2006 Fruit and Vegetable Crops Research Report

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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 countys Cooperative Extension Service if you need assistance in interpreting pesticide labels.

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

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University of Kentucky Fruit and Vegetable Program Overview—2006

Dewayne Ingram, Chair, Department of Horticulture

The University of Kentucky Fruit Crops and Vegetable Crops Programs are the coordinated efforts of faculty, staff, and students in several departments in the College of Agriculture for the benefit of the Kentucky fruit and vegetable industries. Our 2006 report is divided into sections providing information on on-farm demonstrations and the plant diagnostic laboratory and the results of research projects involving small fruits, tree fruits, and vegetables. 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 have come from the Agricultural Development Board through Kentucky Horticulture Council grants and the Kentucky Grape and Wine Council, as well as U.S. Department of Agriculture grants for the New Crop Opportunities Center. These funds have allowed us to double the number of field research plots statewide in recent years. 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 Extension Associates, located throughout the state, who are helping new and existing growers understand and apply the technologies of more profitable production and marketing systems. The associates achieve these goals mostly through on-farm demonstrations, on-farm consulting, and collaboration with county Extension agents. 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. We are progressing with improvements to the Horticulture Research Farm (South Farm). This year we have moved and improved a "production" greenhouse, constructed a headhouse for the greenhouse complex, and have just awarded the bid for construction of six research greenhouses. We now have 3 acres of grape research plots and have expanded other perennial fruit plots (blueberries, blackberries, and raspberries). We are on schedule to have 11 acres of the farm become "certified organic" in 2007. You are invited to visit the farm at your convenience, and make sure you watch for the announcement of the field day in the summer of 2007.

Although the purpose of this publication is to report research results and summarize our Extension program results, we have also highlighted below some of our undergraduate and graduate degree program activities.

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. The Plant and Soil Science degree program had nearly 100 students in the fall semester of 2006, of which almost one-half are horticulture students, and another one-third are turfgrass students. Twelve horticulture students graduated in the 2005-2006 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 2006.

- An 11-day study tour to Europe was led by Dr. Robert McNiel involving 11 students.
- Horticulture students competed in the 2006 Professional Landcare Network (PLANET) Career Day competition at Brigham Young University in March (Dr. Robert McNiel, faculty advisor).
- Students accompanied faculty to the following regional/national/international meetings, including the American Society for Horticultural Science Annual Conference, Eastern Region—International Plant Propagators' Society, the Kentucky Landscape Industries Conference, Southern Nursery Association Research Conference and Trade Show, and the Mid-States Horticultural Expo.

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 and John Snyder, Department of Horticulture

The 2006 Fruit and Vegetable Crops Research Report includes results of more than 35 research trials that were conducted in 17 counties in Kentucky (see map, below). In addition to these locations, producers statewide were surveyed about their marketing intentions, and the Plant Disease Diagnostic Lab served all parts of the state.

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. Most of these reports are of crop variety (cultivar) trials. Other reports deal with aspects of crop management or crop economics.

Growers usually put variety trials at the top of the list when rating projects at a public institution's research stations. These trials provide a wealth of information not only to growers but also to Extension agents, researchers, and seed companies. Trials also form the basis for including variety and other recommendations 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 plot size ranges 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 calculated yields per acre may not be realistic, and errors are amplified when correction factors are used. For example, the calculations may overestimate yields because the experimental plots harvested do not include empty spaces occupied by things such as drive rows in a grower's field. Not accounting for 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 2006.

1. *Lexington*
2. *Princeton*
3. *Quicksand*
4. *Henderson County*
5. *Daviess County*
6. *Bracken County*
7. *Gallatin County*
8. *Marion County*
9. *Taylor County*
10. *Hardin County*
11. *Logan County*
12. *Simpson County*
13. *Clay County*
14. *McLean County*
15. *Union County*
16. *Webster County*
17. *Hancock County*

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 near that location. Results may 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. Trials conducted 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 management practices, and these varieties usually become top sellers.

Climatic conditions may differ considerably from one season to the next, and it follows that some varieties may 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 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 of the four small plots. The average yields reported in the tables are calculated by multiplying these 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

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.

actual differences in performance of varieties. The last line at the bottom of most 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 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. For example, when the yield difference of two varieties is less than the LSD value, we cannot say with any certainty that one variety really yielded better than the other. In other words, we conclude that the yields are the same. For example, in Table 1, variety X3R Aristotle yielded 25.0 tons per acre and Boynton Bell yielded 21.7 tons per acre. Because the difference in their yields (25.0 - 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 (25.0 – 18.0 = 7.0), 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

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.

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). Also, there are no differences in pounds/acre in Table 2, as indicated by the "ns" (not significant) at the bottom of this column.

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 are 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 (25.0 - 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 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 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 small 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. Also, some wholesale market channels only accept certain varieties. For example, 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. Customers of direct markets may also ask for specific varieties. Good marketing plans start with the customer's (market) requirements and work backward to determine variety and production practices.

RACE Trials

In cases when 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

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 a 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 for vegetable crop varieties that will receive different market prices based on when they are harvested (earliness) and on pack-out of different fruit sizes and grades (bell peppers, tomatoes, cucumbers). In these cases, for a given harvest date, yields in each size class/grade are multiplied by their respective market prices on that date to determine gross returns (= income) for each cultivar in the trial.

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 and still 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 the previous page, will help fill a need and will demonstrate best use of limited resources at the research farms. See the "Leafy Greens RACE Variety Trial," page 49.

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.

Despite the advantages of hybrids, there are some crops for which few hybrids have been developed or for which hybrids offer no particular advantages (most bean varieties). Interest in OP varieties has resurged among home gardeners, market gardeners, and others 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 and quality required by this channel. 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, the last page 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 variety. This method is 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 other trials that may be of interest 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 2005 reports have been posted in PDF (Acrobat) format at www.ag.auburn.edu/aaes/communications/publications/fruitsnutsvegs.html.

Produce Marketing Intentions Survey—Continued Expansion

Jim Mansfield and Tim Woods, Department of Agricultural Economics

Introduction

The Kentucky Produce Planting and Marketing Intentions Survey was conducted for the fifth consecutive year in 2006. Results of the survey allow producers, researchers, government officials, and others involved in Kentucky agriculture to get a general sense of Kentucky's produce production and marketing trends. Responses to the 2006 Kentucky Produce Planting and Marketing Intentions Survey, combined with a decrease in acreage contracted by Kentucky's two remaining vegetable marketing co-ops, indicated that direct marketing would continue to drive growth in Kentucky's produce industry. Produce production acreage is expected to expand 8% from the 2005 levels to 10,611 acres. Vegetable acres based on the survey results are predicted to be up 19% from 2005 levels to 8,131 acres. Fruit acres are predicted to decrease -18% from 2005 to 2,500 acres.

Materials and Methods

Surveys were mailed to 1,194 growers in February 2006. The survey was returned by 268 producers representing 1,814 commercial vegetable acres and 526 commercial fruit acres. An additional 47 surveys were returned but were unusable. The 22% 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 growing has primarily occurred on farms operated by those over 50 (Table 1). Many new, inexperienced growers began growing produce between 1998 and 2001. Despite the efforts directed at helping new producers diversify into horticultural crops, the proportion of new growers has been declining until this year when a slight (3%) increase in "new" growers was noted. Kentucky's produce farmers continue to gain production experience and expand their acreage. Survey respondents indicated approximately one-third of the farmers earned 50% or more of their income from farming. Another one-third indicated they earned 10% or less of their income from farming, and the other one-third fell somewhere in between.

Table 1. Years of experience growing produce.

Year	Years of Experience <3	3-6	7-10	>10
2001	25%	23%	14%	38%
2002	15%	32%	15%	38%
2003	15%	33%	13%	38%
2004	6%	28%	18%	48%
2005	9%	29%	19%	43%

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

Year	Grew Produce and Tobacco
2001	44%
2002	46%
2003	41%
2004	45%
2005	23%
2006	21%

Table 3. Interest in growing organic produce.
Are you interested in growing organic produce in the future?

	Yes	No/No Response
2003	20%	80%
2004	2%	98%
2005	20%	80%
2006	32%	68%

Production Outlets

Tobacco production. Predictions that the tobacco buyout would cause significant producer exit from tobacco production seem to have been correct. The survey indicated about half of the farms that grew produce and tobacco have since quit raising tobacco (Table 2). While some of these growers indicated that they were interested in expanding produce acreage, it was beyond this surveys scope to accurately predict the effects of tobacco industry changes on possible produce acreage expansion. However, this survey did indicate an 8% expansion in Kentucky produce acreage.

Organic production. This year's survey showed a strong interest in organic produce with almost one-third of the respondents indicating an interest in future organic production. (Table 3). This increased interest may be due to increased awareness of support available for organic certification through the Kentucky Department of Agriculture (KDA). Other encouraging developments could include the University of Kentucky College of Agriculture offering a degree in sustainable agriculture for the first time in 2006. Overall, the organic food industry continues to expand at a rate of approximately 20% annually. Because of consumer acceptance of organic products into the more mainstream marketing channels, buyer demand continues to grow.

For the purposes of 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 2005 was 90%, 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. An all-time record was set in 2006 with 107 farmers' markets operating in Kentucky. Total farmers' market sales in 2005 remained steady at approximately $7 million. More than 1,800 registered vendors participated in farmers' markets in 2005.

More than half (63%) of the respondents to this survey indicated that they used farmers' markets to sell some of their produce; 58% indicated that 10% or more of their sales occurred at farmers' markets (Figure 1).

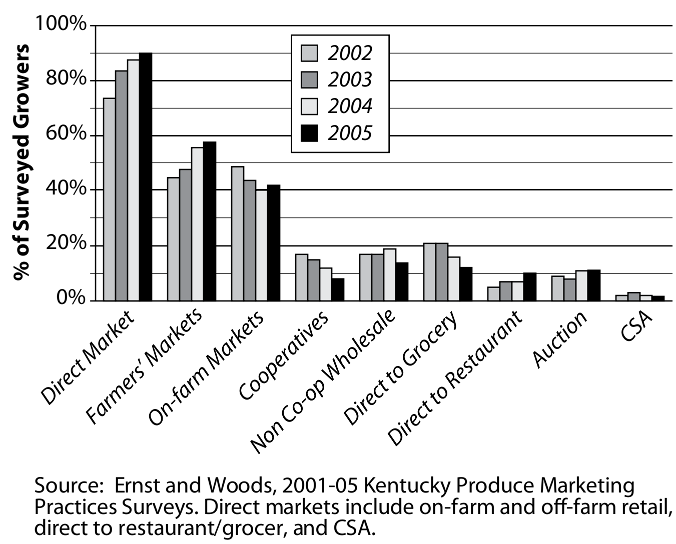
On-farm markets. The next most frequently used market channel was the on-farm market, used by 42% of the respondents. These markets include roadside stands and pick-your-own. Kentucky Farm Bureau listed an all-time high of 78 certified roadside markets in 2006.

Restaurants. Selling directly to local restaurants is gradually becoming more popular with produce growers in Kentucky. Two fairly recent programs may be opening doors for Kentucky products: the state park restaurants' ability to purchase in-season local produce and the "Restaurant Rewards" program available through KDA and the Partners for Family Farms. The Restaurant Rewards program provides incentives for restaurants to buy Kentucky-grown products. Refunds are available for up to $1,250 per month for restaurant advertising expenses.

Community-Supported Agriculture (CSA). CSA marketing was used by 1% of respondents. This market channel is popular with certified organic producers near large population centers. Although currently minor, sales volume through the CSA channel is expected to increase as organic acreage increases.

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 used in 2005. This channel tends to be used by larger farms and was used by 24% of the survey respondents. Eleven percent of respondents indicated selling 10% or more of their produce direct to a local grocery in 2005. This market channel is often arranged through the buying office of a larger grocery 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.

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



Source: Ernst and Woods, 2001-05 Kentucky Produce Marketing Practices Surveys. Direct markets include on-farm and off-farm retail, direct to restaurant/grocer, and CSA.

Cooperatives. Citing poor weather and weak markets, the boards of directors of two of Kentucky's vegetable marketing cooperatives (West Kentucky Growers Co-op, Owensboro and Green River Produce Co-op, Horse Cave) voted to close their doors after the 2005 season. These co-ops had received substantial support through tobacco settlement monies as opportunities for tobacco growers to diversify. There were 19 producers responding to this survey that sold produce through a co-op in 2005. All but one of these producers planned to grow produce in 2006.

Auctions. Eleven percent of respondents indicated that they used auctions to market some of their produce in 2005. 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 totaled approximately $2 million in 2005 with more than 300 growers marketing 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 which crops are viewed favorably or unfavorably for expansion (expansion potential).

Survey respondents indicated increases in snap beans, ornamental corn, and hot pepper acreage in 2006. Minor vegetable crops (less than 100 acres each) with projected increases greater than 100% included sweet potatoes, garlic, and beets. These are all crops with direct and or wholesale market potential. Surveyed produce farmers indicated that they would be growing fewer herbs and potatoes (both white and red).

Kentucky fruit growers are learning to grow blueberries on a commercial scale. The 2006 survey indicated a rapid increase in blueberry acreage, which increased from 15 acres in 1997 to 60 acres in 2005 and doubled in 2006 to 120 acres. Bearing acreage of wine grapes has also continued increasing from 220 bearing acres in 2004 to 410 acres in 2005. Apple acres were reduced considerably from 1,800 acres in 2004 to an estimated 980 acres in 2006. Some of this could be a substitution of older, less productive orchards in favor of more intensive, higher density plantings. Peach acres, on the other hand, were estimated to expand approximately 100 acres and total 600 acres.

Summary

Producers using direct markets comprise the majority of fruit and vegetable growers and generate most of the sales volume in Kentucky. Wholesale produce marketing has shifted more to sales through wholesalers, multi-state grower/shippers, direct to grocery stores, and produce auctions. The industry continues to work through significant marketing challenges and is affected by changes across all of agriculture. Volume requirements in wholesale markets, infrastructure for direct marketing, and delivery of products to local institutional markets represent the biggest marketing issues facing Kentucky growers.

Acknowledgment

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Kentucky Restaurant Produce Demand and Marketing Implications

Tim Woods, Matt Ernst, Jeffrey Herrington, and Jim Mansfield, Department of Agricultural Economics

Introduction

The foodservice sector includes restaurants and other institutions providing prepared meals away from home. The foodservice market sector has been growing for all foods and for fresh produce in particular. A recent study estimated that 50% of consumer produce sales are through foodservice establishments.[1] This phenomenon is happening in Kentucky as well. Local restaurants provide a ripe market niche for Kentucky farmers selling fresh vegetables and fruits. Although sales to restaurants typically account for less than 15% of a grower's total sales, prices paid by restaurants are normally stronger than wholesale and auction prices. Selling to restaurants is especially a way for growers who have had some success with on-farm or farmers' market stands to increase their sales volume.

This article highlights some of the findings of a 2006 survey of Kentucky restaurant chefs and owners. For the complete analysis, see "2006 Kentucky Produce Buyer Survey" available at www.uky.edu/Ag/NewCrops.

Materials and Methods

A single-mailing survey was sent to 280 restaurants and state resort parks in Kentucky, including the northern Kentucky/Downtown Cincinnati area. Restaurants were selected from the Kentucky AAA restaurant directory. Usable responses were returned by 64 restaurants, a 23% response rate. The survey explored restaurant interest in specific vegetables, fruits, and herbs and sought to identify the barriers restaurants perceive in purchasing Kentucky-grown produce.

Restaurant Demographics

Restaurants were asked to classify their restaurants in one of four categories: American casual, American white tablecloth, ethnic, and other.

[1] P. Kaufman, C. Handy, E. McLaughlin, K. Park, and G. Green, "Understanding the Dynamics of Produce Markets," USDA-ERS AI Bulletin No. 758, August, 2000.

Most of the restaurants (39, 62%) fell in the American casual category. There were 12 responses (18%) from white tablecloth American restaurants and five responses (8%) from ethnic restaurants. Eight (13%) of the restaurants fell in the "other" category. These restaurants were identified as bed and breakfasts, bistros, or cafés specializing in organic cuisine. Frequency of response was similar among geographic areas.

Demand for Locally Grown Vegetables and Melons

The percentage of respondents indicating interest in each crop is listed in Figure 1. The survey asked respondents to rank crops they were "interested" or "very interested" in purchasing. Interest in fresh vegetables is particularly high. Regular tomatoes, bell peppers, and greens of all kinds were at the top of the list and are widely used among most restaurants.

Demand for Locally Grown Fruit

Blackberries, grapes, apples, and blueberries are the most popular fruit crops for more than half of the restaurants surveyed. While interest was slightly less for fruits than for vegetables, there was still significant demand. The fruit crops tend to be higher value items, more perishable, and more difficult for many local restaurants to find locally. As with the vegetables, most of the fruit products are going to be used as an ingredient. Qualities of ripeness and flavor are going to be at least as important as the physical appearance of the product. A summary of demand by fruit item is presented in Figure 2.

Herbs

Due to the volume of requests for information about selling herbs to restaurants, an extensive listing of herbs was included in this survey. Herbs are relatively easy to grow, and many restaurants are interested in purchasing fresh herbs from growers. Herbs like basil, garlic, and cilantro that are used in comparatively greater quantities are most demanded by restaurants. The market for more minor herbs may be less, especially since many chefs will grow their own herbs in a small "kitchen garden."

A challenge for including these products is the relatively small amount of each product that is used by any one restaurant. A summary of restaurant interest in local herbs is presented in Figure 3.

Kentucky Restaurants and Demand for Locally Grown Produce

The survey also explored the demand for locally grown produce generally among Kentucky restaurants. These questions provided some perspective on the buyers' perceptions of their patrons' interests in local produce as well as the restaurants related marketing programs.

A significant majority of restaurants replying (89%) indicated that it was at least "somewhat" important for their patrons to connect the restaurant's menu to the local agricultural community.[2] Specific responses are summarized in Table 1.

Table 1. How important do you believe it is for your restaurant clients to be able to connect your restaurants menu to the local agricultural community?

Importance	Number (%)
Not very important	7 (11%)
Somewhat important	23 (37%
Very important	33 (52%)

Barriers to Purchasing Locally Grown Produce

Many restaurants are interested in purchasing locally when possible and are aware that their own patrons respond favorably to promotions of local produce. Still, these buyers face important barriers when trying to source locally. Produce buyers for restaurants were asked an open-ended question about barriers that they perceived or experienced when sourcing local produce. Availability, consistent quality, and reliability of supply were cited as the most common barriers. Uniform quality and consistent availability *in season* emerge as the keys for growers to deliver to potential restaurant customers.

[2] There is always a danger of response bias in surveys like this. It is conceivable that restaurants more interested in local produce were more likely to respond to the survey, given its subject. The percentages could therefore overstate somewhat the responses to client interest in local produce, for example, that would be observed from a full reporting of all the restaurants surveyed.

Figure 1. Restaurant interest in local vegetables and melons (based on 64 usable surveys).

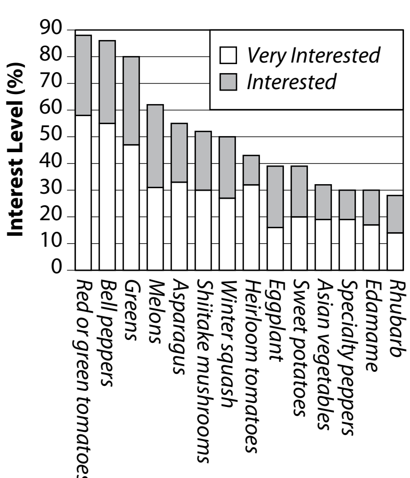


Figure 2. Restaurant interest in locally grown fruit (based on 64 usable surveys).

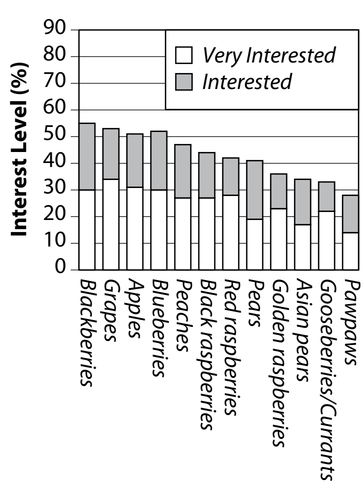
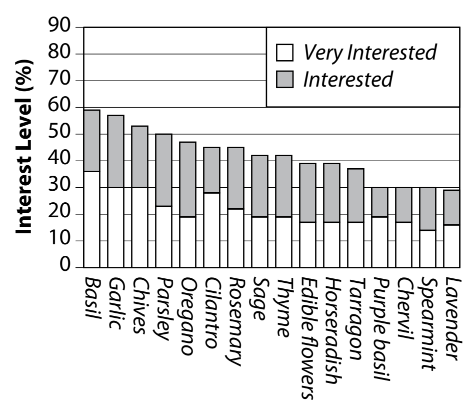


Figure 3. Restaurant interest in locally grown herbs (based on 64 usable surveys).



Restaurant Rewards Program

The Kentucky Department of Agriculture and the Partners for Family Farms conduct a program to promote restaurants buying local foods. Participating restaurants can receive a cash rebate for advertising expenses based on the amount of locally produced food they purchased. The research reported included a discussion of the program and how it fits nicely with the perceived demand for local foods. Unfortunately, of the restaurants surveyed, only 44% were aware of the program. It was suggested that additional efforts be made to inform produce growers and Kentucky restaurants of this timely and unique opportunity.

Summary

Readers are encouraged to read the full report at the Web site referenced above. Findings from a 2006 survey of Kentucky restaurant chefs and owners found a good deal of interest in buying local products and a perception that many restaurant patrons believe local farm products are important. The fruits, vegetables, and herbs most in demand were identified. Additionally, barriers to local purchasing were identified with the top three being availability, consistent quality, and reliability of supply. The report also included questions about business practices desired from suppliers and a question about participation in the Restaurant Rewards program.

