1.5	7.7	lg with pk interior	str yl	heart shaped	2.0	coarse	Does not resemble last year's Jenny Lind.
Prescott Fond Blanc	1.3	6.0	or	str	pumpkin	1.0	lt	Very deep sutures.
Noir de Carmes	1.0	5.1	or	dg and o	round	2.5	none	Very short harvest season, deep sutures.
Yellow Star	2.5	10.3	cr	by	elongated	1.0	none	Harvest when rind is bright yellow.
Golden Liner	1.8	6.9	cry wh	by	elongated	1.0	none	Harvest when rind is bright yellow, susceptible to powdery mildew, which causes vine to die.

[1] Flavor: 1 = poor, 5 = excellent, sweet taste, pleasant texture.
[2] Interior color: o = orange, cr = cream, lg = light green, wh = white, cry = creamy, pk = pink.
[3] Rind color: lg = light green, gr = green, dg = dark green, yl = yellow, by = bright yellow, str = straw, o = orange, gd = gold.
[4] Cracking: 1 = little or no cracking, 4 = severe cracking and fruit splitting.
[5] Net type: lt = light netting, md = medium netting, na = none.

Table 3. Specialty melon fruit characteristics from two replications, Lexington, Ky., 2005.

Variety	Melon Type[1]	Seed Source	Days to Harvest	Yield (cwt./A)[2]	Avg. No. Melons/A	Avg. Wt./ Fruit (lbs.)	Culls (%)	Outside Measurements Length (in.)	Outside Measurements Width (in.)	Flesh Thickness (in.)	Seed Cavity Length (in.)	Seed Cavity Width (in.)
HSR4250	MM	HL	87	860	15039	5.7	2.3	7.5	6.8	2.0	4.5	2.7
HSR4270	MM	HL	87	754	10717	7.1	0.0	8.5	6.9	2.2	5.6	2.6
HSR4260	MM	HL	87	709	9680	7.3	3.5	7.4	6.8	1.8	4.4	3.1
HSR4276	MM	HL	83	666	11581	5.8	0.0	8.1	6.6	2.1	5.1	2.3
Halona	MM	HL	83	651	10890	6.0	1.5	6.9	6.8	2.0	4.1	2.6
Athena	MM	SW	83	547	9161	6.0	0.0	8.6	6.8	1.9	5.8	2.9

[1] Melon type: MM = muskmelon.
[2] cwt = hundredweight per acre.

Asian. Neither Asian melon looked good in this year's trial. Golden Liner was one of the better performing Asian melons in the 2004 observation trial, but this season powdery mildew was a serious problem even with a weekly fungicide spray program.

Observation Trial

Cantaloupes. Athena, the current, "gold standard" for cantaloupes had excellent quality, but tended to be at the low end in terms of yield. HSR4270, HSR4276, and Halona all looked very good. The two numbered selections must be harvested at half slip and no later to preserve eating quality. Halona had a very good, but slightly muskier flavor.

Charentais. Serenade was grown for market evaluation this season in an adjacent plot. This has been an outstanding melon in the previous two seasons of evaluation in that it had exceptional quality, was moderately attractive and did not split open as all of the other charentais melons have over the years. However, this season this variety developed excessive surface checking and did not look marketable.

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Table 4. Specialty melon fruit and vine characteristics from two replications, Lexington, Ky., 2005.

Variety	Flavor[1] (1-5)	Sugar (%)	Interior Color	Rind Color	Fruit Shape	Cracking[2] (1-4)	Net Type[3]	Comments
HSR4250	2.3	8.4	orange	straw w/ lt green	round	1.0	hv	Pick at ½ slip, attractive orange flesh.
HSR4270	3.8	13.0	orange	cream	oval	1.0	med. coarse	Must be picked at ½ slip, large melon, no sutures, attractive exterior and interior.
HSR4260	3.0	10.8	salmon	straw green	round	2.0	hv	Pick at ½ slip, no sutures.
HSR4276	3.5	10.3	orange	cream	oval	1.5	med	Pick at ½ slip.
Halona	3.9	12.5	orange	cream	round	2.5	lt	Very musky, deep sutures.
Athena	4.1	11.4	orange	beige	oval	1.5	lt	Excellent variety.

[1] Flavor: 1 = poor, 5 = excellent, sweet taste, pleasant texture.
[2] Cracking: l = little or no cracking, 4 = severe cracking and fruit splitting.
[3] Net type: lt = light netting, med = medium netting, hv = heavy raised netting, na = no netting.

Observations on Seedless Watermelon Varieties in Western Kentucky

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Introduction

This trial was designed to evaluate the marketability of seven seedless (triploid) watermelon varieties including three new "personal-sized" seedless varieties.

Materials and Methods

Seeds were started in cell packs in the greenhouse on May 3, 2005. Trial entries included standard red-fleshed seedless varieties Ruby, Independence, and Constitution and red-fleshed, personal-sized seedless varieties Solitaire and Bobbie. Yellow and orange-fleshed varieties tested were Buttercup and Orange Sunshine, respectively. Cell packs were placed on heated pads to aid in germination. Plants were transplanted with a waterwheel setter into raised black plastic-mulched beds on June 6. Beds were on 6 ft centers, and watermelon plants were spaced 3 ft apart in the rows. There were four rows in the plot with a total of 25 watermelon transplants for each variety. A seeded pollinator variety was planted in every other row. This was a non-replicated observation trial.

The plot was fertilized according to university recommendations. All fertilizer was applied preplant. The plot was irrigated on an as-needed basis. Strategy and Gramoxone herbicides were used for weed control. Herbicides were applied to row middles using a backpack sprayer with a shielded boom. A post-emergent application of Select was used to control emerged grasses.

Results

The 2005 growing season was very hot and dry. Above-normal temperatures and below-normal rainfall were common throughout the growing season. The higher temperatures caused the fruits to ripen two weeks ahead of schedule. Despite these growing conditions, the watermelons were high yielding, and the vines stayed healthy throughout the entire season. Watermelons were harvested on August 8.

Watermelons were evaluated for vine appearance, yield of harvestable melons, fruit appearance, and taste. Vine appearance was above average the entire season. There were no differences in vine appearance among the seven varieties (Table 1). Yields ranged from 1.4 fruit per vine to 2.8 fruit per vine; the personal-sized watermelons yielded more fruit per vine than the traditional-sized watermelons (Table 1). Fruit appearance was rated on a scale of 1-7 with 7 being the best and 1 being the worst. Ruby and Independence rated the highest in appearance, while Orange Sunshine, Solitaire, and Bobbie rated the lowest.

Sugar content was measured with a refractometer prior to the taste test. Sugar contents ranged from 11% to 13% but there were no statistically significant differences among the watermelon varieties (Table 1). Eighteen people participated in the taste test; participants were asked to rate the watermelons for taste using a scale of 1-7 with 7 being the best and 1 being the worst. Results from the taste rating were then used to rank the melons from worst to the best tasting. The best tasting watermelons were the standard, red-fleshed seedless varieties Ruby, Independence, and Constitution. The yellow and orange-fleshed melons Buttercup and Orange Sunshine together with the two personal-sized melon varieties Bobbie and Solitaire had the lowest taste scores (Table 1).

Table 1. Yields, appearance, taste, and sugar contents of seedless (triploid) watermelon varieties from single plots at Princeton, Ky., 2005.

Variety	Seed Source	Days to Harvest	Avg. No. Melons per Vine	Appearance (1-7)[1]	Taste (1-7)[1]	Taste Rank	Sugar Content (%)	Vine Appearance (1-7)[1]
Bobbie	SW	84	2.2	3	3.4	7th	12.6	5
Buttercup	SW	82	2.0	4	3.6	6th	12.6	5
Constitution	SW	85	1.6	6	4.8	2nd	13.2	5
Independence	SW	85	2.0	5	4.5	3rd	12.6	5
Orange Sunshine	HM	85	1.9	1	4.2	5th	11.4	5
Ruby	HM	85	1.4	7	5.6	1st	12.8	5
Solitaire	HM	85	2.8	2	4.3	4th	12.6	5

[1] Ratings based on a scale of 1-7 with 1 = worst and 7 = best. Taste ratings are averages from 18 participants.

Seedless Mini-Watermelon Spacing Trial

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Introduction

Considerable interest has recently been shown in seedless (triploid) mini-watermelons (also called palm or personal-sized watermelons). Field plant spacing continues to be a concern to achieve maximum production of melons less than 9 lb in weight. This study was conducted to determine the optimum plant spacing for Mohican mini-watermelons under Kentucky conditions.

Materials and Methods

Mini seedless Mohican (Southwestern Seeds) and seeded watermelon Stars N' Stripes (Seedway Inc.) seeds were sown in Styrofoam plug trays (72 cells/tray) on 29 April. Trays were placed on a bench with bottom heat in a warm greenhouse. Seedlings were thinned to one per cell and the trays moved to a slightly cooler house. On 2 June, the plants were set into raised plastic-mulched beds using a waterwheel setter on Maury silt loam at the University of Kentucky Horticultural Farm in Lexington, Kentucky. Each plot consisted of two 20 ft rows of plants with the same in-row spacing. Each of these two rows contained 21, 14, 11, or 9 plants, with 1, 1.5, 2, or 2.5 feet between plants, respectively. Between-row spacing was 6 feet, providing 6, 9, 12, or 15 ft^2 per plant, respectively. Plots were replicated four times in a randomized complete block design. Seeded pollinator Stars N' Stripes plants were used as a border on both sides of the planting, and one row was planted down the center of the plot with two rows of seedless melons on each side. Drip irrigation was used to irrigate and fertigate as needed.

Eighty-three lbs N/A as ammonium nitrate and 150 lbs K/A as potassium chloride were applied preplant. A total of 28 lbs N/A as ammonium nitrate was fertigated over seven applications throughout the season. A systemic insecticide, Admire 2F, was applied as a drench to the base of each plant soon after planting, at the high rate of 24 fl oz/A. The foliar insecticides Sevin, Capture, and Pounce were also used. Foliar fungicide sprays included Quadris, Nova, Topsin M, and Bravo. Epsom salts foliar sprays were applied twice.

The pre-emergent herbicide Curbit was applied between rows before vine coverage. All fruit were weighed individually, and 16 fruit from each replication were measured and evaluated for soluble solids, flavor, hollowheart, and seed number per fruit.

Results and Discussion

In 2003 mini-watermelons were planted using 20 ft^2 per plant, and most of the watermelons were too large or over nine pounds. In 2004 a density of 15 ft^2 per plant was used with better success. Since most Kentucky growers have a market for seeded watermelons, these were used for pollination instead of non-productive pollinator plants.

Watermelon quality was excellent because of the dry season. There were no statistical differences in total yield of marketable fruit per acre among the spacing treatments (Table 1). The average number of marketable fruit per acre was greater for the 1 ft in-row spacing than the 2.5 ft in-row spacing. The average weight per fruit was smaller for the 1 ft in-row spacing than for the 1.5 ft in-row spacing, which in turn was smaller than the 2 and 2.5 ft in-row spacings. There was no difference in the number of cull fruit harvested at the different plant spacings (data not shown). Fruit external measurements showed a slight trend toward an increase in melon length with the wider plant spacings.

Fruit percent soluble solids and flavor were both higher for the 1 foot in-row spacing treatments (Table 2). There was no difference in hollowheart between the plant spacing treatments. Average seed number per fruit trended toward being higher for the 2.5 ft in-row spacing, and there was no difference in melon rind thickness between treatments.

Table 3 shows fruit size comparisons for the different spacing treatments. The 1 and 1.5 ft in-row spacings had the greatest percentage of melons less than 6 lb in weight. There was no difference in the percentage of melons produced in the 6 to 8 pound category. The percent melons produced in the greater than 8 lb size class was low; 27 percent and 34 percent of the melons fall in this category for the 1 and 1.5 foot spacings, respectively.

The best in-row plant spacings to achieve the greatest number of small Mohican watermelons with the best quality are 1 and 1.5 ft on 6 ft row centers. The best plant spacing should be determined by the grower based on seed or plant cost and if a premium will be paid for the smaller melons to justify a higher plant population at the 1 ft in-row spacing.