On-Farm Vegetable Demonstrations in Northwestern Kentucky

Nathan Howard, Department of Horticulture

Introduction

Seven on-farm vegetable demonstrations were conducted in northwestern Kentucky in 2006. Grower/cooperators were located in Union, Daviess, Webster, and Hancock counties. Three grower/cooperators were located in Daviess County. One grower grew one-half acre of mixed vegetables for direct sales in the Owensboro area. The other two grower/cooperators each raised one acre of mixed vegetables for sales at a roadside stand and farmers' markets. The Hancock County grower/cooperator raised one-half acre of mixed vegetables for farmers' markets in the county, as well as for wholesale to buyers. The Webster County grower/cooperator raised one acre of mixed vegetables for a roadside stand in the county, as well as for local area restaurants. There were two grower/cooperators located in Union County. One experimented with one-half acre of sweet corn on black plastic along with his traditional production to attempt hitting an early market. The other grower/cooperator raised one acre of pumpkins on white plastic for fall sales from his home. All growers were experienced with the crops that were raised but had never utilized the plasticulture system for production. Three of the grower/cooperators had raised tobacco in the past or were still raising tobacco and were trying a different enterprise to supplement income on their farm.

Materials and Methods

Each grower/cooperator was provided with up to an acre of black plastic mulch and drip irrigation lines for production. Also, the University of Kentucky Department of Horticulture's plastic mulch layer, waterwheel setter, and plastic mulch lifter were used by each grower/cooperator. An Extension Associate made weekly visits to provide production information throughout the season. Some of the farms were selected for field days, and county Extension agents assisted in these. All grower/cooperators took soil tests and fertilized according to University of Kentucky recommendations. Also fungicides and insecticides were applied according to recommendations in *Vegetable Production Guide for Commercial Growers (*ID-36). The grower/cooperators irrigated either out of farm ponds or with county water.

Results and Discussion

The 2006 season was perfect for production in the area, as regular rainfall and warm temperatures were evident throughout the season. The first grower/cooperator in Daviess County had raised vegetables for the past few years but had never used the plasticulture system. They raised tomatoes, cantaloupe, cucumbers, watermelons, and peppers. They had a productive season selling their entire crop through the Owensboro Regional Farmers' Market. The grower/cooperators posted a net income for the season (Table 1). The second grower/cooperator was also from Daviess County. He raised one-half acre of mixed vegetables including tomatoes, cantaloupe, squash, peppers, and sweet corn for local sales. All of his sales were direct sales in the Owensboro area. This grower was also able to post a net income for the season. The third grower/cooperator from Daviess County opened a roadside stand for sales on a busy highway in the area. He raised one acre of mixed vegetables including tomatoes, squash, eggplant, peppers, green beans, and cantaloupe. The spring wet weather kept him from transplanting most of his crop until late May. Despite the late planted crop and opening a roadside market for the first time, this grower/cooperator still managed to make a profit.

There were two grower/cooperators from Union County. One grower/cooperator was an experienced sweet corn grower, and wanted to try transplanting sweet corn on black plastic to determine if he could hit an early market. The grower tried a one-half acre by setting three-week old transplants grown in 200-cell trays the middle of April and was harvesting sweet corn the last week of June. This allowed him to hit an early market, and receive $3/doz for this early sweetcorn. This method of production looks to be profitable for early production or for any markets where $3/doz or more for sweet corn can be regularly achieved. The second Union County grower/cooperators were an experienced pumpkin growing family and wanted to try pumpkins on plastic. They raised one acre of pumpkins of many varieties and sizes for direct sales in the county. The plastic helped them with weed control, as well as gave them the ability to irrigate in a very hot and dry August. The grower/cooperators

Table 1. Costs and returns of seven commercial vegetable demonstration plots in northwestern Kentucky, 2006.

	Mixed Vegetables					Sweet Corn	Pumpkins
	Daviess County			*Webster County*	*Hancock County*	*Union County*	*Union County*
	1 ac	*0.5 ac*	*1 ac*	*1 ac*	*0.5 ac*	*0.5 ac*	*1 ac*
Inputs							
Plants/seed	$672	$178	$320	$550	$140	$80	$56
Fertilizer/lime	375	200	126	320	253	20	56
Plastic	197	99	197	197	99	99	197
Drip lines	150	75	150	150	75	75	150
Herbicide	100	33	17	49	49	50	67
Insecticide	175	35	74	114	122	15	37
Fungicide	300	65	165	231	276	0	82
Irrigation/ Water[1]	156	198	316	350	241	0	357
Field labor[2]	640	160	0	700	300	150	0
Machinery	45	23	59	47	26	125	50
Marketing	252	100	113	288	200	35	140
Total expenses	3062	1166	1537	2996	1780	649	1194
Income	5300	2700	2100	3800	5100	825	1498
Net income (loss)	2238	1534	563	804	3320	176	304
Net income (loss)/acre	2238	3068	563	804	6640	352	304
Dollar return/ Dollar input[3]	$1.73	$2.32	$1.37	$1.26	$2.87	$1.27	$1.25

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

were pleased with their first year's success, making a profit, and are excited to do the same method of production next fall.

Another grower/cooperator was in Webster County. This grower/cooperator opened a roadside stand and sold wholesale to local restaurants. He raised one acre of mixed vegetables including eggplant, tomatoes, squash, peppers, and okra. Despite a challenging wet spring that delayed transplanting until late May, he was still pleased with his profits and plans to expand production next season.

The last grower/cooperator was from Hancock County. He is a former tobacco producer and has been raising vegetables the past few years for wholesale markets and the Hancock County Farmers' Market. He had never used the plasticulture system before and was very pleased with the method of production. This grower also made a net income on the season raising a half-acre of tomatoes, squash, okra, and peppers.

All seven of the producers were very pleased with their method of production and marketing techniques. As always, they see ways to change things in the future, but they plan to continue raising vegetables in 2007.

On-Farm Commercial Vegetable Demonstrations in South-Central Kentucky with Observations on Low Tunnel Tomato Production

Nathan Howell, Department of Horticulture

Introduction

Three on-farm commercial vegetable demonstrations were conducted in south-central Kentucky together with an observation plot looking at the use SRM-Olive plastic mulch and poly low tunnels for early tomato production. Grower/cooperators for the demonstrations were located in Hardin, Logan, and Simpson counties. The cooperator in Hardin County had a demonstration plot of approximately 0.75 acre consisting of cantaloupe and watermelon; the majority of the crop was cantaloupe production. The cooperator marketed his produce at the Leitchfield Flea Market in Grayson County. The demonstration plot in Logan County was approximately 0.8 acre of watermelon production with a small percentage in cantaloupe production. The Logan County cooperator marketed his melons at the Fairview Produce Auction in Christian County. For both plots, Athena variety cantaloupe and the Crimson Sweet watermelon variety were used. The Simpson County demonstration plot consisted of approximately 0.6 acre of mixed vegetables including tomato, pepper, okra, zucchini, cucumber, and squash. The cooperator marketed his product through his established greenhouse and retail landscape business in Simpson County.

The low tunnel tomato production observation plot was located in Warren County and consisted of approximately 600 feet of split-vented high-density poly tunnels on SRM-Olive plastic mulch or on traditional black plastic mulch. Irrigation water was also heated with an outside wood furnace in the observation plot. The cooperator in Warren County marketed his tomatoes through the Southern Regional Farmers' Market in Bowling Green, Kentucky.

Materials and Methods

Grower/cooperators were provided with production supplies such as black plastic mulch, drip irrigation lines, blue layflat tubing, and fertilizer injectors. Grower/cooperators were also able to use the University of Kentucky Horticulture Department's equipment for raised-bed preparation and transplanting. The cooperator participating in the low tunnel tomato observation plot was provided split row cover and the SRM-Olive plastic mulch.

Field preparation was followed by fertilizer applications according to soil test results and recommendations provided by the University of Kentucky. Plastic for the demonstrations was laid in March and April, several weeks before transplanting. The plastic mulch for the observation plot was laid in February, and broiler litter was applied as organic manure under the mulch. Only one additional mid-season spray of an organic Neptune's Harvest product was used for fertilizer on the observation plot. The plastic on all the plots was laid in rows with irrigation runs no longer than 400 feet. A city water source was used for irrigation on the plots in Hardin, Simpson, and Warren counties, while the Logan County plot used well water.

To aid weed control, ryegrass was sown between the plastic mulch middles at a rate of 70 to 90 pounds per acre. Approximately one week before the ryegrass reached the heading stage of development, it was sprayed with Poast 1.5 E at a rate of 2 pints per acre; additional spot treatment with Roundup was needed in some areas.

The grower/cooperators in Hardin and Logan counties had local greenhouse managers grow their transplants, while the grower/cooperators in Simpson and Warren counties produced their own transplants. Demonstrations were set from 10 May to 27 May; most transplants were four weeks old. The mixed vegetable plot used spacing of 12 to 24 inches in both single and double row, depending on the transplant type. The bed rows were 6 feet from center to center. The melon demonstrations were placed on 24-inch single row for the cantaloupe and 36-inch single row for the watermelon; both plots had 6 feet between bed centers. The low tunnel tomato observation plot was set 7 March; a SRM-Olive mulch and black plastic mulch were used; approximately 300 feet of each mulch was used in the observation plot. The grower/cooperator used gallon size and a 21-count cell size for transplants; both cell sizes were transplanted on 18-inch, single row spacing with 6 feet between bed centers. The plants were immediately covered with the split poly tunnel for frost protection.

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; later control was achieved by alternating insecticides on a weekly basis until harvest. Three weeks after transplanting, Bravo WeatherStik, Mancozeb, and Quadris were applied on the demonstration plots on an alternating weekly schedule for disease control. The University of Kentucky's recommendations from *Vegetable Production Guide for Commercial Growers* (ID-36) were used for insecticides and fungicides. The grower/cooperator for the low tunnel tomato production used organic production practices; therefore, organically approved sprays and insecticidal soaps were used. Plants were irrigated/fertigated weekly using 5 to 7 pounds actual nitrogen per week for the demonstration plots, while the observation plot was fertigated with all natural organic fertilizers. Harvest for the observation tomato plot began in early June; however, the first ripe tomatoes were harvested 26 May. The demonstration plots were harvested from the first of July and were completed by September.

Results and Discussion

The 2006 season was mostly a normal production season; however, cooler temperatures during early production did slow growth on newly transplanted fields. The grower/cooperator in Hardin County experienced a week of wet weather during the harvest of his second setting of cantaloupe and thus had some fruit loss during harvest due to fruit decay and disease in the field.

Weed control with ryegrass. This was the fourth season for vegetable growers in south-central Kentucky to use annual ryegrass for a weed control. This season the ryegrass method of weed control worked very well in crops that vine; however, it seemed more spot spraying was needed in crops like the tomatoes. Caution should also be taken in using ryegrass in watermelon production; some fruit discoloration was noticed on the larger varieties. If timely spraying of the grass is allowed, such a problem would not be an issue. The ryegrass must be sprayed at least a week before head development. The higher rate of Poast 1.5 E should be used in this situation also. The discoloration has not been an issue of concern in cantaloupe production nor in vegetables that do not come in contact with the ryegrass.

SRM-Olive Plastic Mulch. SRM-Olive plastic mulch is a hybrid between clear and black plastic mulches. The olive mulch transmits near infra-red radiation and blocks photosynthetic active radiation (PAR). Therefore, it simultaneously generates almost as much heat as the clear mulch and suppresses weeds like black mulch. The SRM-Olive mulch was 0.7 mil embossed and did provide excellent weed control. Soil temperatures of 6 to 7° F warmer than the black plastic mulch soil were recorded. Because of this difference, harvest was four to five days earlier, and total volume of harvest was higher on the olive-colored plastic mulch, justifying the 2.3 cents per foot increase in expense over the black plastic mulch.

Low tunnel production of early tomatoes. A newer high-density poly tunnel of 0.5 mil plastic proved to be a comparable alternative to the older 1.1 mil low-density poly and even at a cheaper cost of 7.4 cents per foot. The poly tunnel provided frost protection to about 28°F; however, the third night after transplanting, temperatures fell below 26°F, and frost damage was noticed on the transplants. The grower/cooperator decided to cover the low tunnels with a floating row cover canvas for extra protection. The canvas was removed mid-April. The poly tunnel covers also had splits in the sides for ventilation. These allowed the grower/cooperator to avoid removing the cover each warm day. In observing the transplants, it appeared that gallon size transplants did best in the tunnel system.

One of the downfalls of such a system was the amount of labor required to place the low tunnel over the plastic mulch. In this observation plot, the edges were covered with soil. However, reports of staking the edges have indicated success with less labor required. Because the tunnels were not removed until the first of May, it was impossible to stake the tomatoes, which hurt quality and yields.

Overall, it was a very productive and profitable year for demonstrators. All the grower/cooperators are planning to continue their efforts and expand upon the knowledge gained in the 2006 demonstration plots. The low tunnel tomato grower/cooperator was pleased with the results. He was able to more than justify the extra labor and 29 cents per foot production cost for the low tunnel, SRM-Olive mulch, drip tape, and wires for tunnel supports by marketing his early tomatoes at $2 per pound throughout June. The grower/cooperator is planning to continue with his low tunnel production and knowledge gained from the 2006 observation plot.

The cooperator's cost and returns are listed in Table 1.

Table 1. Costs and returns from on-farm demonstrations of mixed vegetable, cantaloupe, and watermelon crops in Hardin, Logan, and Simpson counties, 2006.

	Cantaloupe	Watermelon	Mixed Vegetables
	Hardin County 0.75 ac	*Logan County 0.8 ac*	*Simpson County 0.6 ac*
Inputs			
Plants/Seeds	$225	$230	$124
Fertilizer/Lime	158	61	66
Black plastic	90	110	92
Drip line	75	75	71
Tomato stakes, pea fence, etc.	0	0	344
Herbicides	38	35	45
Insecticides	115	78	85
Fungicides	130	56	36
Pollination	free	free	none
Machine[1]	125	255	75
Irrigation/Water[2]	150	90	355
Labor[3]	20	30	550
Market fees	15	115	20
Total expenses	1141	1135	1863
Income—retail	3560	2985	2652
Net income	2419	1850	789
Net income per acre	3225	2313	1315
Dollar return/Dollar input	3.12	2.63	1.42

[1] Machine rental, fuel and lube, repairs, and depreciation.
[2] Three-year amortization of irrigation system plus city water cost where applied.
[3] Does not include unpaid family labor.

On-Farm Commercial Vegetable Demonstrations in Southeastern Kentucky

Bonnie Sigmon, Department of Horticulture

Introduction

Two on-farm commercial vegetable demonstrations were conducted in southeastern Kentucky. Grower/cooperators were located in Clay County. One cooperator grew one acre of early sweet corn using plasticulture and marketed through the Clay County Farmers' Market. The other cooperator grew one acre of mixed vegetables using plasticulture and organic methods. The vegetables were marketed through consumer-supported agriculture (CSA). Cooperators were supplied the plastic and irrigation supplies for their demonstrations as well as the usage of the plastic mulch layer and waterwheel transplanter. The grower/cooperators were visited on a weekly basis to address any production problems that developed.

Materials and Methods

Sweet corn. Soil testing was conducted, and the recommended fertilizer was applied in early spring. An acre of plastic alternating from black and translucent green along with trickle irrigation was laid on 28 March. The sweet corn was also seeded in the greenhouse about the same time. The four sweet corn varieties were bicolor and sh2 with maturity dates from 74 to 80 days. The corn was transplanted on 15 April using a waterwheel transplanter with a special wheel made for sweet corn. One row of plastic had four rows of sweet corn with the rows 8 in. apart and plants 4 in. apart in the row. The plant count for 7,500 feet of plastic is approximately 22,500. Preplant fertilizer and zinc were applied through the transplant water at recommended rates. Nitrogen was applied through the drip irrigation weekly at a rate of 7 lb per application. Pesticides were applied as needed for insect and disease control. Plastic row covers and hoops were purchased and on standby, but thanks to the unusually warm spring temperatures, they were not necessary.

Mixed vegetables. The mixed vegetable demonstration used a field that had been left fallow for two years. The soil test determined the soil fertility levels to be adequate. Soybean meal was applied preplant at a rate of 1,000 lb per acre for an organic nitrogen source. On 18 April, 7,500 feet of black plastic and trickle irrigation were laid with rows spaced 6 feet apart. The space between the rows of plastic was seeded with rye grass at a rate of 75 lb/A and was mowed as needed for weed control. Thirty different vegetables, with multiple varieties of each, were planted on the black plastic throughout the growing season so as to have a steady diverse supply of fresh produce available for CSA members.

Results and Discussion

The 2006 growing season had unusually warm spring temperatures with the average minimum temperature of 47° in London for March. This enabled vegetable producers to begin production a little earlier than normal with minimal risk of frost damage. Precipitation for the growing season was drier than normal but not considered drought conditions.

Sweet corn. The early sweet corn demonstration was impressive, with the first sweet corn being harvested on19 June. This is at least three weeks ahead of traditional sweet corn production, which allowed the cooperator to market the product at a premium price. The four varieties all produced well when compared to each other and on the different plastic colors.

The weed control under the translucent green plastic was poorer than the black, with weeds growing under the plastic and around the base of the corn plant near the end of production.

Bird damage became a major problem during harvest and affected yield and quality. A taste aversion product made from Concord grapes was applied with good bird control for the first three days. On the fourth day, the birds seemed not to be affected. A five-day preharvest interval interferes with harvesting. Despite the bird problem, the cooperator was very happy with the demonstration and plans to plant early sweet corn on black plastic again next year. The grower intends to purchase a propane bird cannon to help with bird control. The grower's cost and returns are listed in Table 1.

CSA mixed vegetables. The CSA organically grown demonstration plot was a new experience for the cooperator and for the author. The CSA had 20 members, with each member receiving a bushel of produce weekly. The CSA delivered a full 16 weeks of fresh organically grown produce to its members. The CSA members were mainly from the Lexington area. The cooperator grows on the family farm where they spend their weekends. The ryegrass grown in between the rows of plastic was very helpful in that the cooperator could still work and harvest the vegetables in very wet conditions. Insect and fertility problems were the

Table 1. Costs and returns of two 1-acre commercial vegetable demonstration plots conducted in Clay County, Ky., in 2006.

Inputs	Sweet Corn	CSA Mixed Vegetables
Transplants /seeds[1]	$123	$537
Fertilizer	155	619
Fertilizer Injector	0	13
Black plastic/Dripline	372	354
Pesticides	95	44
Irrigation supplies[2]	215	465
Stakes and twine	0	39
Market fees/Advertising	25	168
Labor[3]	0	0
Machinery[4]	368	410
Total expenses	1,353	3,059
Yield	500 doz	335 bu.
Income—retail	$3/doz.	$70/4bus.
Income @	$1,500	$5,853
Net income	$147	$2,794
Net income per acre	$147	$2,794
Dollar return/Dollar input	$0.11	$0.91

1 Transplants produced by grower.
2 Five-year amortization on irrigation system plus water cost.
3 Does not include grower's labor.
4 Machinery depreciation, fuel, lube, and repair.

most limiting factors in the demonstration plot. Organically approved fertilizers and pesticides were applied only as a last resort and at labeled rates. The cooperator stated that his main goal for this year was to see if he could handle the actual production part of a CSA and have a variety of vegetables available for harvest each week. He is now convinced that this is possible. The CSA currently has a list of 16 additional families awaiting membership. The cooperator is extremely happy with the CSA model of marketing and the use of plasticulture in production. The cooperator is planning to continue the CSA next year with a short-term goal of decreasing the off-farm input and moving toward the farm's self sustainability. The grower's cost and returns are listed in Table 1.

On-Farm Commercial Vegetable Demonstrations

Dave Spalding and Brent Rowell, Department of Horticulture

Introduction

Eight on-farm commercial vegetable demonstrations were conducted in Central and South Central Kentucky in 2006. Grower/cooperators were from Bracken, Fayette, Gallatin, Marion, and Taylor counties. There were four grower/cooperators producing specialty hot peppers for a hot sauce processed in Bracken County. The grower/cooperators in Fayette and Marion counties each grew about one acre of mixed vegetables, while the grower/cooperator in Taylor County grew about two acres of mixed vegetables (tomatoes, peppers, squash, green beans, melons, and sweet corn) for on-farm markets and the local farmers' market. The grower/cooperator in Gallatin County grew about five acres of mixed vegetables with an emphasis on summer squash (yellow and zucchini) for the wholesale and local farmers' market.

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 from each plot and scheduled, promoted, and coordinated field days at each site. An Extension Associate made regular weekly visits to each plot to scout the crop and make appropriate recommendations.

There were four specialty hot pepper demonstration plots of approximately one half-acre each. Three of the plots were planted with a combination of Habanero, hot banana, and cayenne peppers. The fourth plot was planted with red and orange Habanero peppers. The 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 with drip lines under the plastic in the center of the beds. The beds were planted at the appropriate spacing for the type of vegetable being grown (e.g., 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/cooperators in Fayette and Taylor counties and three of the grower/cooperators in Bracken County sowed annual ryegrass in the middles soon after laying the plastic and drip lines in mid- and late April. The ryegrass was sown at the rate of 75 pounds per acre.

Results and Discussion

A wet and cold period early in the growing season affected all the crops but appeared to be particularly detrimental to early tomato production in the whole area. Most of the growing area had normal to above-normal rainfall during most of the growing season with no significantly hot or dry conditions for any extended period. Producers generally were able to get the crops transplanted in a timely manner, and most had good growing conditions for the season.

For those grower/cooperators who sowed annual ryegrass in the middles, weeds were not a big problem, although keeping the middles mowed posed some challenges. The grower/cooperator in Taylor County killed the ryegrass with an herbicide (Roundup) and experienced some crop damage, probably associated with the use of the generic version of the herbicide. The generic version seems to volatilize and drift, particularly in hot weather. The damage that occurred was mostly confined to tomato plants and was particularly devastating on some varieties. The same problem with generic versions of Roundup herbicide has been observed in other parts of the state the past couple of years and seems mostly to affect tomatoes. Despite the damage, the grower/cooperator still had a profitable year due to the variety of produce grown (Table 1). The grower/cooperator in Marion County tried on-farm marketing for the first time and was very pleased with the results (Table 1). From what was learned this year, they believe that they can improve in coming years. The grower/cooperator in Fayette County marketed all of the production through the Community Supported Agriculture (CSA) program of weekly baskets for participating members. Both grower/cooperators were very pleased with the results and intend to expand the program in coming years (Table 1). The grower/cooperator in Gallatin County grew summer squash (yellow and zucchini) for a wholesale market and a variety of vegetables for local farmers' markets. The wholesale market was not as profitable as hoped because the squash were not suitable for that market. It appeared that the primary problem was the varieties that were grown; more than 60 percent of the product harvested was not marketable through the wholesale outlet. The grower/cooperator was very impressed with this year's production and intends to increase production with more suitable varieties in the future.

The Bracken County grower/cooperators each grew about one half-acre of specialty hot peppers for use in a hot sauce production project (Fire on the Ridge) that was funded in part by the Kentucky Agricultural Development Board. As part of that project, the local processor contracted with local growers to grow and deliver Habanero, hot banana, and cayenne peppers. The transplants were grown locally, and the wet, cool, and cloudy weather in early May delayed transplanting by a couple of weeks. Overall, the delay did not materially affect the outcome because the processor had as much product as could be handled this year (Table 2). The grower/cooperators and the processor were pleased with the initial production. Growers intend to make future adjustments, such as lowering the raised beds to allow mowing of weeds near the plastic edge without tearing the plastic.

Table 1. Mixed vegetable costs and returns of grower/cooperators.

Inputs	*Marion County 1 ac*	*Taylor County 2 ac*	*Fayette County 1 ac*	*Gallatin County 5 ac*
Plants and seeds	625	1,175	1,274	1,550
Fertilizer	110	225	272	825
Black plastic	120	240	120	600
Drip lines	165	330	165	825
Fertilizer injector	65[1]	65[1]	65[1]	65[1]
Herbicide	25	227.50	40	75
Insecticide	50	125	51.06	360
Fungicide	24	160	100	500
Water	180[2] (180,000 gal)	420[2] (280,000 gal)	2,285[2] (160,000 gal)	1,890[2] (540,000 gal)
Labor	0[3] (310 hrs)	3,200[3] (500 hrs)	2,428[3] (450 hrs)	352[3] (864 hrs)
Machine	63 (8.5 hrs)	130 (17.5hrs)	121.50 (16.5hrs)	285.25 (38.5hrs)
Marketing			1,368	2,720
Total expenses	1,428	6,298	8,290	10,047
Income	4,530	11,500	10,646	11,536
Net income	3,102	5,202	2,356	1,489
Net income/acre	3,102	2,601	2,356	298
Dollar return/Dollar input	3.2	1.8	1.3	1.15

[1] Cost amortized over three years.
[2] Includes cost of water and five-year amortization of irrigation system.
[3] Does not include unpaid family labor.

Table 2. Bracken County hot pepper grower/cooperator cost and returns.

Inputs	**Hot Banana Cayenne Habanero**	**Hot Banana Cayenne Habanero**	**Hot Banana Cayenne Habanero**	**Habanero**
Plants and seeds	410	410	410	410
Fertilizer	48	40	246	172
Black plastic	65	65	65	65
Drip lines	90	90	90	90
Fertilizer injector	65[1]	65[1]	65[1]	65[1]
Herbicide	40	-------	40	40
Insecticide	-------	-------	------	-------
Fungicide	-------	-------	------	-------
Water	110[2] (20,000 gal)	445[2] (110,000 gal)	760[2] (125,000 gal)	225[2] (65,000 gal)
Labor	660[3] (120 hrs)	1,150[3] (192 hrs)	2,464[3] (216 hrs)	882 (102 hrs)
Machine	89 (12 hrs)	126 (17 hrs)	192 (26 hrs)	63 (8.5 hrs)
Marketing	40	50	65	------
Total expenses	1,617	2,441	4,397	2,012
Income	1,333	3,212	6,332	1,335
Net income	(284)	772	1,935	(677)
Net income/acre	(567)	1,543	3,871	(1,354)
Dollar return/ Dollar input	0.8	1.3	1.45	0.66

[1] Cost amortized over three years.
[2] Includes cost of water and five-year amortization of irrigation system.
[3] Does not include unpaid family labor.

Regional Wine Grape Marketing and Price Outlook for 2006

Tim Woods and Jim Mansfield, Department of Agricultural Economics

Introduction

Wine grape acreage in Kentucky has expanded significantly since 2000 and is currently estimated at around 580 acres. As plantings mature, more acres are beginning to bear fruit. Approximately 410 acres of wine grapes are expected to be harvested in Kentucky in 2006. The survey, the second conducted by the University of Kentucky New Crop Opportunities Center, indicates that wine production capacity in the surveyed states will continue to increase, with 62% of the respondents indicating some degree of capital improvements planned for 2006 and 59% expecting to increase their wine production over 2005 (Table 1). This increase is uniformly noted among the wineries surveyed, regardless of location or winery size. The largest number of wineries reported an expectation to make major capital improvements to expand capacity.

While this increase in capacity and production could create market opportunities for grape growers in the region, the survey report cautions that significant grape plantings in the Midwest could create a future market glut for some wine grape varieties.

One of the challenges grape producers face is finding price information for their crop. To determine regional prices for wine grapes, a survey was mailed to 331 wineries in Illinois, Indiana, Kentucky, Missouri, Ohio, Tennessee, and Virginia during the summer of 2006. The survey included questions concerning business practices, production plans, and prices paid for wine grapes in 2005.

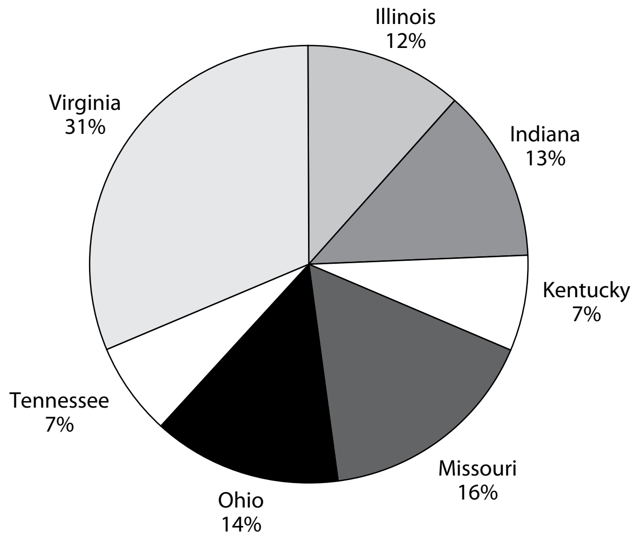
Survey Procedure and Demographics

Winery addresses were obtained from state winery association lists, and surveys were mailed to 331 wineries in June 2006. A second mailing followed three weeks later in early July. Eighty-six usable surveys were returned for a 26% response rate. The proportion of survey respondents by state is shown in Figure 1.

Winery size. The size of the wineries surveyed was well distributed but with slightly more midsize wineries responding. Twenty-seven percent of the wineries surveyed produced less than 1,000 cases of wine in 2005 (21), 44 percent produced between 1,000 and 2,999 cases of wine (35), and 29 percent of the wineries produced 3,000 or more cases of wine (30).

Grape purchasing. Almost three-quarters (71%) of respondents indicated that they purchased wine grapes in 2005. Less than half (44%) of the wineries said that they made 100% of their grape purchases from in-state growers. This is a somewhat lower result than found in the 2003 survey where more than half (51%) of the wineries purchased 100% in-state grapes. However, both the 2003 and 2006 surveys found 74% of the wineries purchased 50% or more of their grapes from in-state growers. The conclusion indicates wineries are purchasing more grapes from out-of-state sources, while still purchasing the majority of their grapes from in-state sources. This may be an indication that the wine grape market is getting more competitive both in terms of price and availability.

Figure 1. Survey respondents by state (86 responses).



Winery and Grower Business Relations

Winery owners tend to work closely with their growers, particularly in sharing viticultural expertise and assisting with variety selection. General sharing of industry information, marketing, and production information is also fairly common. There is less direct winery involvement in the capital and business aspects of the grower's business. Such close interactions are characteristic of the wine industry, reflecting the high level of investment, the long-term nature of the business, and the sensitivity to quality by all involved. A summary of winery and grower business interaction is presented in Table 2.

Winery Marketing Approaches

Most of the wineries in the region use a tasting room and have on-premises retail sales (Table 3). While the list of strategies is by no means comprehensive, the responses to alternative strategies suggest that wholesaling and off-premises selling are much less common. Most of the marketing focus is on direct sales. Few of the wineries are of adequate size to be significantly focused on wholesale markets or extensive distribution. Still, based on the widespread indication that they will be expanding

Table 1. Production outlook.

Capital/Capacity Improvements	Small Wineries No.	Small Wineries %	Larger Wineries No.	Larger Wineries %	2006 Production Changes	Small Wineries No.	Small Wineries %	Larger Wineries No.	Larger Wineries %
None planned	21	38%	8	36%	Decrease	2	4%	2	9%
Minor (< 5%)	13	23%	5	23%	Same	17	30%	7	31%
Major (> 5%)	22	39%	9	41%	Increase	37	66%	13	59%

Note: Smaller wineries were those producing less than 3,000 cases. Seven additional wineries responded but did not report volume.

facilities, capacity, and production, the wineries generally seem to be enjoying profitable and growing opportunities in the markets they are targeting.

Price Report

Grape price ranges, as well as median and average prices paid, are reported in Table 4. The most frequent price range reported for each variety is also noted where applicable. Wineries surveyed expect most grape prices to remain steady at 2005 price levels during the 2006 season.

Price increases for Cabernet Sauvignon, Merlot, and Riesling were expected by more than 20% of wineries purchasing these varieties. The most common varieties purchased by the wineries responding to this survey were Chambourcin and Vidal Blanc. There was a strong overall demand reported for vinifera varieties in all states except Missouri.

Prices by State

The price ranges for varieties reported by 14 or more wineries are listed by state in Table 5. These varieties are also those most frequently reported as being purchased in Kentucky (except for Cabernet Franc with only one reported Kentucky purchase). The prices reported by the wineries in this survey suggest that Kentucky and Tennessee wine grape prices are within the range of wine grape prices in the surrounding states. If anything, Kentucky/Tennessee prices are on the high end of the price ranges. Kentucky and Tennessee are grouped together because their climate and terrain are similar, and there are fewer wineries in these states.

In-State vs Out-of-State Purchases. Unlike the 2004 survey where no significant differences were found between purchasers who bought 50% or more of their grapes from in-state sources versus wineries that purchased less than 50% of their grapes in-state, the 2006 survey found significant differences in some varieties. The 58 wineries that purchased 50% or more of their grapes in-state on average paid 62% more for Concord and

Table 2. Winery and grower business interactions.

Business Activity	Not Practical	Sometimes	Often
Share viticulture expertise	21%	31%	48%
Assist with variety selection	37%	31%	31%
Internet or e-mail exchange	26%	47%	27%
Formal discussions about wine industry trends	34%	43%	23%
Share retail demand information	42%	35%	28%
Assist with site selection	55%	33%	11%
Assist with operating loans	90%	6%	4%
Assist with financing long-term capital improvements	91%	6%	3%

Table 3. Marketing approaches in wineries.

Marketing Activity	Not Practical	Sometimes	Often
Tasting room	7%	6%	87%
On-premise retail	5%	16%	79%
Wholesale	16%	51%	33%
Enter wines in regional/national wine-tasting contests	17%	52%	30%
Direct mail promotions	37%	35%	28%
Off-premise retail	26%	47%	27%
Sponsored dinner functions	27%	49%	24%

Table 4. Price paid per ton in 2005 (by variety; 86 wineries surveyed in Illinois, Indiana, Kentucky, Ohio, Missouri, Tennessee, Virginia).

	Number Responding	Min. Price	Max. Price	Median Price	Average Price	Most Frequent Range Reported ($) Per Pound	Per Ton
American							
Concord	23	215	800	425	462	0.15-0.30	300-600
Niagara	14	235	1000	480	523	0.18-0.40	350-800
Norton/Cynthiana	19	300	1500	1000	1024	0.45-0.50	900-1000
Hybrid							
Cayuga White	20	450	1000	650	709	0.30-0.45	600-900
Chambourcin	31	450	1300	900	898	0.40-0.50	800-1000
Chardonel	19	600	1200	925	901	0.40-0.50	800-1000
Traminette	21	700	1300	1000	1040	0.45-0.60	900-1200
Seyval	18	450	1200	850	808	0.30-0.45	600-900
Vidal Blanc	34	475	1200	900	866	0.30-0.50	600-1000
Vignoles	14	610	1500	1025	1027	0.45-0.60	900-1200
Vinifera							
Cabernet Franc	28	875	2500	1475	1509	0.65-0.90	1300-1800
Cabernet Sauvignon	29	850	2500	1500	1541	0.65-0.90	1300-1800
Chardonnay	30	780	2200	1425	1439	0.65-0.90	1300-1800

Prices for varieties reported by 10 or fewer wineries *(price range per ton and comments):*
Catawba $400 - $700; most $500-$600
Merlot $1,000-$2,100; no price trend identified, median = $1,500
Riesling $1,100-$1,700; no price trend identified, median = $1,300
Viognier $1,400-$2,000, most $1,800
Foch $375-$1,200, most $575 - $750

Table 5. Price range paid ($/ton) by state for seven most frequently reported wine grape varieties in 2005 (by variety; 86 wineries surveyed in Illinois, Indiana, Kentucky, Ohio, Missouri, Tennessee, Virginia).

	Illinois	Indiana	Kentucky/ Tennessee[1]	Missouri	Ohio	Virginia
Concord	290-600	300-800	300-750	360-455	215-650	600-700
Chambourcin	800-1200	650-950	950-1250	600-1050	450-900	700-1300
Cayuga White	600-900	500-850	500-1000	600-1000	450-690	---
Vidal Blanc	800-900	550-900	719-1000	700-1000	475-720	750-1200
Cabernet Franc	1300	1700	1400-1900	1400	875-1890	900-2500
Cabernet Sauvignon	900-950	850-2100	1200-2000	1400	1400-2000	900-2500
Chardonnay	1000-1800	1000-2000	1200-1800	2000	780-1800	1000-2200
Chardonel	600-1200	800-1000	1000	800-1000	690	---

[1] Kentucky and Tennessee are grouped together because their climate and terrain are similar.

90% more for Niagara than the 19 wineries that purchased 50% or more of their grapes out of state. One potential explanation for these differences is that the smaller wineries are willing to pay more for local in-state grapes due to constraints of smaller amounts needed and therefore less bargaining power and higher transportation costs. Another explanation is that American wine grape varieties were available much cheaper from large out-of-state production areas such as southwest Michigan.

Conclusion

This price survey supplies grape growers and buyers in the region with a sample of common prices paid for wine grapes. The results indicate that wine grape prices will hold steady at 2005 levels, while wine production in the states surveyed (Illinois, Indiana, Kentucky, Missouri, Ohio, Tennessee, Virginia) will increase in 2006. Prices are predicted to remain stable for Kentucky-grown wine grapes based on several factors, including a fairly modest Kentucky acreage, a rapid increase in the number of wineries in Kentucky, and this survey's results showing winery expansion plans and evidence that competitive prices are being paid for Kentucky- and Tennessee-grown grapes.

For further information, see Timothy Woods, "2006 Regional Winegrape Price Survey," *Wine East*, pp. 26-30 September-October, 2006.

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Effects of Pruning and Cluster Thinning on Canopy Microclimate, Yield, and Fruit Composition of Vidal Blanc Grapevines

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Introduction

Vidal Blanc is of economic importance to Kentucky and the lower Midwest, comprising 25% of Kentucky's vineyard acreage. Vidal Blanc is a cross between *V. vinifera* × *V. riparia* and is classified as a vigorous vine. It has the propensity to overcrop due to high cluster numbers and many fruitful secondary shoots. This study is designed to investigate the ability of Vidal Blanc to ripen a commercial crop without adversely affecting yield, fruit composition, winterhardiness, and bud fruitfulness under the long, warm growing seasons typical of the lower Midwest. More specifically, the study will investigate the effects of balanced cropping (pruning plus cluster thinning) on canopy microclimate, yield components, and fruit composition and ultimately identify the optimal cropping window for Vidal Blanc.

Materials and Methods

Plant material, site, and experimental setup. This study was conducted in 2006 at a commercial vineyard located in Central Kentucky. Vines were planted in 2001 at 545 vines/acre with own-rooted Vidal Blanc grapevines at an 8 x 13 ft (vine x row) spacing. Vines were spur-pruned and trained to a 6 ft high bilateral cordon in a north-south facing arrangement. Nitrogen was applied annually at 60 lb/acre, and vines were not irrigated. Experimental setup consisted of a 3 x 3 factorial arrangement in a completely randomized block design with four vines per replication and three vines designated as an experimental unit.

Pruning treatments. Canes from 2005 were pruned to five nodes with an upper limit of 65 nodes per vine. Dormant prunings were weighed (Table 1), and final nodes-per-vine counts were determined by dormant pruning weights and pruning severity level. Buds retained at these nodes are referred to as count-buds versus non-count buds (buds at the bases of the canes, known as basal buds). Three levels of pruning severity were applied at (20+10), (30+10), and (40+10). These levels refer to number of buds retained per initial pound of dormant prunings, plus number of buds retained for each additional pound of prunings (e.g., 20 buds retained on the vine for the initial pound of prunings and 10 more buds for each additional pound of prunings).

Cluster thinning treatments. In 2006, three cluster thinning severity levels were applied two to three weeks post bloom (1/8-inch diameter berry size). Cluster thinning treatments were then adjusted after fruit set at Eichorn-Lorenz scale 31, where one cluster per shoot (thinned to basal cluster), two clusters per shoot, and two or more clusters per shoot were retained.

Non-count and count shoots. At bud burst, the total shoots per vine were measured by the addition of count shoots (borne from buds > 5 mm distal to the base of the cane) and non-count shoots (< 5 mm distal to the base of the cane). In order to decrease intra-vine shading, vines were vertically positioned downward every 14 days after tendrils were touch sensitive.

Canopy microclimate. The total leaf area of one shoot and its lateral shoots was measured from one vine of each replicate. One count-shoot was harvested 10 weeks post bloom and placed in a sealed plastic bag and kept in storage until measured. Shoots were then separated into main shoots and lateral shoots. Individual leaf areas were measured using a LI-3000 leaf area meter (Li-Cor Inc., Lincoln, NE). The number of leaves measured from the main shoot and lateral shoots were counted. The total leaf area for each shoot was calculated by adding the areas for the main and lateral shoots. The total canopy leaf area was calculated by multiplying the total shoot number for that treatment replicate by the total leaf area per shoot. The leaf area:fruit (cm^2) was calculated by dividing the canopy leaf area by the crop weight collected from that single treatment replicate. Calculations for percent light interception, leafiness index, shoots per acre, distance between shoots, and leaf layer number can be found in methods of Smart (1985).

Yield components and fruit composition. Fruit yield and cluster numbers for all treatments were measured on a single treatment replicate (each experimental unit), and all treatments were harvested on the same date. Random 100-berry samples were collected from each treatment-replicate, placed in polyethylene bags, stored on ice, and analyzed within 24 hours. Before analysis, the 100-berry samples were weighed, and average sizes were determined. The samples were then crushed by hand, and the juice was placed in 250mL beakers. A 5ml portion of each sample was used to determine the percent total soluble solids (TSS), using a digital refractometer (Spec Scientific Ltd., Scottsdale, AZ). The juice pH was determined with a glass electrode and a pH meter (model AR15; Fisher Scientific, Pittsburgh, PA). The titratable acidity (TA) of each sample was determined by titrating to pH 8.2 with 0.1 N sodium hydroxide and expressed as grams per liter of tartaric acid.

Statistical analysis. Standard, completely randomized design analysis of variance analyses were performed using the Type III tests of fixed effects with the MIXED procedure of SAS (v.8.1) (SAS Institute Inc., Cary, NC) after all the assumptions for ANOVA had been met. Treatment means were then tested for polynomial trends across treatment levels using GLM procedure of SAS.

Results and Discussion

Effect of pruning formula on nodes per vine and shoot numbers. Pruning treatments applied in 2006 affected the number of count nodes per vine (Table 1). The number of count nodes increased linearly, as the severity of pruning treatment decreased, where the 20+10 treatment had 27%, and 30+10 had 10% less nodes retained than the 40+10 pruning treatments, respectively. Number of non-count nodes and count shoots borne were not influenced in 2006. Number of non-count shoots per vine fit a quadratic trend where 20+10 and 40+10 treatments had 7% less non-count shoots borne (Table 1). Pruning treatments did not affect the ratio of count shoots and non-count shoots per vine in 2006.