Table 1. Mohican seedless mini-watermelon spacing trial yield and fruit characteristics, Lexington, Ky., 2005.

Plant Spacing (ft)	Sq. Ft per Plant	Yield (cwt/A)[1]	Avg. No. Mkt. Fruit/A	Avg. Wt/ Fruit (lbs.)	Outside Measurements Length (in.)	Outside Measurements Width (in.)
1 x 6	6	1886 a	28223 a	6.7 c	7.6	7.3
1.5 x 6	9	1637 a	23232 ab	7.0 b	7.5	7.0
2 x 6	12	1783 a	23958 ab	7.4 a	7.8	7.3
2.5 x 6	15	1499 a	20056 b	7.5 a	7.8	7.3

[1] Numbers followed by the same letter are not significantly different (Waller-Duncan LSD P = 0.05).

Acknowledgments

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Table 2. Mohican seedless mini-watermelon spacing trial fruit characteristics, Lexington, Ky., 2005.

Plant Spacing (ft)	Soluble Solids (%)	Flavor (1-5)[1]	Hollow-heart (1-2)[2]	Avg. Seed No./Fruit	Rind Thickness (in.)
1 x 6	12.8 a	4.8 a	1.9 a	2.3 ab	0.69 a
1.5 x 6	12.0 b	4.3 b	1.8 a	2.0 b	0.63 a
2 x 6	11.9 b	4.3 b	2.0 a	2.9 ab	0.67 a
2.5 x 6	12.1 b	4.3 b	2.0 a	3.4 a	0.66 a

[1] Flavor rating: 1 = poor, 5 = excellent.
[2] Hollowheart rating: 1 = hollowheart, 2 = no hollowheart.

Table 3. Mohican fruit size class evaluation for plant spacing by fruit number.

Plant Spacing (ft)	% < 6 lbs[1]	% 6-8 lbs	% ≤ 8 lbs	% > 8 lbs
1 x 6	33 a	40 a	73 a	27 c
1.5 x 6	26 ab	40 a	66 ab	34 bc
2 x 6	20 b	35 a	55 c	44 ab
2.5 x 6	21 b	36 a	57 bc	44 ab

[1] Numbers followed by the same letter are not significantly different (Waller-Duncan LSD P = 0.05).

Effect of Habitat Modification on Biological Control of European Corn Borers in Bell Peppers

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Introduction

Pest management practices for vegetable growers are becoming more diverse with the adoption of integrated pest management (IPM). One component of IPM is biological control using supplemental releases of natural enemies to control a pest. This should result in a reduction in pesticide use and preserve natural enemies of other insect pests in the field.

The European corn borer (ECB), *Ostrinia nubilalis*, presents a unique problem to pepper growers as the primary pest for the crop. The larvae tunnel below the stem cap and enter the fruit to develop and pupate. Once inside the fruit, it is impossible to control using pesticides. Timing is therefore crucial for all management options. The major damage is caused by mid- to late-season presence of the second and third generation ECB larvae in early July through late August.

As part of an ongoing study on the use of *Trichogramma ostriniae* (*T.o.*), a parasitic wasp imported to control ECB in sweet corn, the University of Kentucky continued experiments to test biological control options for ECB in bell peppers. Previous studies at Virginia Polytechnic Institute and State University and the University of Kentucky have found significant reductions in ECB-infested pepper fruit by using this method. A new project to test the effects of habitat modification (providing a food source within the crop) on the performance *T. ostriniae* was carried out in 2005.

Materials and Methods

This study was conducted at five sites at University of Kentucky Research Farms in Lexington, Kentucky: four replicates were located at the Spindletop Research Farm (North Farm) and one replicate at the Horticulture Research Farm (South Farm). A popular bacterial spot-resistant cultivar, 'Aristotle,' was used for the experiment. Seeds were sown in the greenhouse at South Farm on 21 March and peppers were transplanted into raised beds with black plastic mulch and drip irrigation on 20 May (South Farm) and 24 May (North Farm). Beds were 6 ft. from center to center and 50 ft. in length. Two rows of 35 pepper plants were grown on each bed with plants spaced 12 in. apart in the row with 15 in. between rows. Each main plot consisted of two subplots of 5 beds (10 rows) each separated by 16 rows of sweet corn. Sweet corn was planted as a lure to attract ECB to the peppers and to buffer the effects of the treatments. Sweet corn was planted on May 27 at the North Farm and on June 6 at the South Farm.

The experimental design was a randomized complete block with a split plot arrangement of treatments. Main plots were *T. ostriniae* release and no release, while subplots were flowers and no flowers. For the flower subplots, 20 buckwheat (*Fagopyrum esculetum* Moench) plants were direct seeded on 3 ft. of plastic at both ends of the pepper beds to provide a nectar source and attract beneficial insects. The buckwheat was planted on 9 June, flowered within four weeks, and continued to flower throughout the experiment until the last harvest.

The two main plots in each replicate were separated by at least 1000 ft to prevent dispersal of *T. ostriniae* into control plots from release plots. Release plots were located downwind from control plots whenever possible. One replicate at the North Farm was separated by only 600 ft due to property boundaries.

ECB pheromone traps (Texas cone traps) were placed adjacent to each plot to monitor ECB moth flights. Traps were checked weekly and pheromone lures were changed monthly. Trap counts were recorded beginning on 16 June and continued until the week of the final harvest on 22 September. Sticky card insect traps were placed in the center of each subplot to gauge beneficial insect activity and determine if the flowers helped attract beneficial insects.

Trichogramma wasps were obtained from Cornell University. They were shipped overnight in parasitized *Ephestia kuehniella* eggs on cards. Each card contained roughly 16,000 parasitized eggs, and each main (release) plot (0.034 acre) received one card per release. The release rate was roughly 464,640 *T.o.*/acre/release. Cards were placed in the center of the plots enclosed in petri dishes with holes covered with fine mesh. This allowed *T. o.* to emerge while protecting the parasitized eggs from predation. Four release dates were established according to a degree-day model predicting egg-laying of second-generation ECB (Brown 1982). Initial releases began near the degree-day target for initiation of second-generation ECB egg-laying (15-18 July). Additional releases were made in coordination with the degree-day target for 25% (27-29 July) and 75% (10-12 August) completion of egg laying and one later release (26-29 August) since ECB activity was still considered steady.

Sentinel ECB egg masses were provided by the USDA Corn Insects and Crop Genetics Research Laboratory at Iowa State University. Twenty egg masses were placed on the underside of pepper leaves at regular intervals on the border rows of each subplot in both the control and release plots. The egg masses were in place at the time of *T.o.* release and collected within 48 to 72 hours. After removal from the field, these were stored in gelatin capsules for later determination of percent parasitism.

Peppers were harvested twice during the season. Peppers from different sites (blocks in the randomized complete block design) matured at different times and were harvested over a relatively long period: the first harvests were made from 28 July to 9 August while the second harvests were made from 11 August to 27 September. All rows except border rows were harvested in each plot. Marketable and unmarketable yields were recorded and marketable fruits were counted and graded according to USDA standards. Insect-damaged fruits were carefully dissected to determine ECB presence. Numbers of infested fruits were recorded as well as the number of ECB larvae found.

An additional harvest was performed on border rows for each subplot on September 1. This was to gauge the impact of *T.o.* and flowers on fruits that had not been harvested since planting and were therefore exposed to potential ECB infestation throughout the season. A sample of 100 fruit from each border row in each subplot was examined for ECB presence.

Total marketable yields were compared among treatments. The number of ECB-infested fruits was compared according to treatment and effect of flowers present in the plots. The experiment was compared using analysis of variance; the arc sine of the square root transformation was used to analyze percentages of infested fruits.

Results and Discussion

The overall percentage of fruits infested with European corn borer appeared to be lower in the release plots than the control plots, but this difference was not statistically significant when data were combined for both main harvests (Table 1). Overall, plots with flowers had lower ECB infestations than plots without flowers, although this difference was also not statistically significant (Table 1). Very low ECB pressure throughout the season, especially in the later two generations, accounts for low ECB infestations in both treatments. Total marketable yields did not differ significantly between treatments which might be expected with low ECB activity (Table 1).

A significant difference was found between treatments with flowers and those without flowers for the harvest of border row fruits (Table 2). Averaged over both release and non-release main plots, subplots with flowers had about half as many ECB-damaged fruit (2%) compared to those without flowers (3.7%, Table 2).

Percent parasitism of sentinel egg masses has not yet been determined. Predation of the egg masses will be a concern in estimating parasitism as it cannot be determined if the eggs were parasitized prior to removal by predators. Sentinel egg mass predation rates will also be determined to see if there is any correlation between the flowers present and the attraction of beneficial insects.

These data together with results from previous experiments indicate reductions in ECB infestations with *T.o.*; thus, biological control of ECB in peppers remains a promising option for vegetable pest management. Habitat modification with buckwheat also appears to be useful in reduction of ECB damage as it could increase natural enemy populations and aid *T.o.* activity. This is an ongoing study that has experienced low ECB presence in several years of experiments. Next year we will attempt to supplement the infestation by releasing ECB larvae into each plot and measuring the effects of the *T. ostrinia* and flowers on an established pest population.

Table 1. Bell pepper yields and European corn borer (ECB)-infested fruit from Control (no *Trichogramma* release) vs. *Trichogramma* Release plots and Flowers vs. No-flower treatment plots in Lexington, Ky., 2005; data are means of five replications.

Treatment	Marketable Yield (tons/acre)	Unmarketable Yield (tons/acre)	ECB-Infested Fruit	
			%	No./Acre
Control	7.6	5.5	7.1	368
Release	8	5.9	4.0	266
Flower	---	---	6.4	368
No-Flower	---	---	4.8	266

Table 2. Percentages of European corn borer (ECB)-infested fruit from harvest of border rows of Control (no *Trichogramma* release) vs. *Trichogramma* Release plots and Flowers vs. No-flower treatment plots in Lexington, Kentucky, 2005; data are means of five replications.

Treatment	% ECB-Infested Fruit/Acre
Control	3.3
Release	2.4
No-Flower	3.7 a[1]
Flower	2.0 b

[1] Numbers followed by different letters are statistically different ($P<0.05$).

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Repellency of Hot Pepper Extracts to Spider Mites

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Introduction

The development of resistance to existing classes of pesticides and the increasing public concern over environmental pollution and toxicity of synthetic pesticides generate a great need for new classes of pest control agents with higher activities against the target pests and lower impacts on the environment. Health hazards created by synthetic pesticides have become a great public concern. Basic and applied research to provide new and effective pest control agents that do not rely upon synthetic pesticides is needed. Many studies have indicated the potential ecological damage due to the widespread use of synthetic pesticides. The U.S. Food Quality Protection Act (FQPA) in 1996 initiated a systematic effort to identify and reduce potential risks posed by synthetic pesticides to safeguard public health. Accordingly, alternatives to synthetic pesticides are urgently needed to control vegetable and fruit pests. Plant-derived natural products can have a broad spectrum of activities against insects and spider mites. The use of hot pepper in pest control has been found among traditional agricultural methods of indigenous people from various countries.

The genus *Capsicum* (Family: Solanaceae) contains five commonly cultivated species (*C. annuum* L., *C. frutescens* L., *C. chinense* Jacq., *C. baccatum* L., and *C. pubescens* Ruiz & Pav.). The pungent components of pepper fruit, capsaicin and dihydrocapsaicin, account for an estimated 80-95% of naturally occurring capsaicinoids in peppers. Scotch Bonnet and Habanero-type peppers are regarded as examples of extremely pungent forms of *Capsicum chinense*, whereas bell peppers are considered non-pungent forms of *C. annuum*. However, the concentrations of individual capsaicinoids and the proportion of capsaicin to dihydrocapsaicin vary within and among species.

The two-spotted spider mite, *Tetranychus urticae* Koch, is a well-known herbivorous pest of cultivated crops. Many crops must be protected with synthetic acaricides during the hot and dry seasons that favor severe outbreaks of spider mites. There is a need to find effective non-toxic chemical compounds to control insects and spider mites. A novel mode of pesticide action is the prevention of pest-plant interaction or repellency. Some advantages of controlling insects by repellent agents are 1) reduced chance for adverse environmental impacts of pesticides, and 2) reduced probability of toxic residues of synthetic pesticides reaching the consumer.

The use of natural plant products for pest control may protect plants by inhibiting, repulsing, and even killing non-adapted organisms that feed upon or compete with the plant. The potential of using hot pepper extracts for controlling spider mites was explored in this study. This investigation is a continuation of our previous work on natural products for pest control and was designed to 1) test the repellency of 24 hot pepper extracts to adult spider mites, and 2) determine the concentration of hot pepper extracts that repels 75% of female spider mites for potential mass production of biochemical compounds from hot pepper for spider mite control.

Materials and Methods

Twenty-four pepper accessions were established in the greenhouse and transplanted to the field. Accessions were selected to represent all five cultivated species and a cross-section of the geographic origin of each species. Fruits of eight *Capsicum chinense* (PI-224424, PI-257059, PI-593925, PI-438622, PI-585253, GRIF-9117, GRIF-9273), GRIF-9317); seven *Capsicum frutescens* (PI-238057, PI-224416, PI-439522, PI-555644, PI-159261, PI-159261, GRIF-9320, and GRIF-9324); four *Capsicum baccatum* (PI-633758, PI-596057, PI-497985, and GRIF-9217); four *Capsicum annuum* (PI-195299, GRIF-9149, GRIF-9169, and GRIF-9270); and one *Capsicum pubescens* (PI-387838) were harvested at random from field-grown plants and used for testing their repellency to spider mites using a choice bioassay.

Total capsaicinoids (the pungent components of pepper fruit) were extracted by blending 10 fresh fruits of comparable size in methanol for one minute. The extracts were filtered, concentrated, and then reconstituted in methanol. Capsacinoids in each extract were detected and quantified with a gas chromatograph (GC) equipped with a nitrogen-phosphorus detector (NPD). Concentrations of the two dominant capsaicinoids, capsaicin and dihydrocapsaicin, as well as total capsaicinoids (capsaicin plus dihydrocapsaicin) in *Capsicum* species were statistically analyzed using the ANOVA procedure.

The repellency of each extract was tested with a choice bioassay (bridge bioassay). In this bioassay, female spider mites (*T. urticae*) are allowed to choose one of two possible exit routes. One route is over the extract; the other route is over a solvent control. Each extract was tested with 30 mites. Time (min:sec) of exit and exit route (extract or control) were recorded for each mite. The exit ratio (extract:control) was tested by chi-square for a significant departure from a 1:1 ratio, the expected ratio if the extract was not repellent.

To compare the degree of repellency among extracts, the crude extracts that were highly repellent in preliminary tests were tested over a range of concentrations. Exit ratios were determined in the bridge bioassay for each concentration and results were submitted to Probit analysis to calculate EC_{75} values, the concentration at which 75% of the mites were repelled in the bioassay.

Results and Discussion

Of the 24 *Capsicum* accessions that were screened for repellency to spider mites, 22 had significant repellency as indicated by a significant chi-square value (Table 1). However, chi-square values were not uniform, ranging from 4.8 to 30, with 30 indicating that all

Table 1. Repellency of hot pepper fruit extracts from 25 accessions of five cultivated *Capsicum* species as measured by spider mite bioassay "diving board bioassay."

Accession	Taxon	Wt. of Fruit Tested,† g/0.75 cm²	Exit Ratio‡ (extract: control)	χ^2 Value
Grif-9217	*C. baccatum*	0.0792	12:18	1.20
PI-387838	*C. pubescens*	0.0685	11:19	2.13
PI-555644	*C. frutescens*	0.0602	9:21	4.80*
Grif-9324	*C. frutescens*	0.2478	9:21	4.80*
PI-593925	*C. chinense*	0.0834	8:22	6.53*
PI-238057	*C. frutesens*	0.0302	7:23	8.53**
PI-585253	*C. chinense*	0.0775	7:23	8.53**
Grif-9169	*C. annuum*	0.2599	7:23	8.53**
PI-224424	*C. chinense*	0.1749	6:24	10.80**
PI-497985	*C. baccatum*	0.0614	6:24	10.80**
Grif-9149	*C. annuum*	0.2106	6:24	10.80**
Grif-9317	*C. chinense*	0.0868	5:25	13.33**
PI-633758	*C. baccatum*	0.0964	5:25	13.33**
PI-439522	*C. frutesens*	0.0353	4:26	16.13**
Grif-9117	*C. chinense*	0.1367	4:26	16.13**
PI-257059	*C. chinense*	0.1182	3:27	19.20**
Grif-9273	*C chinense*	0.0511	3:27	19.20**
PI-224416	*C. frutescens*	0.0400	2:28	22.53**
Grif-9320	*C. frutescens*	0.1529	2:28	22.53**
PI-438622	*C. chinense*	0.1067	1:29	26.13**
Grif-9270	*C. annuum*	0.1739	0:30	30.00**
PI-596057	*C. baccatum*	0.1030	0:30	30.00**
PI-159261	*C. frutescens*	0.0250	0:30	30.00**
PI-195299	*C. annuum*	0.0091	0:30	30.00**

† Weight of fruit used to cover a filter paper strip of 0.5 × 1.5 cm for testing spider mite repellency.

‡ The exit ratio is the ratio of the number of mites exiting over the hot pepper extract and the number exiting over the methanol control. The expected exit ratio used for calculating χ^2 was 1:1.

*, ** = significant and highly significant departure ($P<0.01$) from an expected 1:1 exit ratio, respectively, as determined by χ^2.

mites were repelled. The results suggested that crude extracts from hot pepper fruits having a potentially acaricidal performance can be explored for developing natural products for use as biodegradable alternatives to synthetic acaricides.

Based on preliminary results, the seven most repellent accessions were chosen for additional characterization (Table 2). There were differences in degree of repellency among extracts. The extract of the *C. baccatum* accession PI-596057 was most repellent, having the lowest EC_{75} value. Other accessions were repellent, but not as repellent as PI-596057.

For the crude extracts of the 24 accessions, neither capsaicin concentration ($r = -0.01$, $P = 0.94$) nor dihydrocapsaicin concentration ($r = -0.08$, $P = 0.71$) was correlated with the chi-square value. The total concentration of capsaicinoids was also not correlated with the chi-square value ($r = -0.03$, $r = 0.88$). Likewise, for the seven accessions for which EC_{75} values were obtained, capsaicin did not correlate with repellency ($r = -0.28$, $P = 0.43$), nor did dihydrocapsaicin correlate with repellency ($r = -0.25$, $P = 0.48$) as estimated by the EC_{75} values. Total capsaicinoids was not correlated with repellency ($r = -0.25$, $P = 0.48$). The data provide strong evidence that capsaicinoids, the pungent components of pepper, are not responsible for spider mite repellency observed in the bridge bioassays. Other unidentified components of the fruit are likely responsible for repellency.

Capsaicin is approved by the FDA for human use and is currently registered for use as a repellent against birds, deer, rabbits, and squirrels. Based on their EC_{75} values, extracts from accessions PI-596057 (C. *baccatum*), PI-195299 (*C. annuum*), GRIF-9270 (C. *annuum*), and GRIF-9320 (C. *frutescens*) are potential candidates for use as repellents for spider mite control. Concentrated extracts prepared from these accessions provided repellency. However, repellency was unrelated to the concentration of pungent components in the fruit. Future work will be designed to identify the repellent components of pepper fruit.

Table 2. EC_{75} values obtained with spider mite bioassasys of pepper extracts.

Accession	Taxon	EC_{75}	95% Fiducial Limits	
PI-596057	*C. baccatum*	0.0314	0.0093	0.0995
PI-195299	C. annuum	0.2010	0.0724	0.6004
GRIF-9270	*C. annuum*	0.4013	0.2110	0.8268
GRIF-9320	*C. frutescens*	0.6140	0.2209	1.9490
PI-224416	*C. frutescens*	1.6013	0.5348	8.8620
PI-438622	*C. chinense*	1.7461	0.5090	9.5885
PI-159261	*C. frutescens*	5.4044	4.0110	7.8532
PI-257059	*C. chinense*	5.6900	2.1848	31.9619

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Antioxidants in Hot Pepper: Variations among Accessions

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Introduction

There is a growing interest in the enhancement of compounds in food that possess health-promoting attributes such as antioxidant properties that were previously regarded as non-nutritive (Van der Sluis et al. 2002). Plants contain numerous non-nutritive bioactive compounds known as "phytochemicals." Many of these components, including phenolic compounds, are antioxidants in nature (Shahidi, 2000). Phenolic compounds are the largest category of phytochemicals and the most widely distributed in the plant kingdom (King and Young 1999). Plant phenolics include simple phenols, flavonoids, anthocyanins, lignans and lignins, stilbenes, and tannins. Phenols are often associated with plant defense mechanisms against predators, bacteria, and fungi (Daniel et al. 1999). Resistance of certain host plants may depend partially or completely on their phenolic compounds (Antonious et al. 1999; Beier and Nigg 2000; Antonious et al. 2003).

The role of phenols as antioxidants with properties similar to vitamins C and E and ß-carotene have prompted a number of studies of these compounds (Hasler, 1998). By virtue of their antioxidant activity, they may play a role in the protection of cardiovascular health and prevention of certain cancers (Ames et al. 1993).

Capsaicin, the pungent component in fruit of members of the genus *Capsicum* (peppers), exhibits antioxygenic activity (Semwal et al. 1999). A wide variety of phenolic compounds derived from spices like capsaicin possess potent antimutagenic and anticarcinogenic properties (Surh and Seoul 2002).

Capsaicin can provide better control of cabbage worms than Karate (λ-cyhalothrin), a synthetic insecticide (Zehnder et al. 1997). Hot pepper extracts also were found as effective as lindane (a synthetic organochlorine insecticide) in protecting bean plants from insect pests (Hogo and Karel 1986).

The USDA *Capsicum* germplasm collection contains many thousands of accessions of *Capsicum* spp. (Jarret et al. 1990). However, limited information is currently available on their phytochemical composition. Variability in the presence and concentration(s) of phytochemicals in pepper species can be a factor affecting the selection of pepper for breeding programs.The objectives of this investigation were 1) to determine the concentration of phenols, ascorbic acid, and capsaicin in 17 commonly cultivated hot pepper accessions, and 2) to select candidate accessions of hot pepper having high concentrations of phenolic compounds, ascorbic acid, and capsaicin for use as a source of antioxidants or as parents in USDA breeding programs.

Materials and Methods

Seeds of hot peppers were established in the greenhouse in the spring of 2004 and transplanted to the field at the Georgia Experiment Station (Griffin, Georgia) in June in a sandy-loam soil of 1.3% organic matter. Four accessions of *Capsicum chinense* (PI-387833, PI-387836, PI-438622, and PI-585253), five accessions of *C. baccatum* (PI-633754, PI-633755, PI-633756, PI-633757, PI-633834), six accessions of *C. annuum* (PI-414729, PI-419133, PI-430490, Grif-14486, Grif-14487, and Grif-14513), and two accessions of *C. frutescens* (PI-387834 and Grif-9320) were harvested and transported to Kentucky State University in Frankfort, Kentucky, for analysis. Mature fruits of the 17 *Capsicum* accessions were analyzed for total phenols, ascorbic acid, reducing sugars, and the two principal capsaicinoids (capsaicin and dihydrocapsaicin). Accessions were selected to represent cultivated species, a wide gene base, and the geographic origin of the accessions (Kobata et al. 1998).

Representative fruit samples were blended with ethanol to extract phenols. Homogenates were filtered and aliquots were used for determination of total phenos by the Folin-Ciocalteu method (McGrath et al. 1982) against a standard calibration curve of chlorogenic acid (Fisher Scientific Company, Pittsburgh, PA). Ascorbic acid was extracted by blending fruit with 0.4% (w/v) oxalic acid solution (Antonious and Kasperbauer 2002) and determined by the 2,6-dichlorophenolindophenol method (AOAC 1970). Free sugars in fruits were extracted with 80% ethanol and quantified by the method described by VanEtten et al. (1974) to test for fruit sweetness. Recoveries of added chlorogenic acid, ascorbic acid, and sugars to fruits of accession Grif-9320 (*C. frutescens*) were 93, 90, and 88%, respectively.