Table 1. Vine size, node counts, shoot counts, and ratio of shoots for Vidal Blanc in 2006.[1]

Pruning Formula[2]	Vine Size per m of Row[3]	No. Count Nodes per Vine	No. Non-Count Nodes per Vine	No. Count Shoots per Vine	No. Non-Count Shoots per Vine	Ratio of Count Shoots per Vine[4]	Ratio of Non-Count Shoots per Vine[5]
20+10	0.456	35c	16	40	24 b	69.92	37.08
30+10	0.433	43b	18	41	29 a	59.26	40.74
40+10	0.456	48a	18	42	27 ab	61.09	38.91
P<	-	0.0001	0.2106	0.6855	0.0212	0.1033	0.1033
Trend[6]							
Linear	-	0.0001	0.0963	0.3736	0.1063	0.3243	0.3243
Quadratic	-	0.0836	0.5309	0.8900	0.0426	0.0920	0.0920
Cluster Thinning[7]							
1 cluster·shoot^{-1}	0.452	42	17	41	26	61.51	38.49
2 cluster·shoot^{-1}	0.531	42	17	41	27	61.11	38.89
2+ cluster·shoot^{-1}	0.470	42	18	41	27	60.65	39.53
P<	-	-	-	-	-	-	-
Trend							
Linear	-	-	-	-	-	-	-
Quadratic	-	-	-	-	-	-	-
Pruning x Thinning	-	-	-	-	-	-	-

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns are not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 Vine size per meter of row = Dormant pruning weight (lb) per length of canopy (meters) measured during treatment application in 2006 in response to 2005 growing season.
4 Ratio of count shoots = [Number of count shoots per vine /(Number of count shoots per vine + number of non-count shoots per vine) x 100].
5 Ratio of non–count shoots = [Number of non-count shoots per vine/(Number of count shoots per vine + Number of non-count shoots per vine) x 100].
6 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
7 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.

Table 2. Effect of pruning formula and cluster thinning on canopy microclimate in Vidal Blanc in 2006.[1]

Pruning Formula[2]	K[3]	Leaf Area per Vine (sq ft)[4]	γ [5] (cm^2/cm)	Shoots per Acre[6]	Distance between Shoots (cm)[7]	Leaf Layer Number[8]
20+10	71.04	268.02	20.75	177,741b	3.49a	5.168
30+10	67.08	250.80	22.78	193,205a	3.22b	6.148
40+10	67.74	241.11	21.31	189,819ab	3.27ab	5.685
P<	0.4242	0.8228	0.6976	0.0578	0.0444	0.3084
Trend[9]						
Linear	0.3184	0.7754	0.8158	0.0655	0.0517	0.4203
Quadratic	0.4200	0.5776	0.4050	0.0954	0.0823	0.1978
Cluster Thinning[10]						
1 cluster·shoot^{-1}	72.83	268.02	21.50	185,437	3.35	5.546
2 cluster·shoot^{-1}	67.49	275.55	21.51	188,201	3.32	5.699
2+ cluster·shoot^{-1}	65.54	257.26	21.83	187,127	3.32	5.757
P<	0.0779	0.9341	0.9879	0.9113	0.9473	0.9412
Trend						
Linear	0.0910	0.8893	0.9948	0.6923	0.7913	0.8171
Quadratic	0.0917	0.7355	0.8754	0.9598	0.8842	0.8139
Pruning x Thinning	0.7557	0.2817	0.9879	0.9113	0.3540	0.1804

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 k = Percent light intercepted [(PPFD intercepted in fruit zone/PPFD ambient) x 100] measured at 10 weeks post bloom.
4 Leaf area per vine = leaf area per shoot x number of shoots per vine.
5 Gamma = Leafiness index: leaf area per shoot/shoot length.
6 Shoots per acre= Total shoots per vine x vines per acre.
7 Distance between shoots = 1000000/row width (4 meters) x shoots per hectare.
8 Leaf layer number = gamma x 0.866/Distance between shoots.
9 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
10 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.

Effect of pruning formula and cluster thinning on canopy microclimate. There was no effect of pruning treatments nor of cluster thinning treatments on percent light interception, vine leaf area, or leafiness index in 2006. Decreasing the severity of pruning increased the number of total shoots per acre (Table 2). Pruning treatments applied in 2006 affected the distance between shoots (Table 2); it decreased linearly as the severity of pruning decreased, where the 30+10 treatment had 7%, and 40+10 had 6% less space between shoots than the 20+10 pruning treatment, respectively. Cluster thinning severity did not affect canopy microclimate.

Effect of pruning formula and cluster thinning on yield components and leaf area:fruit. There was no effect of pruning treatments on yield components. Cluster thinning treatments affected the number of clusters harvested per vine (Table 3); it increased linearly as the severity of thinning decreased. The one cluster/shoot treatment had 44%, and two clusters/shoot had 6% less clusters harvested than the two-plus clusters/shoot treatment, respectively (Table 3). Cluster thinning treatments affected yield per vine (Table 3); it increased linearly as the level of thinning severity decreased, and one cluster/shoot had 46%, and two clusters/shoot had 13% less yield than the two-plus clusters/shoot treatment, respectively. Cluster weight and weight of a single berry were not affected by either pruning or cluster thinning. The leaf area:fruit ratio was affected by cluster thinning (Table 3). Pruning formula in 2006 did not affect yield components or leaf area:fruit ratio in 2006 (Table 4). The leaf area:fruit ratio increased linearly as the severity of cluster thinning increased, where one cluster/shoot had 47%, and two clusters/shoot had a 28% greater leaf area:fruit ratio than the two-plus clusters/shoot treatment, respectively.

Effect of pruning formula and cluster thinning on fruit composition. Pruning and cluster thinning had no apparent effects on TSS, juice pH, TA, or the berries set per cluster.

The 2006 results indicated that the grapevines have not yet come into vine balance in regard to canopy microclimate variables measured in the first year, except for the distance between shoots. The yield components indicated that even with the most severe cluster thinning treatments, the vines had excessive crops (> 21.7 lb/vine). There was an indication that the two-plus clusters per shoot treatment did not have enough leaf area to ripen the number of clusters retained on the vines in 2006. This study needs to be carried on for one more growing season to determine the effects of pruning and cluster thinning on canopy microclimate, yield components, fruit composition, and cold hardiness.

Table 3. Effect of pruning formula and cluster thinning on yield components and leaf area:fruit ratio of Vidal Blanc in 2006.[1]

Pruning Formula[2]	Clusters Harvested per Vine	Yield per Vine (lb)	Cluster Weight (g)	Berry Weight (g)	Leaf Area: Fruit Ratio (cm^2/g)[3]
20+10	90	25.6	129.18	1.99	24.74
30+10	99	25.7	125.40	1.99	23.43
40+10	88	23.7	123.64	2.00	30.47
P<	0.4872	0.8433	0.9159	0.9970	0.6182
Trend[4]					
Linear	0.8881	0.6744	0.6623	0.9499	0.4757
Quadratic	0.3902	0.7740	0.9267	0.9576	0.5481
Cluster Thinning[5]					
1 cluster·shoot^{-1}	62b	16.9b	127.56	200.77	32.21a
2 cluster-shoot-1	104a	26.9a	117.75	196.02	23.35ab
2+ cluster·shoot^{-1}	111a	31.1a	132.90	200.43	17.07b
P<	0.0001	0.0035	0.5301	0.9454	0.0274
Trend					
Linear	0.0001	0.0101	0.4317	0.7488	0.0441
Quadratic	0.0013	0.0067	0.3437	0.8737	0.0320
Pruning ×Thinning	0.5068	0.7515	0.9835	0.8137	0.8912

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 Represents the ratio of leaf area to fruit [(leaf area per vine (cm^2)/yield per vine (g)].
4 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
5 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.

Table 4. Effect of pruning formula and cluster thinning on fruit composition of Vidal Blanc" in 2006.[1]

Pruning Formula[2]	TSS (%)[3]	Juice pH	TA (g/l)[4]	Berries per Cluster
20+10	16.58	3.36	4.71	65
30+10	16.99	3.39	4.75	66
40+10	15.88	3.29	4.62	64
P<	0.1512	0.0895	0.0894	0.9877
Trend[5]				
Linear	0.1929	0.1242	0.1196	0.9211
Quadratic	0.1096	0.0996	0.1023	0.8952
Cluster Thinning[6]				
1 cluster·shoot^{-1}	16.50	3.35	4.68	66
2 cluster·shoot^{-1}	16.76	3.35	4.69	60
2+ cluster·shoot^{-1}	16.18	3.36	4.70	68
P<	0.6079	0.9600	0.9597	0.6343
Trend				
Linear	0.7198	0.8841	0.8643	0.4539
Quadratic	0.3540	0.8484	0.8377	0.4906
Pruning × Thinning	0.7530	0.2727	0.2804	0.7726

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 TSS: Total soluble solids measured as Brix in juice.
4 TA: Titratable acidity measured as grams of tartaric acid per liter of juice.
5 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
6 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and > 2 clusters per shoot were retained.

Effects of Pruning and Cluster Thinning on Yield and Fruit Composition of Traminette Grapevines

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Introduction

Traminette is an important white wine grape cultivar in the lower Midwest due to its adaptability to climate and soil and increased local demand. Traminette is a Gewürztraminer hybrid that produces wines of excellent quality, with well-balanced sugar, acid, and pH. The vine is much more winterhardy than its Gewürztraminer parent, productive, and moderately resistant to powdery mildew. However, there is insufficient experience and research on grapevine canopy and crop level management for sustainable production of Traminette under the climatic conditions of the lower midwestern United States.

Materials and Methods

This study was conducted in 2006 at a commercial vineyard in Lexington, Kentucky, planted with own-rooted Traminette grapevines at 8 x 13 ft (vine x row) spacing. Vines were trained to a 6 ft high bilateral-cordon. The vines were supplied with 60 lb per acre of nitrogen annually and were not irrigated. The experiment was a 3 x 3 factorial arrangement in a completely randomized design with four replications. Each experimental unit consisted of three vines.

Pruning treatments. The previous year's (2005) canes were pruned to five-nodes, to an upper limit of 65 nodes per vine. The buds at these nodes are referred to hereafter as count-buds. The prunings were weighed (Table 1). The number of nodes to be left on the vine in 2006 was then determined by the weight of the cane prunings. The three levels of pruning severity selected were (20+10), (30+10), and (40+10). These numbers refer to number of buds left for the initial pound of prunings, plus number of buds retained for each additional pound of prunings.

Cluster thinning treatment. Three levels of cluster thinning were established two to three weeks post bloom (3 to 5 mm diameter berry size) in 2006. The numbers of clusters per shoot and per vine were counted prior to thinning. Thinning treatments consisted of retaining one (thinned to only the basal cluster), two, or all clusters per shoot.

Shoot counts and pruning weights. At bud burst, total shoots and nodes that did not produce a shoot were counted. For emerged shoots, the count shoots, non-count shoots, and total shoots (count + non-count) retained per vine were tallied. Count shoots are those borne from count-buds retained at pruning (> 5 mm distal to the base of the cane). Non-count shoots are borne from basal buds (buds < 5 mm distal to the base of the cane) or buds on wood older than one year. During the growing season, shoots were vertically positioned downward, every 14 days to reduce intra-vine shading. No leaf removal was conducted in the fruit zone.

Canopy microclimate. The total leaf area of one shoot and its lateral shoots was measured from one vine of each replicate. One count-shoot was harvested 10 weeks post bloom and placed in a sealed plastic bag and kept in storage until measured. Shoots were then separated into main shoots and lateral shoots. Individual leaf areas were measured using a LI-3000 leaf area meter (Li-Cor Inc., Lincoln, NE). The number of leaves measured from the main shoot and lateral shoots were counted. The total leaf area for each shoot was calculated by adding the areas for the main and lateral shoots. The total canopy leaf area was calculated by multiplying the total shoot number for that treatment replicate by the total leaf area per shoot. The leaf area: fruit (cm^2/g) was calculated by dividing the canopy leaf area by the crop weight collected from that single treatment replicate. The percent light interception in the fruit zone, leafiness index, shoots per hectare, distance between shoots, and leaf layer number calculations were based on the methods of Smart (1985).

Yield components and fruit composition. Fruit yields and cluster numbers for all treatments were measured on a single-treatment replicate (each experimental unit), and all treatments were harvested on the same date. A random 100-berry sample was collected from each treatment-replicate, placed in a polyethylene bag, stored on ice, and analyzed within 24 hours. Before analysis, the 100-berry samples were weighed and average berry sizes determined. The samples were then crushed by hand, and the juice was placed in 100-mL beakers. A 5-ml portion of each sample was used to determine the percent total soluble solids (TSS) using a digital refractrometer (Spec Scientific Ltd., Scottsdale, AZ). The juice pH was measured with a glass electrode and a pH meter (model AR15; Fisher Scientific, Pittsburgh, PA). The total acidity (TA) of each sample was determined by titrating to pH 8.2 with 0.1 N sodium hydroxide and expressed as grams per liter tartaric acid (Iland et al., 2002).

Statistical analyses. Standard CRD analysis of variance was performed using the Type III tests of fixed effects with the MIXED procedure of SAS (v.8.1) (SAS Institute Inc., Cary, NC) after all the assumptions for ANOVA had been met (Wilcox, 2001). Treatment means were separated by Duncan's new multiple range test at $P \leq 0.05$. Treatments were then tested for polynomial trends across treatment levels using the GLM procedure of SAS.

Results and Discussion

The number of count nodes significantly differed among the three pruning treatments, producing a linear trend. The 40+10 treatment had 20% and 13% more nodes retained than the 30+10 and 20+10 treatments, respectively (Table 1). As the severity of the pruning formulas decreased, more count nodes were retained on the vine. The 40+10 treatment had 15% more non-count nodes than the 30+10 and 40+10 treatments, respectively. The pruning treatments did not have any effect on the number of count- or non-count shoots, ratio of count shoots, or ratio of non-count shoots per vine (Table 1).

The percent of light in the fruit zone (measured as photosynthetic photon flux density (PPFD)) intercepted in the fruit

Table 1. Vine size, node counts, shoots counts, and ratio of shoots during experiment setup in Traminette[1], 2006.

Pruning Formula[2]	Vine Size per Meter of Row[3]	No. Count Nodes per Vine	No. Non-Count Nodes per Vine	No. Count Shoots per Vine	No. Non-Count Shoots per Vine	Ratio of Count Shoots per Vine[4]	Ratio of Non-Count Shoots per Vine[5]
20+10	0.5267	40 c	20 b	45	26	63.30	36.71
30+10	0.5042	45 b	20 b	45	27	62.97	37.04
40+10	0.5363	48 a	23 a	46	25	65.25	34.75
P	0.1107	0.0001	0.0032	0.7481	0.4772	0.1420	0.1420
Trend[6]							
Linear	0.8005	0.0001	0.0008	0.5592	0.3439	0.1178	0.1178
Quadratic	0.4090	0.4271	0.1549	0..6387	0.4290	0.2236	0.2236
Cluster Thinning[7]							
1 cluster•shoot^{-1}	0.5353	44	21	44	25	63.83	36.17
2 clusters•shoot^{-1}	0.4978	44	21	45	25	64.49	35.51
2+ clusters•shoot^{-1}	0.5341	44	21	46	27	63.19	36.81
P	0.0833	0.7513	0.6741	0.1876	0.3294	0.5643	0.5643
Trend							
Linear	0.3246	0.6757	0.8631	0.3260	0.9150	0.6037	0.6037
Quadratic	0.5945	0.8366	0.4519	0.1026	0.1287	0.3845	0.3845
Pruning x Thinning	0.0101	0.0898	0.7277	0.5282	0.6011	0.2697	0.2697

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each 454 g of dormant pruning.
3 Vine size per meter of row = Dormant pruning weight (kg) per length of canopy (m) measured during treatment application in 2006 in response to 2005 growing season.
4 Ratio of count shoots = [Number of count shoots per vine /(Number of count shoots per vine + number of non-count shoots per vine)].
5 Ratio of non–count shoots = [Number of non-count shoots per vine /(Number of count shoots per vine + Number of non-count shoots per vine)].
6 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
7 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.

zone was not affected by the pruning treatments (Table 2). However, cluster thinning treatments affected PPFD where the 2+ clusters per shoot treatment intercepted 20% more PPFD than the 1 cluster and 2 clusters per shoot treatments. There was no effect of pruning or cluster thinning on leaf area per vine, leafiness index, shoots per hectare, distance between shoots, and leaf layer number in 2006 (Table 2).

The yield components of Traminette were not affected by the pruning treatments in 2006 (Table 3). However, the number of clusters harvested per vine increased linearly with reduction of cluster thinning severity (Table 3). The 2+ clusters per shoot treatment had 53% and 7% more clusters harvested than the 1 cluster and 2 clusters per shoot treatments, respectively. The cluster weight of Traminette decreased linearly with the decrease in cluster thinning severity in 2006 (Table 3). The yield per vine increased linearly as the severity of cluster thinning decreased. The 2+ clusters per shoot treatment had 16% and 7% more yield than the 1 cluster and 2 clusters per shoot treatments in 2006. The yield per vine exceeded the 21.4 lb recommended for hybrids in the lower Midwest (Kurtural et al., 2006). The leaf area:fruit increased linearly with the increase in the severity of cluster thinning (Table 3). The 1 cluster per shoot treatment had 36% and 45% more leaf area: fruit than the 2 clusters per shoot and 2+ clusters per shoot treatments, respectively in 2006. The leaf area:fruit observed in 2006 exceeds the 10-14 cm^2/g range recommended for hybrids grown in the lower Midwest (Kurtural et al., 2006). In 2006, the pruning and cluster

Table 2. Effect of pruning formula and cluster thinning on the microclimate of Traminette[1], 2006.

Pruning Formula[2]	K[3]	Leaf Area per Vine (m^2)[4]	γ[5] (cm^2/cm)	Shoots per Hectare[6]	Distance between Shoots[7] (cm)	Leaf Layer Number[8]
20+10	41.48	21.91	18.60	79520	3.173	5.216
30+10	43.00	24.13	21.01	79707	3.165	5.747
40+10	42.01	26.94	24.73	78804	3.192	6.838
P	0.9280	0.6232	0.4050	0.9517	0.9746	0.4466
Trend[9]						
Linear	0.9899	0.3437	0.1696	0.8140	0.8754	0.1974
Quadratic	0.7218	0.9479	0.8656	0.8362	0.8718	0.7945
Cluster Thinning[10]						
1 cluster•shoot^{-1}	38.25 b	28.67	23.95	76938	3.266	6.52
2 clusters•shoot^{-1}	40.26 a	22.84	22.96	78680	3.206	6.353
2+ clusters•shoot^{-1}	47.97 a	21.46	17.43	82413	3.056	4.928
P	0.0514	0.3438	0.3139	0.1994	0.2274	0.4074
Trend						
Linear	0.5828	0.2643	0.8203	0.5466	0.6070	0.8924
Quadratic	0.0092	0.3412	0.1174	0.0720	0.0839	0.1660
Pruning × Thinning	0.9876	0.3106	0.8408	0.6571	0.579	0.80641

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represents retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 k = (Percent light intercepted): [(PPFD intercepted in fruit zone/PPFD ambient) x 100].
4 Leaf area per vine = leaf area per shoot x number of shoots per vine.
5 γ (leafiness index): leaf area per shoot/shoot length.
6 Shoots per Hectare = Total shoots per vine x vines per hectare.
7 Distance between shoots = 1000000/row width (4 meters) x shoots per hectare.
8 Leaf layer number = 'Y x 0.866/Distance between shoots.
9 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
10 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.

Table 3. Effect of pruning and cluster thinning on yield components and leaf area per fruit of Traminette, 2006.				
Pruning Formula[1]	**Clusters Harvested per Vine**	**Yield per Vine (kg)**	**Cluster Weight (g)**	**Leaf Area:Fruit Ratio (cm²/g)**[4]
20+10	72	14.91	191.42	15.85
30+10	72	14.11	193.32	19.10
40+10	76	13.97	188.10	19.58
P	0.2496	0.7918	0.9447	0.5450
Trend[2]				
Linear	0.6773	0.5839		0.3647
Quadratic	0.7891	0.8203		0.6975
Cluster thinning[3]				
1 cluster·shoot^{-1}	44 c	11.22 b	210.72	25.04 a
2 clusters·shoot^{-1}	85 b	15.28 a	176.21	15.84 b
2+ clusters·shoot^{-1}	92 a	16.49 a	185.91	13.63 b
P	0.0001	0.0038	0.0934	0.0097
Trend				
Linear	0.0001	0.0073	0.0261	0.0100
Quadratic	0.0001	0.0126	0.5599	0.0139
Pruning × Thinning	0.6887	0.6373	0.6447	0.5714

1 Pruning formula represent retaining 20, 30, or 40 nodes for each pound of dormant pruning.
2 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
3 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters, and 2+ clusters per shoot were retained.
4 Leaf area:fruit = Leaf area (cm^2) · fruit yield (g)$^{-1}$.

Table 4. Effects of pruning and cluster thinning on fruit composition of Traminette[1], 2006.			
Pruning Formula[2]	**TSS (%)**[3]	**Juice pH**	**TA (g/l)**[4]
20+10	16.54	3.53	8.59
30+10	16.35	3.50	8.44
40+10	16.22	3.48	9.22
P	0.7022	0.3346	0.2029
Trend[5]			
Linear	0.4398	0.1525	0.1742
Quadratic	0.9436	0.8626	0.2433
Cluster Thinning[6]			
1 cluster·shoot^{-1}	16.53	3.54	8.94
2 clusters·shoot^{-1}	16.57	3.48	8.30
2+ clusters·shoot^{-1}	16.00	3.49	9.01
P	0.2561	0.1478	0.2377
Trend			
Linear	0.9330	0.0680	0.1687
Quadratic	0.1160	0.4536	0.3295
Pruning x Thinning	0.1056	0.4920	0.5034

1 n = 36. Significance for main effects and interaction according to Type III tests of fixed effects. Means with no letter designation within columns not significant at Pr>F 0.05 according to Duncan's Multiple Range Test.
2 Pruning formula represent retaining 20, 30, or 40 nodes for each pound of dormant pruning.
3 Total soluble solids measured as Brix in juice.
4 Titratable acidity measured as grams of tartaric acid per liter of juice.
5 Trend analyses carried to the quadratic level using single degree of freedom planned orthogonal contrasts.
6 Cluster thinning treatments represent post-fruit set cluster thinning at Eichorn-Lorenz scale 31 where 1 cluster, 2 clusters and 2+ clusters per shoot were retained.

thinning treatments did not have an effect on the fruit composition variables measured (Table 4).