Extracts of capsaicin were prepared by steeping 5-10 fresh fruits in methanol and subsequently blending at a high speed for one minute. The solvent extracts were filtered. Capsaicins were determined with the aid of a gas chromatograph (GC) equipped with a nitrogen-phosphorus detector (NPD). To determine the performance of the capsaicin analytical procedure, concentrations of capsaicin and dihydrocapsaicin were added to fruit of accession Grif-9320. Recoveries of the added capsaicin and dihydrocapsaicin were 98% and 95%, respectively.

Data for total phenols, ascorbic acid, capsaicinoids, and reducing sugars in hot pepper fruits were statistically analyzed using the ANOVA procedure. Means were compared using Duncan's Multiple Range test (SAS Institute 2001).

Results and Discussion

Concentrations of total phenols were significantly higher in accessions PI-633757, PI-387833, and PI-633754, respectively, compared to other accessions analyzed (Figure 1). These accessions may be useful as parents in hybridizations to produce the high phenol and ascorbic acid containing varieties. On the contrary, PI-414729, PI-387834, and Grif-9320 had the lowest contents of both phenols and ascorbic acid (Figure 1), while PI-438622 had the lowest sugar content (Figure 2). Pronounced differences in total capsaicinoids (capsaicin plus dihydrocapsaicin) concentrations were found among accessions. Total capsaicin and dihydrocapsaicin concentrations were greatest in PI-438622 and lowest in Grif-9320.

Table 1 shows the concentrations of total phenols, ascorbic acid, capsaicinoids, and reducing sugars per whole fruit. Accession Grif-14513 had the greatest fruit weight and greatest concentration of total phenols, ascorbic acid, and reducing sugars. Fruit of this accession contained only 1.2 mg of capsaicinoids. The highest concentration of capsaicinoids was found in accession PI-438622 of *C. chinense*. Strong correlations were observed between total phenols and ascorbic acid and between total phenols and reducing sugars (Table 2). Total capsaicinoids were not correlated with fruit weight or any of the other fruit components analyzed.

Our data suggest that great variability exists within and between *Capsicum* species in phytochemical compounds with antioxidant properties, and that these traits might be manipulated via plant breeding or other research approaches to produce fruit with value-added traits.

Figure 1. Concentrations of total phenols and ascorbic acid in the fruits of 17 accessions of four *Capsicum* species. Bars accompanied by different letter(s) for each compound indicate significant differences (P< 0.05) between accessions using Duncan's LSD test.

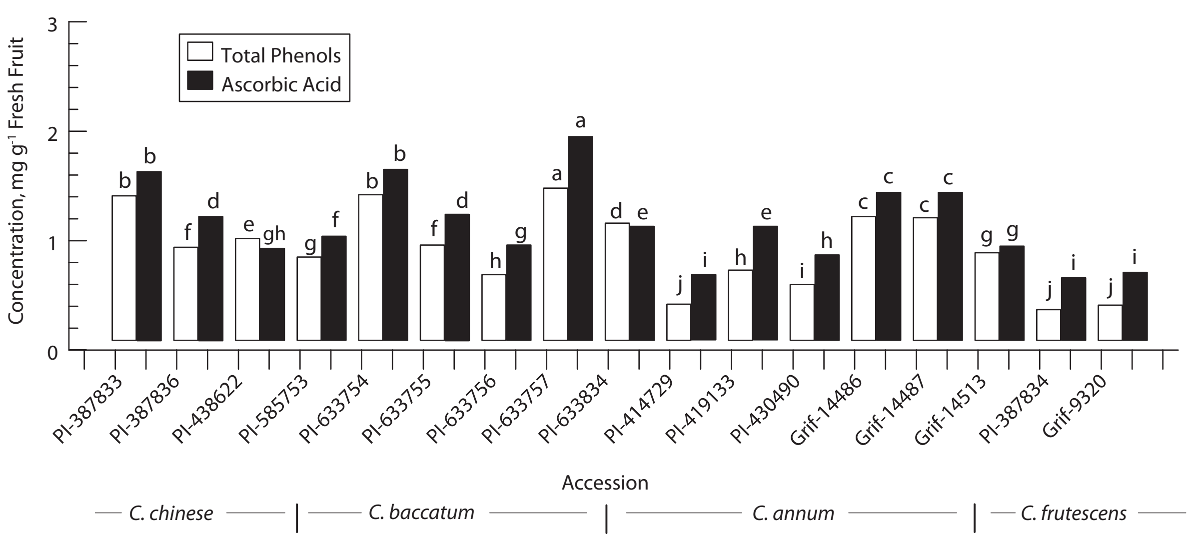

Figure 2. Concentrations of reducing sugars and capsaicinoids (capsaicin plus dihydrocapsaicin) in the fruits of 17 accessions of four *Capsicum* species. Bars accompanied by different letter(s) for each compound indicate significant differences (*P*<0.05) between accessions using Duncan's LSD test.

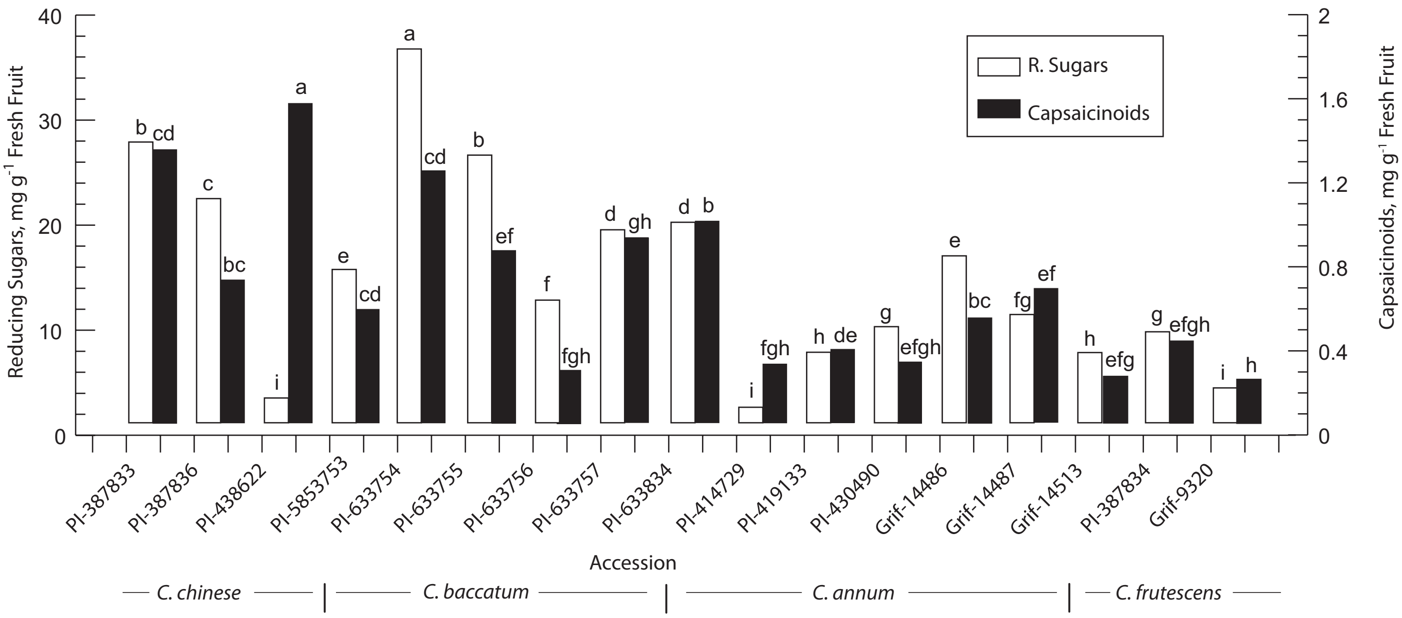

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Table 1. Concentrations† of total phenols, ascorbic acid, capsaicin, and reducing sugars in the fruits of several accessions of *Capsicum* species grown under field conditions (University of Georgia, USDA/ARS, Griffin, Georgia).

	Concentration, mg Fruit-1				
Capsicum Species	Total Phenols	Ascorbic Acid	Capsaicinoids	Reducing Sugars	Wt. (g) of Each Fruit ‡
C. chinense					
PI-387833	2.65 h	2.49 ij	2.20 cd	53.54 hg	2.00 p
PI-387836	4.55 f	4.44 e	2.55 bc	113.94 e	5.34 k
PI-438622	7.95 d	4.59 e	10.64 a	20.15 j	8.54 h
PI-585253	7.33 e	6.21 d	2.20 cd	140.13 c	9.61 g
C. baccatum					
PI-633754	2.84 h	2.69 hij	2.13 cd	75.87 f	2.13 o
PI-633755	2.03 i	1.98 jk	1.44 ef	59.11 g	2.32 n
PI-633756	11.85 b	11.32 b	0.91 fgh	230.49 b	19.75 b
PI-633757	1.30 j	1.45 k	0.65 gh	17.10 j	0.93 q
PI-633834	4.15 fg	2.88 ghi	2.94 b	13.67 f	3.86 l
C. annuum					
PI-414729	3.71 g	3.34 fgh	0.88 fgh	16.56 j	11.24 e
PI-419133	7.06 e	8.10 c	1.61 de	73.86 f	11.01 f
PI-430490	6.95 e	6.53 d	1.18 efgh	123.69 de	13.52 c
Grif-14486	9.22 c	8.56 c	2.49 bc	129.84 cd	8.18 i
Grif-14487	3.84 g	3.60 fg	1.49 ef	35.17 i	3.42 m
Grif-14513	30.03 a	21.05 a	1.23 efg	251.49 a	37.64 a
C. frutescens					
PI-387834	1.74 ij	1.64 k	1.16 efgh	53.0 gh	6.13 j
Grif-9320	4.06 fg	4.09 ef	0.55 h	41.9 hi	12.65 d

† Detectability limits (minimum detectable concentration in µg divided by sample weight in g) for capsaicin and dihydrocapsaicin were similar (0.001 µg g-1 fresh fruit).

‡ Average weight of each fresh pepper fruit (n = 10). Values within a column having different letter (s) are significantly different (*P* <0.05), using Duncan's Multiple Range test (SAS Institute, 2001).

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Table 2. Pearson's correlation coefficients and probability of significance† between pepper fruit components.

	Total Phenols	Ascorbic Acid	Capsaicinoids‡	Reducing Sugars
Ascorbic Acid	0.9763*			
	(<0.0001)†			
Capsaicinoids	0.0259ns	-0.0814ns		
	(0.9215)†	(0.7561)†		
Reducing Sugars	0.7924*	0.8586*	-0.2284ns	
	(0.0001)†	(<0.0001)†	(0.3780)†	
Fruit Weight	0.9309*	0.9343*	-0.1229 ns	0.7693*
	(<0.0001)†	(<0.0001)†	(0.6384)†	(0.0003)†

+ Pearson's correlation analysis, [*] indicates significant correlation, ns = not significant (P>0.05). ‡ Capsaicinoids refer to capsaicin plus dihydrocapsaicin.

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Solarization and Cultivated Fallow for Weed Control on a Transitioning Organic Farm

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Introduction

Surveys of organic farmers and those wishing to transition to certified organic crop production consistently report that weed control is one of their most important concerns (Bond and Grundy, 2001; Walz, 2004). Numerous tools and techniques to destroy germinating weeds and reduce weed populations over time are available to organic farmers, but the efficacy of some newer weed control strategies have yet to be tested against more time-honored techniques, particularly when confronted with a troublesome perennial weed species like johnsongrass (*Sorghum halepense*).

Johnsongrass is considered an invasive and noxious weed in many states, and while it is controlled with repeated herbicide applications on conventionally managed farms, herbicides are not available for use by organic or transitioning-to-organic farmers (USDA, 2005). Prior to the use of herbicides, johnsongrass control was accomplished primarily by a combination of mowing and tillage (Cates, 1907). A technique recommended early in the 20th century was to plant pasture grasses in the infested area; these grasses were repeatedly mowed or grazed for hay throughout the first season. Repeated mowing or grazing alters johnsongrass root growth forcing it to become more shallowly rooted, a fact that was exploited by farmers and Extension workers (McWhorter, 1989). The pasture system was maintained for at least a year or until shallow cultivation (either in association with a cash crop or bare fallow) could be used to kill the weakened perennial weeds. Multiple passes of a cultivator equipped with sweeps was suggested to bring rhizomes to the surface during the summer months to allow them to desiccate and die (Hunt, 1915; Talbot, 1928). Although it took up to two years to pass through the cycle of mowing and cultivation, this method was considered effective.