These preliminary results indicate that Traminette, a vigorous cultivar when grown on a single canopy system in the lower Midwest, has the propensity to overcrop even with aggressive cluster thinning. The primary bud cold-hardiness has to be evaluated in conjunction with the cropload index for another growing season before recommendations can be made for this cultivar.

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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 the fall of 2005 to evaluate the residual control of various herbicides on weed pressure and other benefits 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. Grapes were in the 0.5 to 2 inch green shoot stage. As weeds had been growing since early March and were 3 to 4 inches tall, 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

Table 1. Weed control ratings three weeks after spring herbicide treatments at UKREC, Princeton, Ky., 2005.								
						Weed Control Ratings and Dates of Ratings[2]		
Treatment Number and Name		**Formula Conc. (%)**	**Formula Type**	**Rate/A**	**Growth Stage[1]**	**DAND May 6**	**CLOVER May 6**	**MATA May 6**
1	Princep	4	L	1.2 gal	PRE, POST	5 b	4 b	8 b
2	Karmex	80	DF	6 lb	PRE, POST	9 a	9 a	9 a
3	Devrinol	50	DF	8 lb	PRE, POST	4 c	2 c	8 b
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.
Means within columns followed by the same letter are not statistically different at P = 5%.

Table 2. Weed control ratings two months after spring herbicide treatments at UKREC, Princeton, Ky., 2005.										
						Weed Control Ratings and Dates of Ratings[2]				
Treatment Number and Name		**Formula Conc. (%)**	**Formula Type**	**Rate/A**	**Growth Stage[1]**	**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 b	9 a	3 b	6 a	8 a
2	Karmex	80	DF	6 lb	PRE, POST	9 a	10 a	10 a	6 a	10 a
3	Devrinol	50	DF	8 lb	PRE, POST	9 a	1 b	10 a	9 a	9 a
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.
Means within columns followed by the same letter are not statistically different at P = 5%.

Table 3. Weed number and weight per sample area in spring 2006 for herbicide treatments applied December 17, 2005, in grapevines at UKREC, Princeton, Ky.								
Treatment Number		**Formula Conc. (%)**	**Formula Type**	**Rate/A**	**Growth Stage**	**Weed No./sq ft April 19, 06**	**Weed No./sq ft May 18, 06**	**Weed Weight g/sq ft May 24, 06**
and Name		4	G	150 lb	Fall	14 a	70 a	132 a
2	Chateau	51	WG	12 oz	Fall	10 a	55 a	82 b
3	Gallery	75	DF	21.3 oz	Fall	6 a	46 a	89 b
1-3	Roundup WeatherMax	5.5	L	16 oz	ALL trts			
LSD (P = 0.05)						7	24	48

Means within columns followed by the same letter are not statistically different at P = 5%.

treatments at same rate as above. 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 on December 17, 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 to 10, with 1 = no control and 10 = complete kill or no weeds present. A rating of 7 (70 to 75% control) or more is considered a commercially acceptable value.

Results and Discussion

Three weeks after PRE application, Karmex performed best, 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. Devrinols lack of control of dandelion and clover is because they are perennial weeds not generally controlled by preemergence herbicides. No weed regrowth was observed on this date in any treated plots.

Two months after PRE applications, annual grasses and broadleaves reemerged 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 does not get tall enough to interfere with the grape canopy.

On April 19, 2006, or 120 days after treatment, all three treatments were equally effective in weed suppression with about 6 to 14 weeds/sq ft (Table 3). This is different from the results observed in the similar studies conducted on apple and peach (see report in this issue). This could be attributed to the fact that the vineyard had much reduced weed pressure at the onset of the experiment in spring 2005 and continued to show reduced weed growth through summer and fall of 2005.

By 148 days after treatment or about five months (24 May 2006), Chateau had significantly fewer weeds in the sampled area compared to Casoron but performed equally to Gallery.

Weed Control in Bearing Grape—UKREC

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Introduction

Herbicides are an important component of a comprehensive weed control regimen, especially in perennial crops such as grape. Herbicides and weed control should be the least time-consuming of all the pest management practices in grape growing. Universities continue to evaluate new and improved herbicides for potential use in grapes. In order to add more herbicides to the arsenal available for growers, an experiment was conducted in 2006 to compare the performance of a new, unregistered pesticide to various labeled herbicides.

Materials and Methods

The experiment was initiated in spring of 2006. 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 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 tree row to avoid spraying the vine trunks. Therefore, weeds on the base of vine trunks were taller throughout the season and did not reflect the effectiveness of the applied herbicides. Plots were 6 ft x 60 ft long. The experimental design consisted of a randomized complete block with three replications.

The preemergence (PRE) treatments were applied on 26 April. Grapes were in the 0.5 to 2 inch green shoot stage. As weeds had been growing since early March and were 3 to 4 inches tall, Roundup WeatherMax at 24 oz/A (1 lb ai/A) was included with all treatments. All treatments were applied early in the morning with average wind speed of 2.5 mph.

No yield data were collected from this experiment as this was not the original intent. Only visual weed control ratings were collected at various dates. The scale used in these 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 to 75% control) or more is considered a commercially acceptable value.

The following are the full names the weed codes used in the tables: DAND = dandelion; LACG = large crabgrass; HONE = horsenettle, HVMW = honeyvine milkweed.

Results

At 30 days after application, plots were much cleaner compared to rows adjacent to, but not part of, the experiment. The new herbicide evaluated this year was V-10142, not yet labeled for use in grape. It was tested at two rates (0.5 and 1 lb ai) alone and in combinations with Chateau. Of the individual herbicide treatments (treatments 2-8), Chateau had 100% kill of all weeds evaluated in this experiment at 28 DAT and had 50% control of HVMW at 75 DAT (Table 1). At 75 DAT, only V-10142 had better HVMW control with about 70 to 75% kill. All other treatments had lost their HVMW control efficacy by that date. V-10142 at 1 lb ai was similar in weed control effectiveness, at 28 DAT, as Surflan, Karmex, and Chateau with ratings ranging from 7 to 10.

Chateau combination with five other preemergence herbicides (treatments 9-14) performed equally at 28 DAT, except for the Chateau + Princep combination, which was a little weak on horsenettle. It is encouraging to see that three perennial weeds, namely honeyvine milkweed, horsenettle, and dandelion, were 100% controlled with treatments 9-14. By 75 DAT, treatments 11 and 12 (Chateau + V-10142, and Chateau + Surflan, respectively) had 70 to 90% control of horsenettle, and treatments 10 and 11 (Chateau+ V-10142 at both rates) had 70% control of honeyvine milkweed and are considered the best treatments. All other combination treatments ranged from 30 to 50% control efficacy.

For the individual herbicide treatments (treatments 2-8), V-10142 1 lb ai/A was comparable to Chateau 0.375 lb ai/A (high end of the labeled rate) in residual control of honeyvine milkweed, with control efficacy of 50 to 70%. However, only V-10142 (low and high rates) had any significant residual control of horsenettle at 75 DAT, with ratings of 80 to 90% control.

Table 1. Results of preemergence herbicide treatments 3 and 10 weeks after application.

Treatment Number and Name		Rate lb ai/A	HONE RATING 28 DAT	HVMW RATING 28 DAT	LACG RATING 28 DAT	DAND RATING 28 DAT	LACG RATING 75 DAT	HONE RATING 75 DAT	HVMW RATING 75 DAT
1	Untreated control	-	6	6	6	3	1	1	1
	Roundup	1							
2	Chateau	0.375	10	10	10	10	10	3	5
3	Prowl	2	5	6	10	10	7	1	1
4	V-10142	0.5	7	9	10	10	2	8	2
5	V-10142	1	6	8	10	10	1	9	7
6	SURFLAN	3	7	7	9	10	9	1	1
7	PRINCEP	2	7	4	10	10	9	1	1
8	KARMEX	2	7	5	10	10	10	8	1
9	CHATEAU	0.375	10	10	9	10	8	2	3
	PROWL	2							
10	CHATEAU	0.375	10	10	10	10	10	4	7
	V-10142	0.5							
11	CHATEAU	0.375	10	10	10	10	10	7	7
	V-10142	1							
12	CHATEAU	0.375	10	10	10	10	10	9	4
	SURFLAN	3							
13	CHATEAU	0.375	7	9	10	10	9	5	5
	PRINCEP	2							
14	CHATEAU	0.375	10	10	10	10	8	3	5
	KARMEX	2							
LSD (P = 0.05)			4.8	2.8	2.2	1.6	0.7	0.7	0.7
Standard deviation			2.9	1.6	1.3	1.0	0.4	0.4	0.4
CV			35.96	20.25	13.7	10.13	5.7	9.38	12.37

Evaluating Host Plant Resistance and the Impact of Japanese Beetle Defoliation on Young Grapevines

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Introduction

Renewed interest in Kentucky's grape and wine industry has led to acreage and production increases statewide. Japanese beetles [JB], *Popillia japonica* Newman, are economically significant vineyard pests. Adult JB feeding can completely defoliate vines, inhibiting vine growth, reducing fruit quality, and decreasing yield. This pest is more troublesome in Kentucky than some other grape growing regions in the eastern United States because of the abundance of farm and pastureland. The proximity of these larval habitats to vineyards can result in large numbers of aggregating adults.

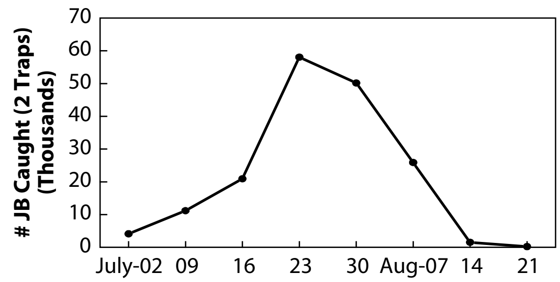
There are three types of major wine grapes grown in the midwestern United States: American (*Vitis labrusca, Vitis aestivalis*), European (*Vitis vinifera*), and French-American hybrids. Numerous cultivars grown in Kentucky possess distinct morphological and physiological characteristics likely to affect the extent of JB feeding damage. The goal of this project is to help develop a sustainable pest management strategy for grape growers in Kentucky and other southern states where this insect is, or has the potential to be, an important economic pest. The objective of this study is to evaluate the basis for existing host plant resistance and the impact of JB defoliation on young vines. Host plant resistance is a sustainable pest management strategy that reduces pesticide inputs and lowers production costs.

Materials and Methods

Research plots were planted in mid-May 2006 at the University of Kentucky Horticulture Research Farm in Lexington. Six grape cultivars including two American, a *labrusca* (Concord) and an *aestivalis* (Norton), two European *vinifera* grapes (Cabernet Franc and Cabernet Sauvignon), and two interspecific French-American hybrids (Chambourcin and Frontenac) were planted with 8 ft spacing between vines and 10 ft spacing between rows, with rows oriented north-south. All vines were trained to a single, high-wire, bilateral-cordon system. Treatments and cultivars were arranged in a randomized complete block design with eight replications, with two vines planted per experimental unit. Weed management, fertilization, and vine training were administered according to guidelines suggested by Brown et al. (1997) and Dami et al. (2005).

Three spray treatments of carbaryl insecticide were used to evaluate reduced insecticide use and host plant resistance of grapevines to JB defoliation. The three treatments were applied to each cultivar. Carbaryl at 1 oz per 3 gal water was sprayed on vines until drip. Both 7 d and 14 d treatments began on 2 June, and continued through 11 Aug. Treatment 1 (control) was not sprayed with carbaryl at any time. Treatment 2 was sprayed every 14 d with carbaryl until drip. Treatment 3 was sprayed every 7 d with carbaryl until drip. The vines were inspected for percentage defoliation for three consecutive weeks by two independent observers during peak JB flight. Flight was monitored using Tréce JB floral lures and traps from two locations at the research farm. Leaf samples of six fully expanded leaves were collected from each cultivar and analyzed for leaf toughness (using a penetrometer), leaf thickness, total leaf area, and percent water content on 30 June 2006. The dominant cordon for each vine was measured for cordon length, number of buds, and bud hardiness for overwintering from 12–19 Oct. 2006.

Figure 1. Adult Japanese beetle flight period, 2006.



Leaves will also be analyzed for concentration of sugars, nitrogen and phenolics. Root starch accumulations will be assessed during the winter to evaluate overwintering accumulation for the different treatments. Relative tolerance to defoliation by JB will be compared across cultivars and treatments by comparing the magnitude of reduction in the specified crop parameters between JB-damaged and protected vines.

Results and Discussion

In 2006, the adult JB flight window occurred from 19 June to 22 Aug. Heavy flight occurred from 10 July to 7 Aug., with peak flight occurring from 17-30 July. During peak flight, more than 25,000 JB were caught per trap each week (Figure 1). In all cultivars excluding Concord, differences in percent defoliation were evident for the different treatments. For all cultivars, the least amount of JB damage occurred on vines with the 7 d carbaryl treatments. A reduction in percent defoliation was also seen in 14 d treatments compared to vines left untreated. All untreated vines received significant JB damage except for the Concord vines (Table 1).

Table 1. Average ratings for cumulative Japanese beetle defoliation by early August 2006.

Cultivar	Carbaryl Treatment	Avg. Percent Defoliation[1]
Concord	7d	2
	14d	7
	NT[2]	7
Norton	7d	8
	14d	15
	NT	44
Cab. Franc	7d	5
	14d	14
	NT	39
Cab. Sauvignon	7d	5
	14d	18
	NT	48
Chambourcin	7d	8
	14d	33
	NT	46
Frontenac	7d	7
	14d	25
	NT	38

[1] Based on 0-100% scale in increments of 5%.
[2] NT = non-treated control.

Table 2. Physical leaf characteristics of grape cultivars evaluated for relative resistance to Japanese beetles.

Cultivar	Toughness to Penetrate (lb)	Thickness (mm)	Leaf Area (cm^2)	Percent Water
Concord	0.231	0.123	192.61	0.284
Norton	0.185	0.086	80.05	0.406
Cab. Sauvignon	0.214	0.067	53.08	0.303
Cab. Franc	0.183	0.058	54.67	0.310
Frontenac	0.101	0.081	120.49	0.379
Chambourcin	0.152	0.084	74.690	0.383

Concord (*Vitis labrusca*) received less than 7% defoliation in all three treatments, exhibiting some form of host plant resistance to JB defoliation (Table 1). Leaf samples from Concord vines were larger, tougher, and thicker, and they contained less percent water than the other five cultivars in the study (Table 2). Norton (*Vitis aestavalis*), the other American cultivar, was one of the most damaged cultivars in the trial with an average of 44% defoliation for the non-treated vines (Table 1).

All cultivars except for Concord showed a decrease in cordon growth between the non-treated vines and the 7 d treatments. Cabernet Franc showed the greatest reduction in average cordon growth with a difference of 2.5 ft in cordon length between the 7 d treatments and the non-treated vines (Table 3). This cultivar also had the highest average defoliation rating with 48% (Table 1).

Information in this report is based on empirical evaluations of the data. Statistical evaluations have not been completed. In the spring of 2007, plants will be evaluated for winter survival, and insecticide treatments will continue. Second-year data for percent defoliation, vine growth, and yield will be taken to further investigate the impact of JB damage on grape vines.

Table 3. Average number of hardened buds, total number of buds, and cordon length in mid-October after the first summer of varying degrees of defoliation by Japanese beetles.

Cultivar	Treatment	Avg. No. Hardened Buds per Vine	Avg. No. Total Buds per Vine	Avg. cordon Length (cm)	Avg. Growth Difference between NT and 7d
Concord	7d	2.8	31.0	209.9	- 37.7
	14d	4.0	34.3	243.2	
	NT[1]	6.0	37.0	247.6	
Norton	7d	8.3	40.8	230.2	+ 43.3
	14d	3.8	34.4	200.7	
	NT	10.2	35.9	186.9	
Cab. Franc	7d	10.6	50.3	222.2	+ 43.6
	14d	6.0	48.2	224.6	
	NT	12.2	45.5	178.6	
Cab. Sauvignon	7d	8.1	55.2	262.7	+ 79
	14d	8.6	55.8	257.5	
	NT	7.8	44.4	183.7	
Chambourcin	7d	8.6	39.6	228.9	+ 28.9
	14d	7.2	40.9	219.9	
	NT	11.4	40.1	190.0	
Frontenac	7d	11.6	41.8	245.4	+ 33.6
	14d	13.0	38.8	210.8	
	NT	16.8	41.6	211.9	

[1] NT = non-treated control.

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Evaluation of Eastern European Wine Grape Cultivars for Kentucky

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Introduction

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 considered 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 completely with soil or mulch to prevent winter injury, a very labor-intensive operation. Northern Europeans have crossed the *vinifera* with other *Vitis* genera, 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 winterhardiness, 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 apart within rows spaced 12 ft apart. The planting stock were 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 was trickle irrigated, and a 4-ft wide herbicide strip was maintained beneath the vines with mowed sod alleyways. The vines were balance pruned according to the previous years 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 (percent 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 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.

Additional advanced selections were released from post-entry quarantine, and nine of these were planted at UKREC in the spring of 2001. 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.

Table 1. 2006 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 (lb)	Yield (T/A)[2]	Cluster Weight (g)	Berry Weight (g)	Soluble Solids (%)	pH
Bromariu	30 Aug	9	1.0	2.2	168	1.7	20.4	3.5
Demetra	30 Aug	6	1.3	1.0	114	1.6	20.6	3.5
Ir 26/5	28 Sept	9	1.1	1.0	96	1.7	20.4	3.3
II 70/21	21 Aug	11	1.1	0.9	249	2.7	18.4	3.4
Plai	22 Aug	8	1.3	0.6	125	1.6	18.8	3.5
L4-9-18	28 Sept	11	0.3	0.4	108	1.3	17.0	3.0
I 55/8	30 Aug	8	0.3	0.4	192	1.8	18.2	3.4
Nero	21 Aug	12	0.8	0.1	141	2.6	18.8	3.5
Golubok	-[3]	-	0.3	-	-	-	-	-

1 Cultivars are arranged in descending order of yield. Bromariu is a white grape; all others are red.
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.

Results and Discussion

Yield and fruit quality components for the 2006 harvest of the 2001 planting are listed in Table 1. These vines are in their sixth year and have been slow to produce economically viable yields. Only Plai had an increased pruning weight from 2005 to 2006, increasing from 1.0 to 1.3 lb. Pruning weights for L4-9-18, I 55/8, Nero and Golubok were the same in both years and were all less than one pound, and thus would not have been cropped in a commercial setting. Pruning weights for Bromariu and Demetra decreased from 1.2 and 1.7 lb, respectively, in 2005 to 1.0 and 1.3 lb in 2006. In 2005, Bromariu, II 70/21, Demetra, and IR 26/5 produced at least 4 tons/A. This year their yields decreased to 2.2, 0.9, 1.0 and 1.0 tons/A, respectively. Yield decreases were due, in part, to bird feeding, in spite of net application. In 2004 Golubok, II 70/21, Bromariu, and Ir 26/5 yielded enough to make wines. In both 2005 and 2006, eight of the nine (Golubok excluded) yielded enough to make wines.

Table 2 compares the fruit yields, percent soluble solids, and pH for 2003-2005 from the 1998 planting. Evaluation of varieties in this plot ended with the 2005 season. Malverina, Toldi, and Rubin Tairovski averaged the highest yields for the last three years in which this planting was evaluated. Table 3 compares the same parameters for 2004-2006 from the 2001 planting. Demetra, Bromariu, and II 70/21 have been the highest yielding varieties in the 2001 planting, but all three yielded less than half of what any of the top three in the older planting yielded. Vine age and growing seasons being compared are not the same between these two plantings, but for all years in the tables, the vines were at least into their fourth year (the first year in which a vine can be

Table 2. Yield summary for the 1998 Eastern European winegrape trial, 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
Iskorka	1.5	0.3	-[2]	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												
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
Rubin Tairovski	10.3	3.8	10.7	8.3	20	22	21	21	3.4	3.3	3.3	3.3
I 31/67	3.5	1.4	-	2.5	17	16	-	17	3.2	3.3	-	3.3
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	2.0	6.5	4.5	19	20	19	19	3.2	3.4	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 Varieties dropped in 2005 due to inadequate performance.

Table 3. Yield summary for the 2001 Eastern European winegrape trial, 2004-2006.

Cultivar[1]	Yield (T/A)[2] 2004	2005	2006	Avg	Soluble Solids (%) 2004	2005	2006	Avg	pH 2004	2005	2006	Avg
Bromariu	1.9	6.1	2.9	3.6	21	21	20	21	3.5	3.4	3.5	3.5
Demetra	0.0	5.7	1.3	3.5	-	19	21	20	-	3.4	3.5	3.5
Golubok	0.3	0.1	0.0	0.2	18	-[3]	-	18	3.4	-[3]	-	3.4
Nero	0.1	0.5	0.1	0.2	18	20	19	19	3.3	3.2	3.5	3.3
Plai	0.0	4.4	0.8	2.6	-	20	19	20	-	3.5	3.6	3.6
Ir 26/5	1.1	5.5	1.3	2.6	21	17	20	19	3.3	3.3	3.3	3.3
L 4-9-18	0.0	2.7	0.5	1.6	-	22	17	20	-	3.2	3.0	3.1
I 55/8	0.7	2.5	0.5	1.2	17	21	18	19	2.9	3.4	3.4	3.4
II 70/21	3.1	6.4	1.2	3.6	20	18	18	19	3.4	3.4	3.4	3.4
Overall Average	1.2	3.8	1.1	2.1	19	20	19	19	3.3	3.4	3.4	3.4

1 Bromariu is a white grape, all others are red.
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. Wine tasting evaluation results for the 2001 through 2004 vintage years—white varieties.

Vintage Year and Cultivar[1]	Average Rating[3,4] 2002	2004	2005	2006	Range of Ratings[5]	Comments from Most Recent Tasting
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		12.6	8.5-15.5	Acidic; slight acidic; apricot aroma; light fruit taste; long aftertaste; well made; pleasant
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)		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	12.3	9.5-15.5	Floral aroma, but not that nice; apple cider aroma; big nose; acidic; slightly oxidized; long aftertaste
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	14.1	11.5-17.5	Clear; crisp; nice flavor; apple, pear; Niagara?; lasting finish
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
2004 Whites[2]						
Bianca				6.3	4-10.5	Clear, straw color; sulfur smell; off nose; thin body in the middle; chemical taste; dry, tart, and balanced
XIV-186				6.8	4-13	Unpleasant aroma; off odor on front end; great color; fruity aroma; harsh taste; lacking sweetness (3); lacks body (3); short finish
Vidal Blanc (std)				11.8	7.5-15	Straw color; slightly acidic; some fruit flavor; crisp taste; Niagara?

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 Other 2004 whites were omitted from 2006 tasting in a preliminary evaluation.
3 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 to 10 tasters: (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; (2006) Tom Cottrell, Jim Wight, Dave and Frances Miller, Butch Meyer, Gari Thompson, Jim Loyd, Mike and Sue Eisenback.
4 White wines are evaluated for two years, with the exception of 2001 Malverina (see results). Where only one rating is shown, that wine was not reevaluated due to very low score in previous evaluation.
5 Range: 1st number = lowest score received, 2nd number = highest score received from most recent tasting.

expected to produce a full crop). The three-year average soluble solids percentages for the 1998 planting varieties ranged from 17 to 21%, and their three-year average pH values ranged from 3.2 to 3.4. The three-year average soluble solids percentages for the 2001 planting varieties ranged from 18 to 21%, and their three-year average pH values ranged from 3.1 to 3.5.

Table 4 lists the white wine tasting results for the 2001-2004 vintages. Each white wine was evaluated approximately one to six

Table 5. Wine tasting evaluation results for the 2000 through 2004 vintage years—red varieties.

Vintage Year and Cultivar[1]	Tasting Average Rating[3,4] 2001	2002	2004	2005	2006[5]	Range of Ratings[6]	Comments from Most Recent Tasting
2000 Reds							
I31/67	8.6	3.2					None
Kozma 55	8.8	12.2	12.1	10.5	10.3	6.5-15.5	Dark purple; nice color (2); spicy, licorice aroma; blackberry aroma; very floral aroma; bitter, green taste; needs acid and oak; thin; Kozma?
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)	14.3						None
2001 Reds							
I 31/67		9.3	10.4	10.7	8.3	3-15	Orange color at edges; chocolate aroma; floral aroma; not balanced, harsh taste; raw taste; nice acids
Kozma 55		12.5	10.1	11.6		2.5-14.5	None
Kozma 525		13.0	11.3	9.1	11.7	8-15.5	Clear, orange color at edges; earthy aroma; not balanced, slightly bitter; light body, short finish; blackberry and licorice taste
Laurot		12.3	13.1	10.3		6-16.5	Green taste
M 39-9/74		11.7	12.0	8.4	12	10-13	Cherry red; light color; fruity aroma; nice nose; very flowery aroma; green taste; jammy finish; harsh finish
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)		13.4					None
2002 Reds							
Kozma 55 blend			12.7	9.6	10.7	7.5-16.5	Light aroma; not balanced, bitter, no fruit; harsh taste; spritz
Kozma 525			9.7	5.1		2.5-8	None
Laurot			13.4	10.3		4-14	Too much oak; green taste
M 39-9/74			8.2	9.3	11.8	8-14.5	Purple color; fruity aroma; floral, licorice aroma; chocolate aroma (2); thin body; high alcohol
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)			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	11.5	7.5-15	Clear, purple
I 31/67				6.0		2-9.5	Oxidized
II70/21				13.8	16.2	13-20	Deep violet; spicy, thyme aroma; herbal aroma; slightly sweet; balanced; pepper taste; smoot;
Kozma 55				9.0	11.1	8.5-16	Cherry red with orange edges; Pinot, woodsy aroma; peanut butter aroma; off aroma
Kozma 525				12.0	11.6	9-15.5	Cherry red with orange edges
Laurot				15.3	13.1	9-16.5	Purple, thick
M 39-9/74				7.1	12.8	4-18	Harsh, off taste; clean, jammy taste; like it; nasty taste
Nero				12.6	12.3	5-16	Purple color; nice tannins; watery
Rubin Tairovski				0.5		0-2	Oxidized
Rubin Tairovski				12.4	9.1	3.5-12.5	Light finish, crisp
XIV-1157				0.6		0-2	Oxidized
2004 Reds[2]							
Ir 26/5					14.4	11.5-17	Purple, clear; fruity taste
Rubin Tairovski					11.4	9.5-15	Light color; brick orange; Brettanomyces aroma; Pinot noir aroma; good mouth feel
2004 Norton (std)					12.2	4-15	Blackberry aroma (2); vinegar aroma; crisp taste; needs a little more fruit, dry finish, peppery

1 Chambourcin and Norton were included as quality French-American and American wine standards for comparison.
2 Other 2004 reds were omitted from 2006 tasting in a preliminary evaluation.
3 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 to 10 tasters: (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; (2006) Tom Cottrell, Jim Wight, Dave and Frances Miller, Butch Meyer, Gari Thompson, Jim Loyd, Mike and Sue Eisenback.
4 Wines receiving low ratings were omitted from later tastings.
5 2000 Laurot and 2001 Kozma 55 were not evaluated because supply of these was exhausted.
6 Range: 1st number = lowest score received, 2nd number = highest score received from most recent tasting.

months after bottling and again about a year later. Table 5 lists all the red wine tasting results. Red wines are evaluated at approximately a month after bottling, and for four years afterward. Members of the Kentucky Vineyard Society have evaluated the wines. For each wine, the average rating, range of ratings between tasters, and their comments from the most recent tasting are listed. Comments from previous evaluations are found in previous annual research reports.

Prior to the 2006 tasting, several of the 2004 vintage wines, and some of earlier vintage, were eliminated from the full panel wine evaluation by a preliminary wine evaluation, led by the University of Kentucky enologist, Dr. Tom Cottrell. This was done primarily to reduce the number of wines to be evaluated by the full panel of tasters. In this year's evaluation, the five highest rated wines, in descending order, were the 2003 II 70/21 (red), the 2004 Ir 26/5 (red), the 2003 XIV-186 (white), and the 2003 Laurot and M 39-9/74 (both red). The 2003 XIV-186 was the highest rated white in last year's evaluation. The 2003 II 70/21, Laurot, and M 39-9/74 were among the four highest rated reds last year.

Table 6 summarizes the wine evaluations. The II 70/21, the French-American hybrid Chambourcin, and the American Norton have received the highest average cumulative ratings so far. The latter two have been included for standards to compare by and are non-*vinifera* grapes in demand by Kentucky wineries. These top three are followed by, in order, 34-4-49, M 39-9/74, Nero, Laurot, Vidal Blanc (standard), XIV-186, and Malverina. Thus, the top rated Eastern European wines are pretty evenly divided among white (34-4-49, XIV-186, and Malverina) and red varieties (II 70/21, M 39-9/74, Nero, and Laurot).

Table 6. Wine evaluation summary.

Cultivar[1]	Vintage Ratings[2,5] 2000	2001	2002	2003	2004	Cumulative Average[6]
Whites						
Bianca	9.7, 9.0	9.4, 9.2, 9.0, 8.8	4.3	7.1, 5.3	6.3	8.6
Iskorka	11.1, 9.9	3.1		2.6		10.5
Liza	15.0, 8.5	5.4	9.4, 8.4	7.6, 4.1		9.8
Malverina	12.7, 11.2, 10.4, 6.4	12.6, 12.4, 10.9		12.3, 10.1, 4.6		11.0
Petra	12.8, 10.2			6.6		9.9
Rani Riesling		12.5, 10.5	9.7, 9.1	7.2		9.8
Toldi	11.1, 10.8		9.1, 7.6, 4.0	4.8		9.7
XIV-1-86	15.2, 14.2, 10.8, 9.4, 7.6	15.6, 11.8		14.1, 13.4	6.8	11.9
XX-15-51	13.0, 10.4	2.8		6.9, 6.6		9.2
34-4-49	11.9, 11.6	14.1, 12.2		3.5		12.5
Cayuga white (std)	8.8					
Vidal Blanc (std)	14.8	10.4			11.8	12.3
Vidal/Seyval blend (std)			10.7			
Traminette (std)			6.2			
Seyval (std)				11.0		
Reds						
Demetra				11.5, 9.5		10.5
I 31/67	8.6, 3.2	10.7, 10.4, 9.3, 8.3		6.0		8.9
II 70/21				16.2, 13.8		15.0
Ir 26/5					14.4	
Kozma 55	12.2, 12.1, 10.5, 10.3, 8.8	12.5, 11.6, 10.1		11.1, 9.0		10.8
Kozma 55 blended[3]			12.7, 10.7, 9.6			11.0
Kozma 525	11.2, 11.0, 10.5, 6.3	13.0, 11.7, 11.3, 9.1	9.7, 5.1	12.0, 11.6		10.7
Laurot	12.8, 12.2, 11.6, 10.7	13.1, 12.3, 10.3	13.4, 10.3	15.3, 13.1		12.3
M 39-9/74	11.9, 11.5, 9.5	12.0, 12.0, 11.7, 8.4	11.8, 9.3, 8.2	12.8, 7.1		12.5
Nero				12.6, 12.3		12.5
Rubin Tairovski	11.2, 10.2, 8.7, 7.6	9.5, 7.7	4.6	12.4, 9.1, 0.5	11.4	9.8
Rubin Tairovski (blended)[4]		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)			15.6, 14.9		12.2	14.2

1 Cayuga white, Chambourcin, Norton, Traminette, Vidal/Seyval blend, and Vidal Blanc were included as high quality American and French-American wine standards for comparison. All standard comparison wines were only evaluated once, with the exception of 2002 Norton.

2 Missing ratings are due to vintages being unsatisfactory and therefore not bottled or 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. The 2002 whites were not rated in 2006 due to their age. Several 2004 reds were omitted from 2006 tasting in a preliminary evaluation.

3 Blend of 50% Kozma 55 and 50% Laurot.

4 The small Rubin Tairovski yield was not sufficient to make wine and thus was blended with Chambourcin.

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

6 Cumulative average: Mean of all average ratings for a variety; however, ratings of less than 6 were not included in the cumulative average (i.e., where wine had obviously spoiled or where there was a winemaking problem).

Most red wines have received lower ratings as they have aged. This year, seven red wines (two to four years old) received higher ratings this year versus last year, and five received lower ratings this year. The two highest rated 2003 whites received higher ratings in this year's evaluation than in last year's. A bottle of 2001 Malverina which was stable was also evaluated. It received a higher rating than it did two and four years ago.

The individuals who made these wines and some professional winemakers believe 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.

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 25 percent of these vines are *vinifera,* or European, cultivars that can sustain extensive damage in very cold winters. Additionally, frequent exposure to low winter temperatures can cause trunk splitting in the European grapevines. These wounds allow entry and infection by the bacteria *Agrobacterium vitis*, which produces the disease crown gall. This often severely weakens and kills the European vines. European varieties are typically trained to the vertical shoot position (VSP) system, having one or two trunks. An alternative is the fan system, in which several trunks are grown. The advantage of this system is that some trunks may escape winter injury and crown gall development, thus allowing the vine to survive crown gall and produce some crop. The objectives of this study were to compare survival, yield, and fruit quality between VSP- and fan-trained grape varieties.

Materials and Methods

One-year-old, dormant, bare-root vines of the *vinifera* cultivars Cabernet Franc clone #332 (fairly hardy), Chardonnay clone #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 that was on its own roots. Vines were spaced 8 ft within the row and 12 ft (454 plants x acre^{-1}) between rows in a randomized block factorial design with six replications.

Half the vines were trained using the VSP system, in which vines are developed with two trunks that become two cordons on the lowest wire (38 inches above ground). From these cordons shoots are trained vertically between two pairs of catch wires (spaced 12 inches above the lowest wire). The remaining vines were fan-trained, in which up to six trunks were grown. They radiate from the vine base or graft union in a fan pattern and are tied to the trellis wires. In 2005, metal post extensions and another pair of catch wires were installed to increase leaf area, bringing the trellis height to 7 ft.

Vines were watered as needed until established, and weeds were controlled in a 3-ft wide herbicide strip 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 vine size. Additional cluster and shoot thinning were performed on vines that had excessive crops and vine size, respectively. Insecticide, fungicide, and herbicide applications were made in accordance with the *Midwest Grape and Small Fruit Spray Guide*.

Vines were fruited for the first time in 2004. Here we report results from the 2006 growing season. Yield, cluster weight, berry weight, total soluble solids, juice pH, and titratable acids (TA) were measured.

Results and Discussion

There were no differences by cultivar in the total number of clusters harvested (Table 1). However, the number of marketable clusters harvested per vine decreased by 5%, and 13%, respectively, for Chardonnay and Shiraz, compared to the own-rooted Vidal Blanc (Table 1). The number of marketable clusters per vine was 15% and 3% higher for Cabernet Franc and Vidal Blanc/3309, respectively, than for the own-rooted Vidal Blanc vines. The per acre yields of Chardonnay, Cabernet Franc, and Shiraz were 4%, 1%, and 4% lower than for the Vidal Blanc on either rootstock (Table 1). There was no difference in cluster weights among the cultivars tested. The training systems did not affect any of the yield components (Table 1).

The cultivars and training systems interacted to affect the percent soluble solids measurements (Figure 1). Vidal Blanc on either rootstock had higher soluble solids measurements than any of the other treatment combinations. The juice pH was influenced by both the training systems and the cultivars (Table 2). The juice pH of Cabernet Franc and Shiraz was 5% higher than that of the Vidal Blanc on either rootstock. The juice pH was lower for grapevines trained to the fan system (Table 2). The cultivars and training systems interacted to influence TA (Figure 2). The TA of Shiraz on the fan training system and own-rooted Vidal Blanc on the VSP system was higher than for the other treatment combinations.

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

	Factor					
Cultivar/Harvest Date	Total Clusters/ Vine	Marketable Clusters/ Vine[1]	Culled Clusters/ Vine[2]	Marketable Weight/ Vine (lb)	Yield (tons/A)[3]	Cluster Weight (g)
Chardonnay (8 Sept.)	61	58.5 b	3.9 bc	14.2 c	9.7 b	339
Cabernet Franc (27 Sept.)	76	79 a	2.6 c	27.517.8 abc	13.7 a	357
Shiraz (27 Sept.)	64	51 b	10.6 a	19.522.0 b	9.7 b	444
Vidal Blanc/own (6 Oct.)	70	64 ba	7.3 ba	29.3 a	14.6 a	486
Vidal Blanc/C3309 (6 Oct.)	64	67 ba	6.5 bac	30.2 a	15.1 a	109
p <	0.1706	0.0405	0.0023	0.0006	0.0006	0.4761
Training System						
Fan	74 a	70	1.0	25.7	12.85	248
VSP	62 b	59	1.5	24.9	12.41	443
p <	0.0031	0.0661	0.1615	06992	0.6992	0.1888
Cultivar x Training System	0.6328	0.3300	0.3187	0.6278	0.6278	0.4511

1 Numbers in same column followed by same letter are not statistically different (P < 0.05); ns = not significant (no statistically significant difference within the column).
2 Clusters that had > 30% visual damage by fungal infection, bird damage, or sunburn.
3 Based on 454 vines per acre.

Figure 1. Interaction of training system and cultivar on percent total soluble solids in 2006.

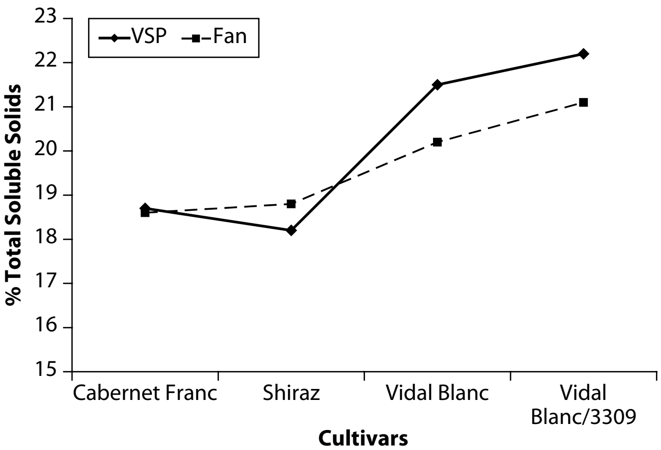
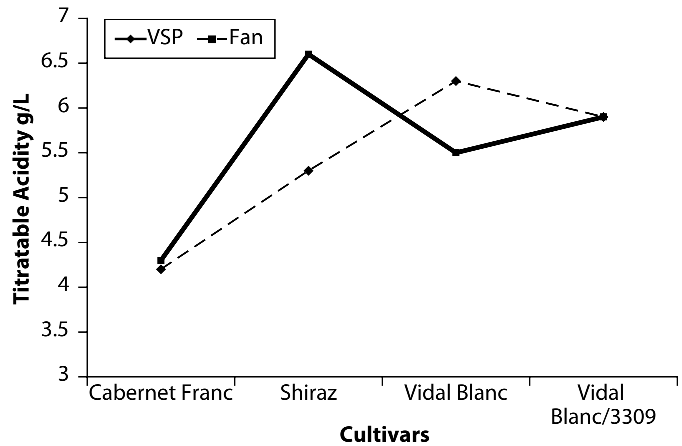


Figure 2. Interaction of training system and cultivar on percent titratable acidity in 2006.



In 2006, Vidal Blanc on either rootstock performed better than Syrah and Cabernet Franc. The Vidal Blanc yields per vine were higher than the recommended yield (> 21 lb/vine) for hybrids grown in the lower midwestern United States. The fruit composition of Vidal Blanc on either rootstock was again better than for the other two cultivars. However, the increased TA measured for Vidal Blanc on VSP indicates intra-canopy shading.

Acknowledgments

The authors would like to thank the following for their hard work and assistance in this trial: Katie Bale and Dave Lowry.

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

	Factor				
Cultivar	**Total Clusters**	**TSS[1]**	**Juice pH**	**TA[2]**	**Berry Weight (g)[3]**
Chardonnay	-	-	-	-	-
Cabernet Franc	76	18.6	3.7 a	4.26	1.842 b
Shiraz	64	18.4	3.7 a	5.95	1.973 a
Vidal Blanc/own	70	20.9	3.5 b	5.90	1.905 ba
Vidal Blanc/C3309	64	221.6	3.5 b	5.93	1.962 ba
p <	0.1706	0.0001	0.0001	0.0001	0.0855
Training System					
Fan	74 a	19.7	3.5 b	5.4	1.9 b
VSP	62 b	20.1	3.6 a	5.4	2.0 a
p <	0.0031	0.1029	0.0279	0.3116	0.0193
Cultivar x Training System	0.6328	0.0543	0.2613	0..0003	0.5041

1 TSS = total soluble solids measured as Brix in juice.
2 TA = Titratable acidity measured as grams of tartaric acid in a liter of juice.
3 Numbers in same column followed by same letter are not statistically different ($P < 0.05$); ns = not significant (no statistically significant difference within the column).

Blueberry Cultivar Trial for Eastern Kentucky

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Introduction

Although blueberries (*Vaccinium* spp.) are native fruits, Kentucky has limited commercial acreage. Blueberries have an excellent potential for local sales and you-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.

Table 1. Harvest measurements, berry measurements, and characteristics of rabbiteye blueberry cultivars, Quicksand, Ky., 2006.

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)
Ira	2.64 A	0.035 B	M	S	A	14 Jul	47
Onslow	1.74 A	0.048 A	ML	TB	A	14 Jul	22
Tifblue	1.84 A	0.036 B	SM	T	A+	14 Jul	15
Powderblue	1.36 A	0.036 B	S	varies	A	14 Jul	14

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 7/14, 7/18, 7/21, 7/25, 7/30, 8/3, 8/7 over a 25-day harvest season.

Rabbiteye blueberry varieties are native to the southern United States. They are recommended for zones 7 through 9 but can be effectively grown in Kentucky (zone 6). Rabbiteye blueberries mature later than highbush blueberries and may prove useful in extending Kentucky's market window for retail sales. Rabbiteye blueberries have the same growing requirements as the highbush, although they tend to be taller and are planted farther apart than the highbush plants.

The high start-up cost for blueberries, approximately $4,000/A, is mainly due to land preparation, plants, 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 for highbush varieties but will continue into mid-August for rabbiteye varieties.

Materials and Methods

A planting of rabbiteye blueberries was established at the University of Kentucky Robinson Station in Eastern Kentucky in the spring of 2004. The planting consists of two rows of four cultivars in a randomized, complete block design, repeated approximately three times in each row. Plants were set 4 ft apart in raised beds 14 ft apart. This planting is next to the highbush variety trial. Drip irrigation with point source emitters (2 gph/plant) was installed shortly after planting. In spring of 2006, one application of 5-20-20 fertilizer (5 lb/100 ft row) was followed by two sidedressings of sulfur-coated urea (5 lb/50 ft row), one at bloom and one three weeks later. An application of urea (0.2 lb/50 ft row) was applied in late August. Netting was used to prevent loss from birds.

Results

Results are shown in Table 1. There was not a significant difference in the pounds per bush between the four varieties. Onslow had the largest berry, while the other three varieties were statistically the same. Tifblue had an above-average appearance rating, while the remaining varieties had an average rating.