Solarization is a hydrothermal soil disinfestation technique that has proven useful in combating many soil pathogens and weed species (Stapleton, 2000; Standifer, 1984). The technique uses clear plastic sheets stretched over bare soil during the summer so that solar radiation heats the soil beneath while leaving soil structure undisturbed (Katan, 1981). Johnsongrass has been documented as being susceptible to solarization together with other perennial weeds such as purple nutsedge (*Cyperus rotundus)* and bermudagrass (*Cynodon dactylon* L.) (Elmore, 1993; Egley, 1990; Ricci et al. 1999). Though most often used in arid climates, this technique offers promise as an alternative to herbicides and is allowed for use by organic farmers.

The objective of this study was to compare soil solarization with the traditional methods of johnsongrass control using a cultivated bare fallow.

Materials and Methods

2003-2004. A 300 ft. by 125 ft. field at the UK Horticulture Research Farm in Lexington, Kentucky, was selected for this trial based on its uniform and heavy infestation of johnsongrass which covered 40 to 50% of the field. This field lies within a 12-acre portion of the farm which was in its second year of transition from conventional to organic management in 2003. Prior to the start of the experiment, the field had been planted to a winter wheat cover crop (80 lb/acre, Southern States, Lexington, Ky.) in the fall of 2002. The field was plowed in mid-May 2003, and the soil (Maury silt loam) was disked twice before the start of the experiment on 15 July. The field was divided into twelve 25 ft. by 125 ft. plots. The following three treatments were assigned to these plots in a completely random design with four replications.

The solarization treatment consisted of stretching a 25 ft. by 125 ft. piece of four mil. plastic over an entire plot and burying the edges. Researchers in California found that solarization worked best as a weed control technique when applied to well-moistened soil during the hottest period of the summer (Elmore et al., 1991). Drip lines were laid underneath the plastic at approximately 4 ft. intervals, and the soil was irrigated until thoroughly moistened. The plastic and drip tape were applied on 15 July and removed 16 Sept.

The second treatment was cultivated bare fallow. This treatment was cultivated weekly using a field cultivator equipped with sweeps. Cultivation began on15 July and ended on 16 Sept. The third treatment was an untreated check (control). These plots were left undisturbed during the season except for two passes with a rotary mower on 26 July and 20 Sept. which prevented johnsongrass from going to seed. Following the second mowing in September, check plots were disked and planted with a winter wheat cover crop (80 lb/acre, Southern States, Lexington, Ky.).

During the fall and winter of 2003, all solarization and cultivated bare fallow plots were left untouched. On 14 May 2004, all solarization and cultivated bare fallow plots were divided in half; half of each of these subplots was then disked to a depth of 3-4 inches. Check plots with winter wheat were left undisturbed until 1 June 2004 when they were plowed and disked twice.

Weed data from the solarization and cultivated bare fallow plots were collected on 15 July from both the tilled and untilled portions of each plot. Data collected included a visual estimation of the percentage of the soil surface covered with johnsongrass and a count of all johnsongrass plants found on a 30 ft. transect line. These plants were separated into those derived from seed and those from rhizomes. Finally johnsongrass plants were counted within a randomly chosen 1-meter square within each plot area.

2004-2005. The check plots from 2003 were used for the experimental plots in 2004. Each of these four 25 ft. by 125 ft. areas was divided into three 25 ft. by 40 ft. plots, and the same three treatments from 2003 were randomly assigned to these plots. This was necessary as no other sections of the UK Horticulture Research farm had a similar infestation of johnsongrass.

All treatments were applied on 16 July 2004 using the same methods as in 2003. Solarization plastic was removed on 18 Sept., and bare fallow cultivation ended on 17 Sept. The check plots were mowed twice (29 July and 25 Sept.); all plots were then left undisturbed until the following spring. On 28 May 2005, half of the plots were randomly chosen for disking to a 3-4 inch depth as in 2004. On 14 July, weed data were collected from all treated plots within the original 300 ft. by 125 ft. area using the same procedures as in 2004.

Analysis of variance of all data was conducted using the PROC GLM procedure of the Statistical Analysis System, and means were separated by Waller-Duncan K-Ratio t-tests (SAS Institute, 1999). Since data for density, transect, rhizome, and seed were small whole numbers, they were transformed by square root plus 0.5 (Steel and Torrie, 1960).

Results

2003-2004. Significant differences were found among the treatments for all five measurements of the johnsongrass population (Table 1). The portion of the plot covered by johnsongrass was significantly lower in the tilled and untilled portions of the solarization plots and in the untilled cultivated plots compared to the check and tilled cultivated plots (Table 1). The solarized and untilled cultivated treatments also had significantly lower johnsongrass plant densities than the tilled cultivated treatments or check plots (Table 1).

The 30 ft. transect reflected the same trend with a significantly lower johnsongrass population in the solarized and the untilled cultivated treatments compared to the check and tilled cultivated treatments (Table 1). When plants on the transect line in the solarized and the untilled cultivated plots were excavated, significantly fewer had grown from rhizomes than from seeds. Only the solarized treatments had significantly fewer numbers of seedling johnsongrass plants along the transect lines compared to the other treatments.

There were no significant differences between the tilled and untilled sections of the solarized plots in 2003-2004 (Table 1). However, johnsongrass density and the number of plants per 30

Table 1. 2004 johnsongrass population data from plots treated in 2003 with solarization or cultivation.

Treatment[z]		Control[a] %	Density[b] No./m²	Transect[c] No. Plants/30 ft.	Rhizomes[d] No./30 ft.	Seed[e] No./30 ft.
Cultivated	Tilled	27.5 ab	35.0 a	15.5 a	6.3 a	9.3 a
	Untilled	11.8 b	7.8 b	4.3 b	1.3 b	3.0 ab
Solarization	Tilled	11.3 b	4.8 b	3.3 b	1.5 b	1.8 b
	Untilled	13.0 b	6.3 b	4.8 b	2.5 b	2.3 b
Check	Untilled	42.5 a	18.0 ab	14.8 a	9.5 a	5.3 ab

[a] Mean percent ground covered by johnsongrass.
[b] Mean number of johnsongrass plants found in 1 sq. m.
[c] Mean number of johnsongrass plants found on one 30 ft transect.
[d] Mean number of johnsongrass plants found on 30 ft transect that derived from rhizome.
[e] Mean number of johnsongrass plants found on 30 ft transect that derived from seed.
[z] Mean separation based on transformed data. Means followed by the same letter are not significantly different (P<0.05).

ft. transect were substantially higher in the tilled portions of the cultivated plots (Table 1).

Check plots from 2003-2004 retained the same average level of johnsongrass infestation that was present at the beginning of this study (Table 1). None of the johnsongrass population data from the check plots were significantly different from the tilled cultivated plots.

2004-2005. As in 2003-2004, there were significant differences among treatments for all five measurements of johnsongrass populations in 2004-2005 (Table 2). The percentage of ground covered by johnsongrass was highest in the tilled cultivated plots and lower in check plots, tilled solarized plots, and untilled cultivated plots. The percentage of ground covered by johnsongrass was lowest in the untilled solarized plots (Table 2). No johnsongrass plants grew in any of the untilled solarized plots; however, this was not significantly different from the low johnsongrass populations in the untilled cultivated plots. Solarized or cultivated plots that were left untilled had the lowest johnsongrass populations as in 2003-2004.

Johnsongrass density was lowest in the untilled solarized plots which was significantly less than densities in tilled solarized, tilled cultivated, or check plots (Table 2). As with percent of ground covered by johnsongrass, the zero johnsongrass population found in the untilled solarized plots was not significantly different from the low johnsongrass population found in the untilled cultivated plots.

The number of plants found on the 30 ft. transect in untilled solarized plots (no johnsongrass) was significantly less than in check plots, which were highest (Table 2). Although more johnsongrass plants found on the 2004 transect were from rhizomes, this was not significantly different from the number of plants derived from seed.

The inclusion of a spring tillage event influenced johnsongrass populations significantly with lower overall control and higher numbers of plants on the 30 ft transect in both cultivated and solarized plots. In addition, tilled solarized and tilled cultivated plots had significantly higher numbers of plants from rhizomes on the 30 ft. transect (Table 2).

Only 9% of the ground was covered by johnsongrass in the check plots in 2004-2005 which was dramatically lower than the 40-50% coverage in 2003. All treated plots had significantly lower johnsongrass populations at the end of the experiment than at the beginning (Table 2).

Discussion

Our major objective was to compare two practical methods of johnsongrass control: solarization and bare fallow with cultivation. Bare fallow with cultivation did not appear as effective as solarization for long-term johnsongrass control in this experiment. Initial populations were reduced in both years to essentially the same levels as found in solarized plots; however, when these plots were tilled, johnsongrass populations rose. Johnsongrass eradication was of great interest in the early part of the 20th century, and cultivation during midsummer was found to be an effective control. This experiment confirmed that bare cultivated fallow is an effective technique; however, one year of bare fallow cultivation may not be enough to eradicate heavy johnsongrass infestations like those present at the beginning of this study. The additional plowing, disking, and cover cropping of the check plots from 2003-2004 (which became treatment plots in 2004-2005) probably played a large role in the overall reduction of johnsongrass by the end of the experiment.

From our results, it appears that solarization effectively controlled johnsongrass as populations were greatly reduced in both years in solarized plots. Even when solarized plots were tilled, johnsongrass populations remained much lower than the 40-50% infestation present at the start of the experiment. These results corroborate findings of Elmore (1993), Standifer et al. (1984), and Ricci et al. (1999), who found solarization effectively controlled perennial weed species with extensive rhizomatous growth.

The majority of solarization research has been conducted in warm temperate and tropical areas with the major focus being on soil-borne pathogen control. Weather is a critical factor influencing the effectiveness of either of these techniques in Kentucky. Precipitation and ambient air temperature play a role in the success of both bare fallow cultivation and solarization. Weather data from Lexington's Bluegrass Regional Airport for the months of July through September of 2003 showed that the mean ambient temperature was 72°F, tying it for the 16th coolest summer period since 1896. Mean ambient temperature from July to September for 2004 was 70°F, which ranked it as the fifth coolest summer period recorded since 1896 (MRCC, 2005). Precipitation for the months of July to September in 2003 was 14.68 inches, which ranked it as the 14th wettest year, and was 15.96 inches in 2004, which ranked it as the 12th wettest year since 1896 (MRCC, 2005). As solarization was the more effective of the two treatments for the control of johnsongrass, it is interesting to note that the two years of this study were both cooler and wetter than average years in Kentucky. In years closer to average, it can be expected that solarization would perform even better than it did in this study.

Organic farmers often depend on cultural and mechanical means to control weeds and farmers transitioning to organic production techniques must learn and master these strategies to achieve profitability. Yet, when confronted with land infested with a troublesome perennial weed such as johnsongrass, growers are understandably interested in faster alternatives for eliminating

Table 2. 2005 johnsongrass population data from plots treated in 2004 with solarization or cultivation.

Treatment[z]		Control[a] %	Density[b] No./m²	Transect[c] No. Plants/30 ft.	Rhizomes[d] No./30 ft.	Seed[e] No./30 ft.
Cultivated	Tilled	10.0 a	5.0 a	4.5 ab	3.0 a	1.5 a
	Untilled	3.8 cd	1.5 ab	1.5 cd	1.0 bc	0.5 b
Solarization	Tilled	5.8 bc	4.3 a	2.3 bc	1.8 ab	0.5 b
	Untilled	0.0 d	0.0 b	0.0 d	0.0 c	0.0 b
Check	Untilled	8.8 ab	4.3 a	6.0 a	3.8 a	2.3 a

[a] Mean percent ground covered by johnsongrass.
[b] Mean number of johnsongrass plants found in 1 sq.m.
[c] Mean number of johnsongrass plants found on one 30 ft transect.
[d] Mean number of johnsongrass plants found on 30 ft transect that derived from rhizome.
[e] Mean number of johnsongrass plants found on 30 ft transect that derived from seed.
[z] Mean separation based on transformed data. Means followed by the same letter are not significantly different (P<0.05).

such weeds. Solarization has been used by limited resource and organic growers in California as an alternative to methyl bromide and for weed control, and from this research it may well be of use to small farmers in Kentucky (Stapleton et al., 2005). Future research might focus on including solarization in a greenhouse rotation so that more value from the purchase of greenhouse plastic could be realized, or utilizing solarization on soils before they are planted to perennial plants such as strawberries or other small fruits.