A variety's maturity is measured as the percent of the total seasons yield that is harvested in the first two pickings. Ira (47%) was the earliest maturing variety, followed by Onslow (22%). Powderblue and Tifblue (both 14%) matured later. Picking of the rabbiteye blueberries began on July 14 and ended on August 7, constituting a 25-day picking season. It is important to remember that these bushes have not reached maturity and in the future will continue to produce higher yields each year until they reach their fifth or sixth growing season.

Blueberry Variety Evaluations

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

Introduction

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

Materials and Methods

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

Plants showing iron chlorosis were fertilized with Miracid Professional Water Soluble Fertilizer 21-7-7 Acid Special and iron chelate the first year. During the season, plants were fertilized with Osmocote Plus 5-6-month controlled release (15-9-12) fertilizer at the rate of 1 oz per plant in March, April, May, June, and July. This fertilizer contains six trace elements and magnesium. Plots were drip-irrigated using point source emitters (1 gph/plant). Foliar insecticide applications included Sevin, Malathion, and Esteem. Fungicide applications included lime sulfur, Pristine, and Captan. Roundup was applied in the fall of 2005 and the summer of 2006 for postemergent weed control.

Flowers were removed from plants each spring until they reached a height of 3 feet. These larger plants were allowed to fruit for the first time in 2006. Fruit were harvested once a week. Twenty-five fruit from each plant were weighed to determine berry size at each harvest. Netting was used over the rows in 2006 for bird control.

Table 1. Highbush and southern highbush blueberry yield and fruit size, Lexington, Ky., 2006.

Variety	Type[1]	Yield (lb/A)[2]		Berry Weight (oz/25 berries)	
Chandler	HB	3846	a	2.7	a
NC-3129	HB	2482	ab	1.4	bc
Bluecrop	HB	2213	ab	1.5	bc
Pamlico	SH	1950	bc	1.2	bc
NC-1871	HB	1687	bcd	1.2	bc
NC-2927	SH	1530	bcd	1.0	c
Ozarkblue	SH	876	bcd	1.5	bc
Lenore	SH	861	bcd	1.7	bc
Star	SH	854	bcd	1.4	bc
Arlen	SH	198	cd	1.9	b
Echota	HB	85	d	1.0	c
Sampson	SH	65	d	-	
Aurora	HB	26	d	-	
Misty	SH	12	d	-	

1 Type: HB = highbush; SH = southern highbush.
2 Numbers followed by the same letter are not significantly different (Waller- Duncan LSD, P = 0.05).

Results

The 2006 season was frost free and hot in June, July, and August. Rainfall was frequent all season. Harvest and fruit size data are shown in Table 1. Eleven of the highbush and southern highbush varieties were harvested for yield in 2006. The Chandler highbush variety tended to have the highest yield and also had the largest berries. NC-3129 and Bluecrop, also highbush varieties, did not differ in yield statistically from Chandler. There was no difference in berry size between the other varieties. The southern highbush varieties Duplin and Legacy were not fruited due to small plant size. Most of the rabbiteye plants were not large enough to fruit, and the few that did fruit failed to provide enough data for statistical analysis.

These data should be considered preliminary, and a number of additional seasons will be required to determine how these varieties perform in Central Kentucky.

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The authors would like to thank the following people for their hard work and assistance in the successful completion of this trial: Matt Anderson, Jessica Ballard, Ryan Capito, Jessica Cole, Christopher Fuhr, Courtney Hart, Mary Lesen, Dave Lowry, Daniel McNatt, Claudia Meeks, Tyler Pierce, Natlanit Piyakarn, Charlie Neal, Kirk Ranta, Kiefer Shuler, Aren Spears, Wissarut Sukhaket, Joseph Tucker, Bonka Vaneva, and David Wayne.

Evaluation of Strawberry Varieties as Matted Rows

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

Introduction

Strawberries continue to be popular with Kentucky consumers, and most growers find that high quality strawberries are readily marketable. This study was initiated to evaluate newer strawberry varieties planted in the matted row system at the University of Kentucky Horticultural Research Farm in Lexington, Kentucky.

Materials and Methods

Nineteen dormant, bare-rooted strawberry varieties were planted on 11 April 2005. Earliglow, Honeoye, Allstar, and Jewel were included as standards. Each plot was 10 ft long and consisted of six plants set 2 ft apart in the row with 4 ft between rows. Plots were replicated four times in a randomized block design. Disease and weed control were conducted in accordance with the *Midwest Commercial Small Fruit and Grape Spray Guide* (ID-94). Nova, Pristine, Abound, Captan, and Topsin M fungicides were used for disease control. Dacthal was used for weed control during the first season. No insecticides were applied. Fifty-seven pounds of nitrogen per acre as ammonium nitrate and 104 lb of K as 0-0-60 per acre were applied preplant and tilled into the soil.

Ten-foot sections in each plot were harvested in the spring of 2006. Yield, fruit size, flavor, and appearance data were collected. The 2005 season was hot and dry, while the spring of 2006 was cool and wet. Data are shown for the 2006 harvest season. Fifteen berries were weighed at each harvest to determine average berry weight. Berry flavor and appearance were assessed on two dates, while firmness was assessed once.

Table 1. Strawberry yield, berry weight, and harvest date, 2006.

Variety	Yield[1] (lb/A)	Avg. Berry Wt.[2] (g/berry)	1st Harvest (date)	Harvest Midpoint[3] (date)	Days of Harvest
Mesabi	22412 A	14.9 BC	19 May EFG	3 Jun FGHI	27 ABCD
Primetime	17930 AB	14.4 BCD	16 May HIJ	30 May MN	27 BCD
Kent	17139 BC	13.5 BCDEF	19 May EFGH	3 Jun EFG	29 ABC
Mira	16214 BCD	12.0 DEF	22 May DE	4 Jun DEF	25 CDE
Darselect	15414 BCDE	13.5 BCDEF	17 May GHIJ	31 May JKLM	28 ABCD
Cabot	14899 BCDE	24.8 A	27 May C	6 Jun C	20 F
Sable	14783 BCDE	11.2 EFG	15 May IJ	27 May P	28 ABC
Honeoye	14266 BCDEF	11.0 FG	15 May IJ	31 May KLM	29 AB
Allstar	13772 BCDEF	13.4 BCDEF	22 May DE	2 Jun GHIJ	24 DEF
L'Amour	13119 BCDEF	16.0 B	19 May EFGH	1 Jun IJKL	26 BCDE
Jewel	12871 CDEF	13.7 BCDEF	23 May CD	6 Jun CD	22 EF
Eros	12805 CDEF	15.0 BC	21 May DEF	5 Jun CDE	26 BCDE
Earliglow	12168 DEF	9.0 G	12 May K	28 May OP	31 A
Evangeline	12120 DEF	9.0 G	14 May JK	29 May NO	30 AB
88741	11613 DEF	24.2 A	6 Jun A	14 Jun A	14 G
Clancy	11523 DEF	15.3 BC	21 May DEF	3 Jun EFGH	26 BCDE
Bish	11265 EF	13.8 BCDE	16 May GHIJ	30 May LMN	27 ABCD
Gurney's Whopper	9776 FG	13.4 BCDEF	18 May FGHI	1 Jun HIJK	28 ABCD
Ovation	6000 G	13.1 CDEF	1 Jun B	11 Jun B	16 G

[1] Means within a column followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05).
[2] Average berry weight based on the weight of 15 berries at each harvest.
[3] Date on which half of the berries were harvested, based on total yield weight.

Results and Discussion

Yields were excellent since there was no late spring frost. Mesabi and Primetime yielded the most, with 22,412 and 17,930 pounds per acre, respectively (Table 1). Cabot and #88741 produced the largest berries. Earliglow and Evangeline produced the earliest berries, while Ovation and #88741 produced the latest fruit.

Earliglow, Darselect, Bish, Evangeline, and Allstar were rated as having the best tasting fruit (Table 2). Allstar, Primetime, Jewel, Earliglow, Bish, Mesabi, Ovation, and Honeoye were rated as having the most attractive berries in a wet season that was not particularly conducive to producing attractive fruit. Clancy, Allstar, Evangeline, Ovation, Jewel, and Earliglow produced the firmest fruit.

Allstar, Earliglow, Evangeline, Darselect, Ovation, and Jewel were judged to have the most desirable fruit quality characteristics.

Table 2. Strawberry flavor, firmness, and appearance, 2006.

Variety	Flavor[1] (1-5)	Firmness[2] (1-10)	Appearance[3] (1-10)	Comments
Mesabi	2.0	5.5	7.4	
Primetime	2.9	6.1	7.7	
Kent	3.0	6.4	6.5	Seedy, badly rain checked
Mira	3.4	6.8	7.1	
Darselect	4.0	6.5	7.1	Floral taste, excellent flavor
Cabot	3.1	5.5	6.9	Very large, some rain checking
Sable	3.6	5.3	7.2	Tart, soft
Honeoye	3.6	5.5	7.3	
Allstar	3.7	8.5	7.7	Firm, low acid
L'Amour	3.3	6.6	7.0	
Jewel	3.3	7.1	7.7	Tart, seedy looking
Eros	3.4	5.0	5.6	Very seedy, some rain checking
Earliglow	4.2	7.1	7.4	Excellent flavor
Evangeline	3.9	7.8	7.1	Flowery, variable flavor
88741	3.0	5.7	6.3	
Clancy	3.4	8.6	6.6	Tart, seedy tasting, cracking
Bish	4.0	5.0	7.4	Excellent flavor
Gurney's Whopper	3.4	4.5	6.4	Considerable rain checking
Ovation	3.4	7.4	7.3	Tart

[1] Flavor rating: 1 = poor; 5 = excellent on May 30 and June 6.
[2] Firmness rating: 1 = poor; 10 = excellent on June 6.
[3] Appearance rating: 1 = poor; 10 = excellent on May 30 and June 6.

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The authors would like to thank the following for their hard work and assistance in this years trial: Matt Anderson, Jessica Ballard, Ryan Capito, Jessica Cole, Christopher Fuhr, Courtney Hart, Mary Lesen, Dave Lowry, Daniel McNatt, Claudia Meeks, Tyler Pierce, Natlanit Piyakarn, Charlie Neal, Kirk Ranta, Kiefer Shuler, Aren Spears, Wissarut Sukhaket, Joseph Tucker, Bonka Vaneva, and David Wayne.

Asian Pear, Apple, and Peach Variety Demonstrations

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

Introduction

Cultivar choice is one of the most important decisions every fruit producer makes. 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 for performing well in Kentucky.

Materials and Methods

In the spring of 1997, an apple variety trial was planted in the orchard of the University of Kentucky Research and Education Center at Princeton, Kentucky. Various apple cultivars (two trees per cultivar) were planted. Four Asian pear cultivars (eight trees) were also included in the west side guard row. In 2004 (1) and 2005 (2), and 2006 phenological stages were recorded in the spring, and yield, fruit size (average weight of 50 fruits), flesh firmness, and percent soluble solids (Brix) were recorded at harvest.

In 2004, a block of 37 peach cultivars was planted, consisting of two trees per variety spaced 6 ft apart within rows 18 ft apart. The phenology of each cultivar was recorded in 2005 (2) and again in 2006. Also recorded in 2006 were yield, number of fruit, and Brix readings of three fruits.

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.

Table 1. Dates of phenological stages for apple and pear cultivars in 2006 at Princeton, Ky.

Cultivars/Rootstock (nursery)	Green Tip	Half-Inch Green	Tight Cluster	Pink	Bloom	Petal Fall	Fruit Set
Asian Pear							
Chojuro / OHxF97 (RM)	8 Mar	10 Mar	13 Mar	15 Mar	29 Mar	5 Apr	11 Apr
Korean Giant / OHxF97 (RM)	8 Mar	10 Mar	13 Mar	15 Mar	27 Mar	5 Apr	11 Apr
Niitaka / OHxF333 (RM)	8 Mar	10 Mar	13 Mar	15 Mar	29 Mar	5 Apr	11 Apr
Apple							
Jonagold De Coster / M.9 (ACN)	13 Mar	17 Mar	31 Mar	3 Apr	8 Apr	17 Apr	19 Apr
Rubinstar Jonagold / M.9 (Wafler's)	17 Mar	29 Mar	31 Mar	5 Apr	11 Apr	17 Apr	19 Apr
Morren's Jonagored / B.9 (Stark's)	16 Mar	23 Mar	30 Mar	2 Apr	7 Apr	17 Apr	19 Apr
Shizuka / B.9 (RM)	13 Mar	17 Mar	27 Mar	31 Mar	3 Apr	17 Apr	19 Apr
Florina / CG.10 (RM)	17 Mar	21 Mar	31 Mar	3 Apr	8 Apr	17 Apr	19 Apr
Enterprise PP9193 / CG.10 (RM)	10 Mar	13 Mar	15 Mar	31 Mar	3 Apr	17 Apr	19 Apr
Sun Fuji / M.9 (ACN)	13 Mar	15 Mar	17 Mar	31 Mar	3 Apr	17 Apr	19 Apr
Yataka / M.9 (Starks)	13 Mar	23 Mar	31 Mar	3 Apr	8 Apr	17 Apr	19 Apr
Senshu / M.9 (Starks)	11 Mar	13 Mar	17 Mar	31 Mar	8 Apr	17 Apr	19 Apr
GoldRush / M.9 (Starks)	17 Mar	25 Mar	31 Mar	3 Apr	8 Apr	17 Apr	19 Apr
Pristine PPAF / M.9 (RM)	10 Mar	13 Mar	15 Mar	29 Mar	3 Apr	17 Apr	19 Apr
Monark / B.9 (RM)	10 Mar	13 Mar	15 Mar	29 Mar	3 Apr	17 Apr	19 Apr
William's Pride PP6268 / O.3 (RM)	10 Mar	13 Mar	15 Mar	29 Mar	31 Mar	17 Apr	19 Apr
Redfree PP4322 / CG.10 (RM)	15 Mar	17 Mar	31 Mar	3 Apr	11 Apr	17 Apr	19 Apr
Sansa PP 6519 / M.9 (ACN)	10 Mar	13 Mar	17 Mar	3 Apr	5 Apr	17 Apr	19 Apr
Rezista Gala (Releika)	10 Mar	13 Mar	17 Mar	31 Mar	5 Apr	17 Apr	19 Apr
Crimson Crisp-Coop 39 / CG.10 (RM)	13 Mar	29 Mar	31 Mar	3 Apr	11 Apr	17 Apr	19 Apr
Big Red BJ 45 Gala / CG10 (RM)	10 Mar	13 Mar	17 Mar	31 Mar	3 Apr	17 Apr	19 Apr
6882 Pixie Crunch Dwarf / M.9	10 Mar	17 Mar	27 Mar	3 Apr	8 Apr	17 Apr	19 Apr
Liberty / M.9 (Starks)	10 Mar	13 Mar	17 Mar	31 Mar	3 Apr	17 Apr	19 Apr
Scarlet O'Hara-Coop25 / B9 (RM)	10 Mar	13 Mar	31 Mar	3 Apr	8 Apr	17 Apr	19 Apr

Table 2. 2006 harvest results from the 1997 apple and pear cultivar trial at Princeton, Ky.

Cultivars/Rootstock (nursery)	Harvest Date	2006 Yield (lb/tree)	Fruit Weight (oz)	Flesh Firmness (lb)	Brix (%)
Asian Pear					
Chojuro / OHxF97 (RM)	9/5	33	5.4	-	-
Korean Giant / OHxF97 (RM)	-	-	-	-	-
Niitaka / OHxF333 (RM)	-	-	-	-	-
Apple					
Jonagold De Coster / M.9 (ACN)	8/31	62	8.1	18.0	13.9
Rubinstar Jonagold / M.9 (Wafler's)	8/31	17	3.0	22.6	15.3
Morren's Jonagored / B.9 (Stark's)	9/7	73	8.4	-	-
Shizuka / B.9 (RM)	9/19	37	9.9	15.9	14.1
Florina / CG.10 (RM)	9/19	70	8.3	17.1	14.1
Enterprise PP9193 / CG.10 (RM)	10/3	60	7.3	16.7	14.6
Sun Fuji / M.9 (ACN)	10/3	120	6.4	15.9	13.4
Yataka / M.9 (Starks)	10/3	79	6.2	16.1	13.6
Senshu / M.9 (Starks)	8/31	148	6.3	16.8	12.3
GoldRush / M.9 (Starks)	9/19	50	8.0	26.8	16.0
Pristine PPAF / M.9 (RM)	7/9	28	5.4	14.5	11.4
Monark / B.9 (RM)	7/14	32	5.1	14.5	11.5
William's Pride PP6268 / O.3 (RM)	7/14	2	-	20.5	11.7
Redfree PP4322 / CG.10 (RM)	7/26	26	6.1	13.0	12.0
Rezista Gala (Releika)	8/19	14	4.3	22.4	15.1
Sansa PP 6519 / M.9 (ACN)	8/3	34	6.0	13.9	13.1
Crimson Crisp-Coop 39/CG.10 (RM)	8/10	55	6.9	22.1	12.7
Big Red BJ 45 Gala / CG10 (RM)	8/10	40	8.3	12.1	12.5
6882 Pixie Crunch Dwarf / M.9	831	6	-	-	-
Liberty / M.9 (Starks)	8/31	34	5.0	21.2	13.5
Scarlet O'Hara (Coop 25 / B.9)	8/10	46	6.6	22.3	14.7

Table 3. Dates of phenological stages for peach cultivars at Princeton, Ky., 2006.

Cultivar	Swollen Bud	Half-Inch Green	Pink	Bloom	Petal Fall	Fruit Set
John Boy	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
White Lady	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
Red Haven	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
RedStar	8 Mar	13 Mar	17 Mar	29 Mar	3 Apr	11 Apr
Snow Brite	8 Mar	13 Mar	15 Mar	17 Mar	5 Apr	13 Apr
Sugar May	8 Mar	10 Mar	12 Mar	13 Mar	5 Apr	13 Apr
Spring Snow	8 Mar	10 Mar	13 Mar	15 Mar	5 Apr	13 Apr
Allstar	8 Mar	13 Mar	14 Mar	15 Mar	3 Apr	11 Apr
Contender	8 Mar	13 Mar	17 Mar	29 Mar	3 Apr	13 Apr
Coralstar	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	13 Apr
Sugar Giant	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	13 Apr
Klondike	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
NJ 275	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
John Boy II	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	13 Apr
Snow Giant	8 Mar	10 Mar	14 Mar	15 Mar	3 Apr	13 Apr
Laurol	8 Mar	13 Mar	14 Mar	15 Mar	3 Apr	13 Apr
Encore	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
Cresthaven	8 Mar	13 Mar	17 Mar	21 Mar	3 Apr	13 Apr
Glowingstar	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
Blushingstar	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
Summer Breeze	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
PF Lucky 21	8 Mar	11 Mar	12 Mar	13 Mar	3 Apr	11 Apr
PF 17	8 Mar	13 Mar	15 Mar	29 Mar	3 Apr	13 Apr
PF 15A	8 Mar	13 Mar	15 Mar	29 Mar	3 Apr	13 Apr
PF Lucky 13	8 Mar	12 Mar	13 Mar	15 Mar	3 Apr	13 Apr
PF 7	8 Mar	13 Mar	14 Mar	15 Mar	3 Apr	13 Apr
PF 5B	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
PF 1	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	13 Apr
PF 35-007	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	13 Apr
Sweet-N-Up	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
Crimson Rocket	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	11 Apr
PF 27A	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
PF 25	8 Mar	10 Mar	13 Mar	15 Mar	3 Apr	11 Apr
PF 24C	8 Mar	13 Mar	17 Mar	29 Mar	3 Apr	11 Apr
PF 20-007	8 Mar	13 Mar	15 Mar	17 Mar	3 Apr	11 Apr
Galaxy	8 Mar	10 Mar	12 Mar	13 Mar	17 Mar	27 Mar
Flat Wonderful	8 Mar	10 Mar	12 Mar	13 Mar	17 Mar	27 Mar

Table 4. Results of the 2006 harvest from the 2004 peach cultivar trial at Princeton, Ky.

Cultivar	Harvest Date	2006 Yield (lb/tree)	Fruit Weight (oz)	Brix (%)
John Boy	24 Jul	15.8	5.5	11.6
White Lady	20 Jul	39.4	3.2	11.2
Red Haven	13 Jul	41.0	3.7	9.9
RedStar	13 Jul	27.8	3.6	9.5
Snow Brite	11 Jul	1.5	4.8	12.6
Sugar May	.	.	.	.
Spring Snow	.	.	.	.
Allstar	31 Jul	55.3	2.8	8.4
Contender	4 Aug	47.5	3.7	9.4
Coralstar	27 Jul	36.5	5.6	8.8
Sugar Giant	4 Aug	1.8	4.7	8.4
Klondike	24 Jul	17.7	5.3	10.1
NJ 275 (Ernie's Choice)	27 Jul	0.4	2.0	11.3
John Boy II	27 Jul	26.9	6.9	10.9
Snow Giant	21 Aug	17.2	5.6	12.3
Laurol	21 Aug	56.4	4.2	11.9
Encore	21 Aug	51.4	11.3	12.1
Cresthaven	7 Aug	34.0	4.8	11.1
Glowingstar	27 Jul	68.5	4.0	10.5
Blushingstar	27 Jul	47.1	3.4	10.5
Summer Breeze	14 Jul	24.7	3.2	10.9
PF Lucky 21	31 Jul	30.4	5.7	11.2
PF 17	24 Jul	42.7	4.3	11.4
PF 15A	13 Jul	37.0	4.6	10.6
PF Lucky 13	6 Jul	37.0	3.9	11.3
PF 7	27 Jun	9.8	3.4	10.8
PF 5B	15 Jun	25.4	3.0	10.0
PF 1	15 Jun	25.6	2.8	10.0
PF 35-007	14 Aug	23.9	5.1	11.3
Sweet-N-Up	31 Jul	0.1	0.5	8.9
Crimson Rocket	31 Jul	2.5	3.1	11.3
PF 27A	7 Aug	13.2	4.7	12.5
PF 25	7 Aug	20.0	4.9	12.3
PF 24C	31 Jul	25.6	3.2	10.4
PF 20-007	24 Jul	56.9	5.5	10.2
Galaxy	.	.	.	.
Flat Wonderful	.	.	.	.