Acknowledgment

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Diseases in High Tunnels and New Diagnostic Techniques—Insights from a Sabbatical in Uruguay

Paul Vincelli, Department of Plant Pathology

Introduction

I was privileged to receive a Fulbright U.S. Scholar Award to spend a three-month sabbatical to work with the vegetable pathologists in the National Institute for Agricultural Research in Uruguay. Although we worked in many areas during my stay, two are worth highlighting here, especially as these relate to vegetable production in Kentucky:

1. Observations on diseases in high tunnels
2. Advances in molecular diagnostics of viruses.

Diseases in high tunnels. Given that vegetable production in high tunnels is relatively new here in Kentucky, I was surprised to learn how Uruguayans have as much as 30 years of experience growing high-quality vegetables in high tunnels. In northern Uruguay, high tunnels seem to "sprout like mushrooms"! They currently produce approximately 1200 acres of vegetables under simple but well-constructed tunnels of plastic sheeting on a framework of eucalyptus poles.

Disease pressure was significant in these tunnels, especially in those that were overly humid. Foliar fungal diseases observed included early blight, Cladosporium leaf mold, and gray mold on tomato, and powdery mildew of pepper. Because of the risk posed by these diseases, growers commonly used fungicides intensively, perhaps overly so in some cases. Bacterial diseases also posed serious threats to profitability, especially bacterial canker and bacterial pith necrosis. It was sad to visit one producer who was forced to destroy two greenhouses full of tomato plants because of an outbreak of bacterial canker. Soil-borne diseases (nematodes, root-rotting fungi) were also a problem and posed a substantial risk because the crops were being grown without rotation. Virus diseases were also problematic because of the high populations of insect vectors that sometimes developed in the tunnels (see Part II of this report).

Significance to Kentucky vegetable producers. I know that some Kentucky vegetable producers have been working in high tunnels for years. As a consumer who prefers fresh vegetables to those that have been shipped, extending the fresh-market vegetable harvest in high tunnels is an idea that I hope expands greatly in Kentucky. However, based on my observations both in Uruguay and here at home, I feel confident that a sustained effort in research and Extension will be needed to identify the most significant disease risks in high tunnels and develop/extend sustainable management practices for these. I say this because: 1) Rotation practices tend to be limited in high tunnels, allowing a buildup of soil-borne inoculum; the Uruguayans were doing some interesting research on the effects on soil-borne diseases of solarization combined with additions of selected types of organic matter. 2) Based on preliminary data from Kentucky State University, it seems soil organic matter may decline in high tunnels because the higher soil temperatures year-round in these production systems enhances microbial activity. Reductions of soil organic matter can sometimes result in more disease-conducive soil. 3) Although tunnels keep rainfall and dew off the foliage of crops, I observed that high humidity and condensation can still be present in high tunnels at levels that can lead to fairly high pressure from certain foliar diseases.

Based on these observations, I am gearing up a collaborative research program on disease management in high tunnels. Collaborators include Dr. Ken Seebold (the new UK vegetable pathologist), Dr. Mike Bomford (KSU Vegetable Horticulturist, focus on sustainable production), and faculty from the UK Department of Horticulture. More will be forthcoming in the future.

Techniques for detecting begomoviruses. While I was in Uruguay, a new virus-like disease was observed on tomatoes growing in high tunnels. Initial test results were negative for all viruses common to that country. Based on the symptoms, my colleagues suspected it was a Begomovirus (a whitefly-transmitted geminivirus), although Begomoviruses had not yet been reported that far south in South America. Because I have experience in molecular diagnostics, they asked me to participate in the diagnosis of this new problem.

To make a long story short, I adapted an existing test for Begomoviruses which is based on the polymerase chain reaction, or PCR <http://gemini.biosci.arizona.edu/index.htm>. Using that technique, I obtained strong evidence that their new disease problem was, in fact, a Begomovirus. An aggressive strain of whitefly—biotype B of the silverleaf whitefly—was first discovered in 2002 in Uruguay. The increasing pressure from the silverleaf whitefly in their high tunnels poses a significant risk to their tomato industry because the silverleaf whitefly biotype B develops high populations in their high tunnels and is the most important vector of Begomoviruses worldwide.

Significance to Kentucky vegetable producers. These results are important as Kentucky expands vegetable production in greenhouses and high tunnels for several reasons. For one, just a few days ago in the UK Plant Diagnostic Lab, we used the same technique I worked on in Uruguay to diagnose a Begomovirus in a tomato crop from a greenhouse in Jefferson County. Much more work remains to be done to identify the specific Begomovirus and determine how it may have been introduced into the greenhouse. However, this is a very serious problem that requires that the entire crop be destroyed. Thus, having the PCR test for Begomoviruses available in the UK Diagnostic Lab will certainly prove useful in cases like this one in Jefferson County. However, the sabbatical was also valuable because it was a chance to advance UK's general molecular plant diagnostic skills by gaining more and more experience with PCR techniques. These skills help producers because molecular diagnostics provide powerful tools to improve our ability to identify threats to plant production in the commonwealth.

Local Composts as Potting Media for Organic Vegetable Production

Sean Clark, Berea College, and Michel Cavigelli, USDA Beltsville

Introduction

As more horticultural producers in the region transition to organic production practices, they are challenged with finding consistent and economical sources of suitable potting media. One potential solution to this problem is the use of local composted organic wastes that can be used as partial, and sometimes as complete, substitutes for peat. Although composts are often considered only as substrate alternatives to peat, the potential nutrient contribution of a compost is an important characteristic to organic producers.

In addition to nutrient content and availability (particularly for nitrogen (N)), other important characteristics of composts used as potting media include maturity and/or stability, salinity, pH, particle size, and water-holding capacity. A mature compost is one that does not undergo further active microbial decomposition (heat up) and is free of phytotoxic substances. In addition to these considerations, certified organic producers have limited choices of organic waste feedstocks for compost production. Composts made from biosolids (sewage sludge), for example, are not permitted in certified organic production systems.

In 1999, the greenhouse operation of Berea College Farms began a transition from conventional to certified organic production.

Local sources of organic waste and compost were considered for use as potting media and nutrients. The College initiated a food-residuals composting program and began informally evaluating the finished compost as a potting medium. In addition, a commercial source of compost derived from used thoroughbred horse bedding was considered. The objective of this study was to evaluate the suitability of the two composts, used solely or diluted in a mixture, for organic vegetable plant production.

Materials and Methods

The materials evaluated in this study included: 1) compost derived from pre-consumer food residuals[1] mixed with yard waste (primarily leaves) as a bulking agent (FR compost); 2) compost derived from used straw horse bedding (HB compost: Creech's Compost, Lexington, KY); and 3) a commercial peat-based potting medium with added synthetic fertilizer (Miracle-Gro, Marysville, OH) used as a control. In addition, both of the composts were mixed (50:50 by volume) with a commercial substrate derived from finely shredded bark, peat, and fine sand (Southern Importers, Greensboro, NC), referred to hereafter as "filler," to generate two additional treatments. The filler was also included as a treatment, for a total of six treatments.

The FR compost was produced by mixing pre-consumer food residuals from Berea College's food service with fall-collected municipal yard waste using a standard tractor-driven manure spreader to form freestanding piles. The piles were aerated 2-3 times using the manure spreader or front-end loader over a three-month period and allowed to cure for about five months. The HB compost was produced at a large turned-windrow facility in Lexington, Kentucky.

The materials were evaluated and compared through chemical analyses, seed germination, and plant growth trials. Chemical analyses included pH, electrical conductivity (EC), total N and carbon (C), and plant-available N, P, and K. The maturity of the materials was measured using the Solvita® test (Woods End Research Laboratory, Mt. Vernon, Maine), which scores the material along an index based on CO_2 and NH_3 emissions. A material with an index value of 7 or 8 (min. = 1, max. = 8) is considered "finished" and suitable for potting mixes. The cost of the material per flat was calculated based on the cost of the material per unit weight or volume.

A seed germination and plant growth experiment was conducted in an unheated greenhouse at Berea College beginning in October 2002. The two crops were lettuce (*Lactuca sativa* var. *longifolia*) and tatsoi (*Brassica rapa* var. *rosularis*) (Johnny's Selected Seeds, Winslow, Maine). For each crop the experiment consisted of the six potting media treatments with four replications in a completely randomized design. All materials were sieved through a screen (½-inch mesh) before use. Germination, plant height, and fresh weight yield were measured.

Samples were taken of each potting medium treatment for analysis of N mineralization at the USDA Sustainable Agricultural Systems Laboratory in Beltsville, Maryland. The samples were extracted with KCl, filtered, and analyzed for ammonium (NH_4^+) and nitrate (NO_3^-) to determine initial mineral N levels. At day 41, the same process was done to measure final mineral N levels.

Results

All of the materials evaluated in this study were considered adequately mature for use as potting media, ranking as a 7 or 8 on the maturity index (Table 1). The two composts, HB and FR, were very similar in C, N, C:N ratio, and P, but differed considerably in pH, EC, and K. The EC of the HB compost was very high, 8.5 dS m^{-1}, indicating a salinity level too high for general use as a potting medium. The EC of the HB compost/filler mixture was 5.2 dS m^{-1}, which is still considered high for potting media.

The HB compost had the lowest cost per flat, at $0.40, while the FR compost was the most expensive at $1.00 per flat (Table 2). The cost per flat of the commercial peat-based material, at $0.70, fell in between these two extremes. Due to the cost of the filler, mixing it with the composts increased the cost of the HB compost/filler blend and decreased the cost of the FR compost/filler blend relative to using the pure composts as potting media.

Germination of both crops was statistically similar among all treatments except for the two media containing HB compost, which had very low germination (Table 3). Plant growth, assessed by plant height and marketable yield, was highest in the FR compost and the commercial peat-based medium. Plant growth in the other four treatments was poor (Table 3).

Initial mineral N was very low in the filler and the two compost/filler blends and very high in both composts and the com-

Table 1. Chemical characteristics of the materials evaluated as potting media for lettuce and tatsoi production, Berea, Ky., 2002.

Potting Medium	pH	EC (dS m^{-1})	Maturity[1]	C %	N %	C:N	P %	K %
Filler	7.1	0.2	8	19.6	0.30	65.3	0.04	0.22
FR compost/filler (50/50%)	7.3	0.6	7	22.7	0.92	24.7	0.15	0.32
HB compost/filler (50/50%)	8.0	5.2	8	25.6	1.28	20.0	0.28	1.39
FR compost	6.6	2.9	7	28.8	1.97	14.6	0.25	0.41
HB compost	8.0	8.5	8	29.6	2.16	13.7	0.46	2.48
Commercial peat-based potting medium	5.6	0.7	8	42.6	0.89	47.9	0.07	0.21

[1] Index value of 7 or 8 (minimum = 1, maximum = 8) is considered "finished" and suitable for potting mixes.

Table 2. Cost per flat of potting media.

Potting Medium	Cost per Flat ($)
Filler	0.50
FR compost/filler (50/50%)	0.75
HB compost/filler (50/50%)	0.45
FR compost	1.00
HB compost	0.40
Commercial peat-based potting medium	0.70

[1] *Organic kitchen waste from food preparation or from food prepared but not served.*

mercial potting medium. Nitrogen mineralization was higher in the FR compost than in all other potting media. Final inorganic N levels (initial inorganic N plus the N released via mineralization), which indicates the amount of N available for plant uptake, was also greatest in the FR compost. Mineral N levels actually declined in the HB compost during incubation. Plant growth, measured as marketable yield, was not correlated with the C:N ratio or total N of the media for either crop. However, initial mineral N level, N mineralized per day, and final mineral N level were significantly correlated with tatsoi growth (Table 4). There was also a nearly statistically significant positive correlation between lettuce growth and initial mineral N level (P = 0.08) and final mineral N level (P = 0.07).

Table 3. Germination, plant height, and marketable yield of lettuce and tatsoi grown in the six potting media.

	Lettuce			Tatsoi		
Potting Medium	Germination at 16 Days (%)[1]	Height at 44 Days (in.)	Marketable Yield at 51 Days (oz flat^{-1})	Germination at 16 Days (%)	Height at 44 Days (inch)	Marketable Yield at 51 Days (oz flat^{-1})
Filler	85 a	0.4 b	0 b	85 a	0.6 b	0 b
FR compost / filler (50/50%)	94 a	1.4 b	1 b	86 a	1.2 b	1 b
HB compost / filler (50/50%)	50 b	0.4 b	0 b	24 b	1.6 b	0 b
FR compost	93 a	5.9 a	9 a	82 a	4.5 a	14 a
HB compost	7 c	0.3 b	0 b	1 c	0.0 b	0 b
Commercial peat-based potting medium	97 a	5.9 a	10 a	94 a	5.3 a	11 a

[1] Different letters within a column indicate statistically significant differences among treatments according to ANOVA and SNK test (P≤0.05).

Table 4. Correlations (r) and their probabilities (P) between lettuce and tatsoi growth, measured as marketable yield at 51 days, and N-related measurements derived from a 41-day incubation.

	Lettuce		Tatsoi	
N variable	r	P	r	P[1]
C:N ratio	-0.04	0.93	-0.11	0.83
Initial total N level (%)	0.16	0.76	0.24	0.64
Initial mineral N level (per flat)	0.75	0.08	0.83	0.04*
N mineralized (per flat)	0.71	0.11	0.81	0.05*
Final mineral N levels (per flat)	0.78	0.07	0.87	0.02*

[1] * indicates a statistically significant correlation (P≤0.05).

Discussion

Although the two composts evaluated in this study had relatively similar total N levels, C:N ratios, and bulk densities, they performed very differently as potting media. Crop growth in the FR compost was similar to that in the commercial peat-based medium, while that in the HB compost (pure and blended with filler) was very poor. Although the HB compost was the least expensive material, the direct effects of the high salinity and/or the indirect effects via inhibition of N mineralization made this material completely unsuitable. This illustrates the importance of testing compost salinity if it is intended as part of a potting medium. By contrast, the FR compost performed very well as a potting medium, but was the most expensive material. Cutting the FR compost with filler reduced the cost, making it similar to that of the commercial medium, but resulted in unacceptable plant growth.

The differences in plant growth among treatments observed in this study were apparently due, at least in part, to mineral N availability. The C:N ratio is often used as an indicator of N mineralization potential of composts and other organic materials. In this study, however, C:N ratio was not a good predictor of N mineralization among these growth media because of the high salinity in two of the six potting-medium treatments.

The higher cost per flat for the FR compost is acceptable if the cost can be passed along to the consumer. Certified organic products are often more expensive to produce than their conventionally produced counterparts, and consequently more expensive for the consumer. Cutting the FR compost with filler to reduce costs was not a viable option due to low N mineralization and poor plant growth in the blend. Therefore, based upon the vigorous plant growth and reasonable cost of the material, the 100% FR compost was the most suitable potting medium for organic production.

Impact of Soil-Incorporated Sewage Sludge on Herbicide Mobility

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Introduction

Editor's note: *Sewage sludge in any form is not approved for certified organic crop production and cannot be recommended at this time for either conventional or organic vegetable production.*

New soil management practices based on knowledge of how agricultural production relates to the fate and transport of agricultural chemicals are needed to meet the challenge of conservation, remediation, and environmental quality. The EPA estimates that 15 million tons of biosolids and 31 million tons of yard waste are discarded annually in the U.S.

Compost is economical as a soil amendment because of its price and availability. By incorporating compost into soil, it is possible to add microbial activity and organic matter. There are many benefits of increasing soil organic matter (SOM). These benefits fall under four categories: biological, physical, chemical, and environmental. Organic matter in compost promotes the growth of beneficial microorganisms. A teaspoon of compost or healthy soil can harbor millions of bacteria, miles of fungi, hundreds of thousands of protozoa, and hundreds of beneficial nematodes. These living organisms create a diversity of life in healthy soil and serve a critical function in metabolizing nutrients. The physical benefits of increased SOM include improved soil aggregation or structure, lessening compaction and surface crusting, increased areation and improved water holding capacity. The chemical benefits of increased SOM are enhanced cation exchange capacity, which helps make nutrients more available to plants, and chelation of metallic micronutrients, which binds trace elements so they can be released slowly and made available as needed for plant uptake. The environmental benefits of increased SOM are carbon sequestration (which helps reduce global warming), adsorption of toxic metals, and adsorption and microbial degradation of toxic organic compounds such as pesticides.

Recycled wastes have unique properties that should be thoroughly investigated in the soil/water/plant ecosystem. In previous research, adsorption of two herbicides, imidazolinone and imazethapyr, to sewage sludge-amended soils indicated that imazethapyr interacts with organic matter in sludge through multiple-binding mechanisms including ionic and hydrogen bonds. The organic matter applied as sludge or yard compost to soil can modify the mechanism of pesticide adsorption to soil and can play a prominent role in pesticide availability and removal processes. The organic matter in compost helps improve soil fertility and provides an organic amendment useful for improving soil structure and nutrient status for stimulating soil microbial activity.

The objectives of this study were: 1) to study movement of napropamide (the herbicide Devrinol) into runoff and infiltration water from a broccoli field that had been treated with two soil amendments (yard waste and sewage sludge compost) and 2) to study the impact of these two soil amendments on spring and fall broccoli yield and head quality.

Materials and Methods

Eighteen plots (72 x 12 ft each) were separated using metal borders 8 in. above ground level to prevent contamination between plots. Three soil management practices, replicated six times, were used: 1) municipal sewage sludge treated with lime and pasteurized for land farming (class-A biosolids obtained from Nicholasville Wastewater Treatment Plant, Nicholasville, KY) was mixed with native soil at 50 t/acre on a dry weight basis, 2) yard waste compost made from yard and lawn trimmings, and vegetable crop residues (produced at Kentucky State University Research Farm, Franklin County, KY) was mixed with native soil at 50 t/acre on a dry weight basis, and 3) no-mulch (NM) treatment (roto-tilled bare soil) used for comparison (control).

Devrinol 50-DF also known as Napropamide [N, N-diethyl-2-(1-naphthyloxy) propionamide] was sprayed and incorporated into the soil surface as a pre-emergent herbicide at the rate of 4 lb of formulated product/acre. Forty-five-day-old broccoli seedlings (*Brassica oleracea* L. cv. Packman F1) were transplanted on April 15, 2003 (spring broccoli) and August 13, 2003 (fall broccoli) at 10 rows/plot along the contour of the land at 10 plants/row. During the growing season, runoff water from irrigation and/or rainfall was collected and quantified at the lower end of each plot using a tipping-bucket runoff metering apparatus. Pan lysimeters were installed at the lower end of each plot down the slope at a depth of 5 ft. Infiltration water was also collected using pan lysimeters for napropamide residue analysis. Napropamide residues were quantified using a Hewlett Packard model 5890A Series II gas chromatograph equipped with a NP detector. Napropamide residues also were confirmed using GC/MS that showed spectral data with a molecular ion peak (M^+) at m/z 271, along with other characteristic fragment ion peaks. At harvest, broccoli head weight and diameter, stalk diameter and length were recorded. Spring and fall broccoli heads were quartered and examined for small and large instars of Imported Cabbageworm (*Pieris rapae* L.) larvae. Data were statistically analyzed using the ANOVA procedure.

Results and Discussion

Runoff water collected from plots treated with sewage sludge was significantly less than from plots treated with yard waste compost. Napropamide residues were significantly higher in runoff water from NM soil compared to yard waste and sewage sludge treatments (Figure 1, upper graph). The organic matter content was significantly higher in soil mixed with sewage sludge (6.0 ± 0.2%) and soil mixed with yard waste compost (5.7 ± 0.2%) compared to NM soil (2.8±0.8%). These results confirm that the sorption of pesticides was highest in soils with the greatest organic matter content. Other research has shown that application of compost to soil has increased the retention or removal of hydrophobic compounds like trifluralin (an herbicide) from runoff water and retention of pyrethrins (natural insecticides) on soil solids. Concentration of napropamide in infiltration water from soil treated with sewage sludge was lower than napropamide in infiltration water from yard waste compost treatment.

Yard waste compost was associated with increased water infiltration and napropamide residue in the vadose zone, the region of the soil above the permanent water table (Figure 1, lower graph). Napropamide residues in the vadose zone were 0.3 mg/acre in the NM treatment compared to 1.4 mg/acre in yard waste compost treatment. Previous results have indicated that the interaction of pesticides with a water-soluble carrier such as dissolved organic matter (DOM) may facilitate chemical movement through the soil. The increased napropamide movement through the soil mixed with yard waste compost into the vadose zone could be attributed to the formation of napropamide-DOM complexes that lack adsorption affinity for the solid phase or due to reduced bulk density and increased soil particle interspaces after addition of yard waste compost. No napropamide residues were collected during the fall season due to lack of rainfall (data not shown).

Addition of sewage sludge to soil increased broccoli head weight and diameter as well as stalk diameter and length compared to the NM treatment (Table 1). Broccoli marketable yield (tight, uniform heads with fine beading) is important in establishing and maintaining marketing opportunities. The use of any soil amendment in vegetable production must provide growers with acceptable and marketable yield in order for them to use this agricultural practice. Organic substances and nutrients in sewage sludge and yard waste support a vast population of soil organisms that "mine" for soil minerals. Evidence of enhanced microbial activity in the rhizosphere of plants grown with soil amendments has been reported. For broccoli, the minimum average head weight should be 7 oz. to meet the marketing opportunities. This requirement can likely be achieved when using sludge for spring broccoli production (Table 1).

Further studies are needed to reduce the dissolved organic matter content of municipal waste before land application. This will protect water quailty from off-site movement of pesticides.

Acknowledgment

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Figure 1. Volume of spring runoff water and napropamide residues in runoff water (upper graph) and napropamide residues in infiltration water (lower graph) collected from broccoli field under three soil management practices. Bars accompanied by different letters are significantly different (P<0.05) using Waller-Duncan LSD test.

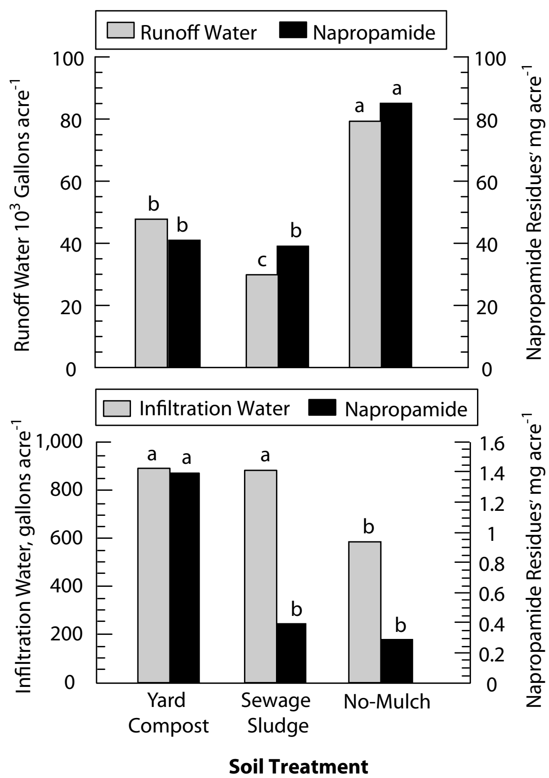

Table 1. Quality of spring and fall broccoli grown under three soil management practices at Kentucky State University Research Farm (Franklin County, Ky.).*

Soil Treatment	Head Weight (oz)	Head Diameter (in.)	Stalk Diameter (in.)	Stalk Length (in.)	No. of Cabbage Worms/Head
Spring Broccoli					
Sewage sludge	6.9 a	5.0 a	1.5 a	1.4 a	1.1 b
Yard waste	6.1 a	4.7 b	1.3 b	0.6 b	1.2 b
No mulch	4.9 b	4.1	1.2 c	1.3 a	2.6 a
Fall Broccoli					
Sewage sludge	6.6 a	4.1 a	1.6 a	2.3 b	0.0 b
Yard waste	6.6 a	3.8 b	1.4 b	2.8 a	
No mulch	6.7 a	4.0 ab	1.5 ab	1.0 c	

* Each value in the table is an average of six replicates. Values within a column for each broccoli season having different letter(s) are significantly different (*P*<0.05) using Waller LSD test.

Fruit and Vegetable Disease Observations from the Plant Disease Diagnostic Laboratory

Julie Beale, Paul Bachi, Kenny Seebold, and John Hartman, Department of Plant Pathology

Introduction

Diagnosis of plant diseases and providing recommendations for their control are the result of UK College of Agriculture research (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 UK Research and Education Center in Princeton. Of the more than 4,000 plant specimens examined annually, approximately 10-15% are commercial fruit and vegetable plant specimens (1). Moreover, the annual number of such specimens diagnosed has more than doubled in recent years—but because of their complexity and diversity, the time needed to diagnose them has more than just doubled. 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 Kentucky Integrated Pest Management funds to help defray some of these additional laboratory operating costs. We have greatly increased the use of consulting on plant disease problems, including solving fruit and vegetable disease problems through our Web-based digital consulting system. Of the nearly 700 digital consulting cases, approximately 18% 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 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. Diagnoses which require consultation with UK faculty plant pathologists and horticulturists, and which need culturing, PCR and ELISA are common for commercial fruits and vegetables. 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, bacterial leaf spot, yellow vine decline, and Pierce's disease. 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, and our laboratories are working to meet that requirement.

The 2005 growing season in Kentucky provided mostly warmer-than-normal temperatures and below-normal rainfall; however, these observations varied by location. The coldest temperatures occurred in late December 2004 and ranged from -11°F in parts of western Kentucky to +9°F in the central and east regions. Cold temperatures occurred before some plants were completely hardened off. A late spring frost occurred the last week of May in some locations. For most of Kentucky, prevailing temperatures were above normal for all months except March and May. Rainfall in most Kentucky locations was below normal every month except January and August (Hurricanes Dennis and Katrina). Indeed, central Kentucky suffered moderate to severe drought for most of the summer, and eastern Kentucky was in a state of severe drought by summer's end. Despite dry weather, there was enough rainfall in spring to promote development of apple rust and fire blight diseases. April and May temperatures were quite variable alternating from unseasonably warm to unseasonably cold. Cold temperatures extended apple and pear flowering periods, and warm periods promoted bacterial growth so that pome fruits were more vulnerable to fire blight than usual.

Results and Discussion

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

- Grape crown gall caused by *Agrobacterium vitis* continues to plague vineyards, even to the extent of forcing the replanting of some vineyards.
- Peach fruit rot caused by a species of *Colletotrichum.*
- Cucurbit yellow vine disease caused by *Serratia marsescens.*
- Downy mildew of cucurbits, caused by *Pseudoperonospora cubensis*, was a serious problem in some areas, particularly on pumpkin.
- Bacterial canker of tomato caused by *Clavibacter michiganensis* subsp. *michiganensis.*
- Copper-resistant bacterial speck of tomatoes caused by *Pseudomonas syringae* pv. *tomato.*
- Root knot nematode (*Meloidogyne* spp.) is becoming a major problem on several crops due to reduced crop rotation and use of old tobacco fields as vegetable sites.
- Although not found in Kentucky, soybean rust occurred in the southern U.S. this fall; many vegetable legumes are also hosts.
- An unknown Begomovirus was diagnosed on tomatoes being grown in a greenhouse; disease incidence was near 100%.

Tree Fruit Diseases

Pome fruits. With periodic warm spring temperatures, fire blight (*Erwinia amylovora*) was observed frequently, and in many orchards was severe. Dry weather helped keep apple scab (*Venturia inaequalis*) levels low, but high levels of cedar rusts of apple (*Gymnosporangium juniperi-virginianae, G. clavipes,* and *G. globosum*) and frogeye leaf spot (*Botryosphaeria obtusa*) were observed. Sooty blotch (*Peltaster fructicola, Geastrumia polystigmatis, Leptodontium elatius*, and other fungi) and flyspeck (*Zygophiala jamaicensis*) appeared late in the season along with apple bitter rot (*Colletotrichum acutatum*). Pears were observed with fire blight and leaf spot (*Diplocarpon mespili*).

Stone fruits. Some stone fruits suffered cold temperature injury to trunk phloem and cambial tissues from the December cold period. Peach leaf curl (*Taphrina deformans*), bacterial spot (*Xanthomonas pruni*), and brown rot (*Monilinia fructicola*), were common; scab (*Cladosporium carpophilum*) was also observed. Plum black knot (*Apiosporina morbosum*) was widespread, and plum pockets (*Taphrina communis*) and cherry leaf spot (*Blumeriella jaapii*) were observed.

Small Fruit Diseases

Grapes. Black rot (*Guignardia bidwellii*), downy mildew (*Plasmopara viticola*), and Phomopsis cane and leaf spot (*Phomopsis viticola*) were widespread; *Phomopsis* infections of fruits in early spring resulted in fruit losses. Anthracnose (*Elsinoe ampelina*) and crown gall (*Agrobacterium vitis*) were also observed. Powdery mildew (*Uncinula necator*) appeared late in the season. No new cases of Pierce's disease (*Xylella fastidiosa*) were found.

Brambles. Cane blight and canker diseases (*Leptosphaeria coniothyrium, Botryosphaeria dothidea*) were observed on blackberry. Blackberry rosette or double blossom (*Cercosporella rubi*) was also seen. An as yet unidentified virus or complex of viruses causing ring spots and leaf mottling was seen on blackberry from several locations. Testing is still in progress to determine the identity of the virus(es).

Blueberries, Stem canker disease (*Botryosphaeria dothidea*) was diagnosed on blueberries. Botrytis twig blight occurred on blueberry in early spring.

Strawberries. Leaf spot (*Mycosphaerella fragariae*) and leaf scorch (*Diplocarpon earlianum*)were frequently observed.

Vegetable Diseases

Vegetable transplants. Pythium root rot (*Pythium* spp.) appeared in tomato, cantaloupe, squash, and pepper fields this year, along with several cases of Rhizoctonia root rot, and may have originated in transplant production.

Cole crops. Cabbage black rot (*Xanthomonas campestris* pv. *campestris*), bacterial soft rot (Erwinia spp.), and Alternaria black spot were observed. Wirestem (*Rhizcotonia solani*) was found on cauliflower.

Tomatoes. Commercial tomato plantings were affected by several bacterial diseases including bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*), bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), and bacterial speck (*Pseudomonas syringae* pv. *tomato*). Early blight (*Alternaria solani*) was common, but caused limited damage due to dry conditions during most of the summer. Sclerotinia stem rot (timber rot), caused by *Sclerotinia sclerotiorum*, was found at several locations in the spring. Fruit maladies in addition to blossom end rot included the fruit infection stages of the fungal and bacterial leaf diseases listed above and also buckeye rot (*Phytophthora cactorum*) and gray mold (*Botrytis cinerea*). Tomato fruit also experienced other physiological disorders such as stem-end internal greening. Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*), southern stem blight (*Sclerotium rolfsii*), and root knot nematode (*Meloydogyne* sp.) were problems in some fields. Tomato spotted wilt virus appeared in several tomato fields. A Begomovirus was identified on greenhouse tomatoes in one location, and the entire crop had to be destroyed. Begomoviruses are transmitted by whiteflies of the genus *Bemisia* and are more common in the southern U.S. The original source of the virus in Kentucky is not known at this time.

Peppers. Bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria*) remains an important problem. Tomato spotted wilt was found in western Kentucky.

Cucurbits. Cucurbits are widely grown in Kentucky, and their diseases are economically important. Phytophthora root rot, stem rot, leaf blight, and fruit rot (*Phytophthora capsici*) are widespread in the state, but caused little loss in pumpkin, watermelon, squash, and cucumber in 2005. Anthrancnose (*Colletotrichum* spp.), gummy stem blight/black rot (*Didymella bryoniae*), Alternaria leaf spot (*Alternaria cucumerina*), and Microdochium blight (*Plectosporium* sp.) were found at serious levels in fields of several different cucurbit crops. Pumpkin and squash powdery mildew (*Erysiphe cichoracearum*) also caused losses. Downy mildew (*Pseudoperonospora cubensis*) was widespread across Kentucky in 2005, but generally was not serious, due to dry conditions; however, where there was more moisture, it caused losses to pumpkin and cucumber on some farms. Bacterial diseases of cucurbits included bacterial wilt (*Erwinia tracheiphila*) and cucurbit yellow vine decline caused by *Serratia marsescens*. However, incidence of the latter was lower than in previous years. Numerous cases of viral diseases (virus complex) were reported on squash and pumpkins.

Other vegetables. Anthracnose (*Colletotrichum lindemuthianum*) was found on beans this year. Cercospora leaf spot was reported on turnip.

Growers are urged to notify their County Extension Agent of new outbreaks and disease trends in their fields. We want to be especially watchful of the new spectrum of microbes and diseases that may occur with changes in fungicide use patterns, from broad-spectrum protectant fungicides such as mancozeb and chlorothalonil, to new chemicals such as the strobilurins (Quadris, Amistar, Cabrio, Sovran, and Abound). These five present a greater risk of pathogen resistance to the fungicide while incurring reduced risks to human health and the environment. For example, we have noted increased bacterial diseases in tomatoes and want to know if this is due to use of new chemicals or how we raise our crops, manage other diseases, or import seeds and transplants.

Because fruits and vegetables are high-value crops, the Plant Disease Diagnostic Laboratory should be a great value to commercial growers. Growers should consult consistently with their County Extension Agents so that appropriate plant specimens are sent to the laboratory quickly. We urge County Extension Agents to stress in their Extension programming the need for accurate diagnosis of diseases of high-value crops. Growers can work with their agents so that Kentucky growers have the best possible information on fruit and vegetable diseases.

Literature Cited

1. Bachi, P.R., J.W. Beale, J.R. Hartman, D.E. Hershman, K. Seebold, and P.C. Vincelli. 2006. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2005. 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
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

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, Ph: (716) 442-0424
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
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

LI .... Liberty Seed, P.O. Box 806, New Philadelphia, OH 44663
LSL....................... LSL Plant Science, 1200 North ElDorado 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, U of MN Hort 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, Kansas 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.)
NZ........................ Nickerson-Zwaan, P.O. Box 19, 2990 AA Barendrecht, The Netherlands

OE........................Ohlsens-Enke, NY Munkegard, DK-2630, Taastrup, Denmark
OS........................L.L. Olds Seed Co., P.O. Box 7790, Madison, WI 53707-7790

P...........................Pacific Seed Production Co., P.O. Box 947, Albany, OR 97321
PA/PK..................Park Seed Co., 1 Parkton Ave., Greenwood, SC 29647-0002
PE.........................Peter-Edward Seed Co. Inc., 302 South Center St., Eustis, FL 32726
PF.........................Pace Foods, PO Box 9200, Paris, TX 75460
PG........................The Pepper Gal, P.O. Box 23006, Ft. Lauderdale, FL 33307-3006
PL.........................Pure Line Seeds Inc., 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, PO 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
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
SI..........................Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503
SK.........................Sakata Seed America Inc., P.O. Box 880, Morgan Hill, CA 95038
SO.......................Southwestern Seeds, 5023 Hammock Trail, Lake Park, GA 31636
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
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, PO Box 1626, Augusta, GA 30903
TW.......................Twilley Seeds Co. Inc., P.O. Box 65, Trevose, PA 19047

UA........................US Agriseeds, San Luis Obispo, CA 93401.
UG.......................United Genetics, 8000 Fairview Road, Hollister, CA 95023
US........................US Seedless, 12812 Westbrook Dr., Fairfax, VA 22030

V...........................Vesey's Seed Limited, York, Prince Edward Island, Canada
VL.........................Vilmorin Inc., 6104 Yorkshire Ter., 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

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