The top three yielding apple varieties in 2006 were Senshu, Sun Fuji, and Yataka, yielding 148, 120, and 79 lb/tree, respectively. Phenology of each peach cultivar is presented in Table 3. Yield, average weight per fruit, and average Brix reading are presented in Table 4.

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Rootstock and Interstem Effects on Pome Fruit Trees

Joseph 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 in Kentucky than 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 titled, "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 this 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 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.

Table 1. 2006 results for the 1999 NC-140 dwarf and semi-dwarf apple rootstock trial, UKREC, Princeton, Ky.

Rootstock	Percent Survival (no. trees planted)	Cumulative Yield (lb/tree)	2006 Yield (lb/tree)	Fruit Weight (oz)	Trunk Cross-Sectional Area (sq in.)	No. Root Suckers
Dwarf[1]						
CG.4031	100 (4)	511	55	7.8	17.0	8.3
CG.3041	50 (2)	494	20	.	11.1	0.0
G.16T	100 (5)	454	60	7.8	11.7	1.8
CG.5179	83 (6)	434	57	7.9	10.5	9.2
G.16N	100 (4)	417	46	7.7	11.6	3.3
CG.5202	80 (5)	390	71	8.1	10.5	3.5
M.9NAKBT337	83 (6)	370	66	8.4	9.7	6.0
Supporter 1	100 (6)	335	40	8.1	8.2	0.0
Supporter 2	100 (6)	320	20	6.2	6.4	1.0
Supporter 3	100 (6)	302	7	3.2	7.2	2.0
M.26 EMLA	83 (6)	287	53	8.1	8.9	0.0
Mean	91	377	44	7.7	9.8	3.2
LSD (5%)	NS	139	49	1.2	2.5	4.4
Semi-Dwarf[1]						
CG.30N	100 (2)	571	62	8.5	14.5	5.5
CG.7707	60 (5)	459	55	7.6	13.6	3.3
M.7 EMLA	100 (6)	362	66	7.9	11.7	4.3
CG.4814	80 (5)	331	33	6.9	11.3	8.0
M.26 EMLA	67 (6)	313	35	7.7	11.6	0.5
Supporter 4	17 (6)	123	18	.	2.5	1.0
Mean	67	373	46	7.7	11.7	4.5
LSD (5%)	NS	198	NS	NS	NS	3.6

[1] Arranged in descending order of cumulative yield.

Materials and Methods

Grafts 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 10 ft x 16 ft spacing.
   ii) six semi-dwarfing rootstocks with six replications per rootstock. Trees are planted on 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 trial compares 11 rootstocks with Golden Delicious as the scion cultivar. Two trees of each rootstock were planted in a randomized, complete block design with four replications (blocks). Trees are planted on 8 ft x 15 ft spacing.

Orchard floor management consists of a 6.5 ft herbicide strip with mowed sod alleyways. Trees are fertilized and sprayed with pesticides according to local recommendations (1, 2). Yield and trunk circumference measurements are recorded for all of the rootstock trials. Tree height and canopy spread (the average of the within-row and across-row tree widths) are recorded at the end of the fifth and final (usually the tenth) seasons of each trial. Fruit size is calculated as the average weight (oz) of 50 fruits.

Table 2. 2006 results from the 2002 NC-140 rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (no. trees planted)	Cumulative Yield (lb/tree)	2006 Yield (lb/tree)	Fruit Weight (oz)	Trunk Cross-Sectional Area (sq in.)	Tree Height (ft)	Canopy Spread (ft)	No. Root Suckers
M.9 Burg 756	29 (7)	173	77	6.0	6.8	12.9	9.8	2.0
P.14	71 (7)	157	91	5.8	9.8	15.0	10.5	0.6
M.9 T337	57 (7)	154	79	6.0	5.4	11.2	8.9	1.5
M.26 EMLA	57 (7)	139	57	6.3	5.0	9.4	8.1	0.0
M.26 NAKB	57 (7)	137	45	5.9	6.0	10.4	8.3	0.0
Supporter 4	86 (7)	131	57	6.1	5.6	10.8	8.7	1.7
M.9 Nic29	86 (7)	130	42	6.2	4.4	10.1	7.9	5.3
B.9 Treco	86 (7)	92	31	5.7	2.5	7.7	7.6	1.8
B.9 Europe	86 (7)	57	19	5.2	1.5	6.9	5.4	2.0
Mean	71	124	52	5.9	5.0	10.2	8.2	1.7
LSD (5%)	NS	48	28	NS	2.3	2.6	1.4	2.3

[1] Arranged in descending order of cumulative yield.

Results and Discussion

The winter of 2006 was generally mild. Temperatures in the 60s and 70s in January were followed by a cold snap where temperatures dropped to 5°F on February 19. Rainfall was near normal for most months, but September was one of the wettest and coolest on record.

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.5179 and CG.4013 had the most root suckers 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.

Cumulative yield has been greatest for scions on CG.4031 and CG.3041 among the dwarf stocks, and CG.30 and CG.7707 among the semi-dwarf stocks. Yield in 2006, fruit size, and trunk cross-sectional area varied significantly only among the dwarf rootstocks, while tree mortality did not vary significantly by rootstock for either the dwarf or semi-dwarf group. 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 freestanding, 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 2006, fall trunk cross-sectional area, tree height, canopy spread, and number of root suckers, but no difference was observed in fruit size as measured by average fruit weight (Table 2). The cumulative yield over the past three years was greatest for trees on M.9 Burg756, P.14, and M.9 T337. Scions on these three rootstocks also yielded the most fruit in 2006. P.14 and B.9 Europe rootstocks have produced the largest and smallest trees, respectively, in this trial.

Table 3. 2006 results for the 2003 NC-140 apple rootstock trial, UKREC, Princeton, Ky.

Rootstock[1]	Percent Survival (no. trees planted)	Cumulative Yield (lb/tree)	2006 Yield (lb/tree)	Fruit Weight (oz)	Trunk Cross-Sectional Area (sq in.)
PiAu56-83	100 (8)	139	123	7.3	11.4
CG.5935	63 (8)	134	88	6.2	4.1
J-TE-H	100 (8)	128	99	6.6	5.1
PiAu51-4	100 (7)	112	97	7.4	10.2
Bud.62-396	100 (8)	106	75	7.0	4.4
CG.3041	88 (8)	88	60	7.5	3.7
M.9T337	88 (8)	88	62	6.2	4.1
M.9Pajam2	100 (8)	88	68	6.9	4.9
G.16	50 (8)	86	60	6.5	4.1
M.26	88 (8)	73	55	7.1	4.2
B.9	88 (8)	24	15	6.0	1.3
Mean	87	99	75	6.8	5.4
LSD (5%)	24	35	29	0.8	1.0

[1] Arranged in descending order of cumulative yield.

III. 2003 Apple Rootstock Trial

Tree survival, cumulative yield, 2006 yield, average fruit weight, and trunk cross-sectional area all varied significantly among the trees in this trial (Table 3). Trees on PiAu56-83 yielded the most fruit in 2006 and are the biggest trees in this trial. Mortality has been greatest for scions on G.16.

Literature Cited

1. Jones, R.T., J.G. Strang, J.R. Hartman, R.T. Bessin, J.G. Masabni. *2006 Commercial Tree Fruit Spray Guide.* University of Kentucky College of Agriculture Cooperative Extension Service, Publication ID-92.
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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 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-year old Red Haven peach orchard, were conducted. The purpose of these experiments was to determine the residual control and benefits of 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 a 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 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. Peach and apple trees were at 100% and 50% full bloom, respectively. As weeds had been growing since early March and were 3 to 4 inches tall, 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 treatments. All treatments were applied early in the morning when the average wind speed was 2.5 mph.

This experiment included labeled and non-labeled herbicides for 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 the University of Kentucky does not recommend their use until they are labeled.

This experiment also evaluated the benefits of Attach, an additive that improves weed control. In the peach experiment, PRE and POST applications of treatment 2 included Attach, while those of treatment 3 did not. In the apple experiment, treatments 2, 4, 6, and10 included Attach, while treatments 1, 3, 5, 7, 8, and 9 did not.

The fall treatments listed in the tables were applied 17 December 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 to 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, less so on clover and marestail. By 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 (6 May). However, its benefit was exhausted by 15 June, with best weed control achieved with treatment 2.

Table 1. Weed control ratings for herbicide treatments applied April 14, 2005, in peach orchard at UKREC, Princeton, Ky.

Treatment No. and Name		Formula Conc. (%)	Formula Type	Rate/A	Growth[1] Stage	Weed Control Ratings and Dates of Ratings[2]						
						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 b	9 a	10 a	9 b	1 d	3 b	1 b
2	Princep	4	L	4.8 qt	PRE,POST	6 c	8 b	10 a	8 c	8 ab	9 a	7 a
	Attach		L	1 pt	PRE,POST							
3	Princep	4	L	4.8 qt	PRE,POST	6 c	9 a	8 c	10 a	8 ab	8 a	4 ab
4	Roundup	5.5	L	16 oz	PRE	1 d	1 c	1 d	1 d	3 cd	1 b	1 b
	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.
Means within columns followed by the same letter are not statistically different at P = 5%.

Table 2. Weed control ratings for herbicide treatments applied April 14, 2005, in apple orchard at UKREC, Princeton, Ky.

Treatment No. and 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 a	9 a	9 b	6 ab	5 abc	6 ab	10 a	6 ab
2	Princep	4	L	4.8 qt	PRE	8 c	4 e	8 c	8 a	8 ab	10 a	10 a	6 ab
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
3	Princep	4	L	4.8 qt	PRE	7 d	4 e	9 b	8 a	3 cd	9 ab	4 cd	7 ab
	Surflan	4	AS	6 qt	POST								
4	Karmex	80	DF	4.8	PRE	10 a	8 b	10 a	7 a	9 a	10 a	10 a	10 a
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
5	Karmex	80	DF	4.8	PRE	9 b	8 b	9 b	6 ab	6 abc	10 a	10 a	10 a
	Surflan	4	AS	6 qt	POST								
6	Devrinol	50	DF	8 lb	PRE	8 c	4 e	7 d	7 a	3 cd	6 ab	5 bc	1 c
	Attach		L	1 pt	PRE								
	Surflan	4	AS	6 qt	POST								
7	Devrinol	50	DF	8 lb	PRE	7 d	4 e	5 e	3 bc	4 bcd	5 b	3 cd	3 bc
	Surflan	4	AS	6 qt	POST								
8	Exp. A			16 oz	PRE	8 c	7 c	9 b	9 a	5 a-d	10 a	9 ab	10 a
9	Exp. A			8 oz	PRE	8 c	8 b	9 b	9 a	3 cd	9 ab	9 ab	9 a
10	Roundup	5.5	L	16 oz	PRE	5 e	5 d	4 f	1 c	1 d	1 c	1 d	1 c
	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.
Means within columns followed by the same letter are not statistically different at P=5%.

Treatments 4 and 5 had the best weed control but also stunted current season shoot growth. Karmex is currently available but not labeled for use on peaches. The observed stunting on peaches is obviously the reason why it is not labeled for 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 6 oz (the low end of the labeled rate) gave better weed control initially but lost its effectiveness after two months. The experimental formula (treatments 8 and 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.

Table 3. Weed number and weight per sample area in spring of 2006 for herbicide treatments applied December 17, 2005, in apple orchard at UKREC, Princeton, Ky.

Treatment No. and Name		Formula Conc. (%)	Formula Type	Rate/A	Growth Stage[1]	Weed No./ sq ft April 17, '06	Weed No./sq ft May 18, '06	Weed Weight g/sq ft May 24, '06
1	Chateau	51	WG	12 oz	FALL	5 b	8 b	12 b
2	Casoron	4	G	150 lb	FALL	31 a	62 a	72 a
3	Gallery	75	DF	21.3 oz	FALL	36 a	80 a	84 a
LSD (P = 0.05)						24	9	24

Means within columns followed by the same letter are not statistically different at P = 5%.

Table 4. Weed number and weight per sample area in spring of 2006 for herbicide treatments applied December 17, 2005, in peach orchard at UKREC, Princeton, Ky.

Treatment No. and Name		Formula Conc. (%)	Formula Type	Rate/A	Growth Stage[1]	Weed No./ sq ft April 17, '06	Weed No./ sq ft May 18, '06	Weed Weight g/sq ft May 24, '06
1	Chateau	51	WG	12 oz	FALL	10 a	8 a	24 c
2	Casoron	4	G	150 lb	FALL	19 a	62 b	67 b
3	Gallery	75	DF	21.3 oz	FALL	8 a	77 b	80 b
4	Roundup	5.5	L	1 oz	FALL	34 a	80 b	137 a
LSD (P = 0.05)						24	46	48

Means within columns followed by the same letter are not statistically different at P = 5%.

In the apple experiment (Table 3), on 17 April 2006 (about four months after fall herbicide application). Chateau 12 oz had the fewest number of weeds in the sample area with five weeds/sq ft compared to 31 and 36 weeds/sq ft for Casoron and Gallery, respectively. By 18 May, or 142 days after treatment, Chateau continued to show significant weed suppression with only 3.5 weeds/sq ft compared to about 30 for the other two herbicides.

Similar results were observed in the peach experiment at 142 days after treatment, with Chateau showing the best weed suppression, while Casoron and Gallery performed as well as the non-residual Roundup herbicide (Table 4). It appears that fall-applied Chateau has at least five months residual activity, whereas Casoron and Gallery run out of weed suppression at least a month earlier.

Evaluation of Herbicide Performance in Newly Planted Pawpaw

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Introduction

An experiment was initiated in 2006 to evaluate the safety and performance of non-registered herbicides in newly planted pawpaw seedlings. Currently, only Roundup, Gramoxone, and Aim are labeled for pawpaw plantings. All three herbicides are postemergent and must be applied with shielded booms as a directed spray while avoiding spraying green leaf or trunk tissue. More herbicides labeled for use in pawpaw are needed, especially with preemergence activity.

Materials and Methods

One-year old seedlings were hand transplanted on 7 June 2006 at a 2 ft spacing between plants. The experimental design consisted of 13 treatments with three replications, with two to three plants per replication. The experiment was set up as a randomized complete block design. Treatments were applied on 13 June 2006, using a CO_2-pressured backpack sprayer with a one-nozzle FF8004 boom set to deliver 20 gpa at 30 psi. The nozzle was set to spray a 3 ft band on either side of the planted row for a total plot width of 6 ft. The nozzle was also set to spray the bottom 6 to 8 inches of the trunks. This was to evaluate the injury potential from direct herbicide application on the seedlings, in addition to any possible injury through root absorption.

On the day of application, it was noted that some leaves showed sunburn injury, which is not related to any herbicide application. The weather conditions at the time of application were as follows:

Air temp., unit:	72°F
% relative humidity:	39
Wind direction, mph:	N 3.5
Dew presence (Y/N):	N
Soil temp., unit:	60°F
Soil moisture:	moist
% cloud cover:	100

Results and Discussion

Table 1 lists the 13 herbicide treatments and their effects on the pawpaw transplants season-long increase of total leaf number, total branch length (cm), total plant height, and percent plant survival by 57 days after treatment (DAT). The most obvious observation is that none of the herbicides killed all of the transplants. Only three herbicides (treatments 2, 3, and 4) resulted in reduced plant survival but not statistically different from the control treatment. Treatments 2, 3, and 4 also resulted in reduced plant growth for all the measured variables.

The best treatment was Solicam at 4 lb ai/A, which resulted in plant growth exceeding even the untreated control plots. The worst treatment was Prowl at 0.412 lb ai/A, which resulted in significantly fewer developed leaves counted at the end of experiment. It is also worthwhile noting that even Prowl was worse than Roundup and Gramoxone, two nonselective herbicides that are effective in killing any green tissue they contact. It is reasonable to assume that the one-year-old pawpaw transplants must have enough bark formation to tolerate direct application of these two herbicides.

It is also worth noting that all preemergence herbicides (Princep, Gallery, Karmex, Surflan, Chateau, Solicam, and V-10142) appear to have potential application in newly transplanted pawpaw plantings.

Table 1. Effects of various herbicides on growth variables of newly-planted pawpaw trees.

Treatment No. and Name		Rate lb ai/A	Increase in: Leaf No. in 55 days	Branch Length in 55 days (in.)	Plant Height in 55 days (in.)	Percent Survival 55 DAT
1	Untreated Control		38 a	13 a	30 a	100 a
2	Princep	4.8	23 a	13 a	19 a	89 a
3	Gallery	1	30 a	21 a	22 a	89 a
4	Karmex	4.8	15 a	16 a	29 a	89 a
5	Surflan	6	16 a	14 a	15 a	100 a
6	Chateau	0.38	37a	19 a	30 a	100 a
7	Prowl	0.412	12 a	7 a	17 a	100 a
8	Treflan	2	30 a	15 a	22 a	100 a
9	Gramoxone Inteon	0.75	32 a	19 a	24 a	100 a
10	Roundup	0.68	22 a	12 a	24 a	100 a
11	Solicam	4	48 a	19 a	33 a	100 a
12	Goal	1.5	16 a	9 a	13 a	100 a
13	V-10142	1	22 a	17 a	26 a	100 a
LSD (P=0.05)			26.4	11	14	15.9

Evaluation of Direct Seeding and Transplant of Sweet Corn on Black Plastic Mulch

Amanda F. Sears and John Snyder, Department of Horticulture

Introduction

The use of black plastic mulch can heat the soil by as much as 8°F in the spring. This temperature difference could allow earlier planting and lead to subsequent early harvest of sweet corn. Using corn seedling transplants may also bring an earlier crop, compared with direct seeding. This research was done to compare the performance of direct seeded and transplanted sweet corn on black plastic mulch.

Table 1. Direct seeded and transplanted sweet corn characteristics on black plastic mulch.

Treatment	Avg. Date of First Harvest	No. of Ears/A (doz)	Ear Length (in.)	Ear Width (in.)	Avg. Ear Weight (lb)	Height to First Ear (in.)
direct seeding	7/5/2006*	1363	7.1*	1.4*	0.46*	15.6*
transplanted	6/23/2006*	1337	6.5*	1.6*	0.37*	4.9*

* Means in the column were significantly different (P < 0.05) as determined by a 1 d.f. F-test.

Table 2. 372A X Tender and 377 X Tender sweet corn characteristics grown on black plastic mulch.

Treatment	Avg. Date of First Harvest	No. of Ears/A (doz)	Ear Length (in.)	Ear Width (in.)	Avg. Ear Weight (lb)	Height to First Ear (in.)
372A	6/27/2006*	1425	6.9	1.5	0.40	10.0
377A	7/1/2006*	1276	6.7	1.4	0.43	10.5

* Means in the column were significantly different (P < 0.05) as determined by a 1 d.f. F-test.

Methods

Two sugary enhanced sweet corn varieties, obtained from Seedway, were used. For transplanting, varieties were seeded into 200-cell flats (two seeds per cell) on 20 March. On 12 April, seeds and transplants were planted into soil covered with black plastic mulch using a double row waterwheel setter. Two gallons of a saturated zinc sulfate solution was added to a 20-10-20 preplant fertilizer in the 100 gal. setter tank. Plots contained 80 hills per replication in a double row (four plants per foot of double row). In the direct seeded treatment, three seeds were placed in each hole. The trial was set up in a randomized complete block design.

According to the soil test results, 100 lb/A K_20 were added to the plot preplant. An additional 190 lb N/A were added through the drip irrigation lines.

Ear length, ear width, average ear weight, total number of ears, height to first ear, and earliness of harvest were all evaluated in this trial.

Results

When comparing direct seeded and transplanted corn (Table 1), there was not a significantly different yield. However, the other variables observed were significantly different between transplanted and direct seeded corn. The direct seeded harvests were 11 days later than those from the transplanted plots. Harvest for transplanted corn began on 23 June, while the harvest of direct seeded corn began on 5 July. Ear length was 0.6 inches longer with direct seeding. Ear width was 0.2 inches wider with transplanting. Average ear weight was 0.09 pounds greater with the direct seeded treatments. Height to first ear was also significantly different. With direct seeding, height was 15.6 inches. The transplanted corn plants were stunted, and height to first ear was only 4.9 inches, a difference of 10.7 inches.

The two corn varieties, 372A X Tender and 377 X Tender (Table 2) did not differ in yield, ear length, ear width, average ear weight, or height to first ear. However, there was a significant difference for earliness. Harvest of 372A began on 27 June, while 377A harvest began on 1 July, a difference of four days.

Growers need to be aware that when transplanting sweet corn into black plastic, plant height may be stunted, but the number of ears per acre should not be affected.

Ornamental Corn Evaluation in Eastern Kentucky

Amanda F. Sears, Terry Jones, and John Snyder, 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 and producing and selling fall decorations have become a significant part of some farms incomes. This research was done to evaluate ornamental corn varieties that might be appropriate for commercial growers in Kentucky.

Methods

Eight ornamental corn varieties were observed in the summer of 2006 at Robinson Station. The eight varieties were planted by hand on 6 June. Plots consisted of 20 ft rows with each cultivar replicated four times in a randomized block. Rows were 3 feet apart and 40 seeds were dropped in each row.

The ornamental corn plot received 50 lb/A of ammonium nitrate preplant. Additionally, on 28 June, the plot was sidedressed with 50 lb/A of nitrogen for a total of 100 lb/A N.

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.

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 2006 growing season. Quicksand received 17.19 inches of rain between 1 June and 20 September.

The ornamental corn was harvested from 19 September to 14 October.

Little Miss Muffet and Little Boy Blue had the highest yields and the best quality ears of the eight ornamental cultivars tested (Table 1). Robust Ruby Red is also recommended, due to good commercial acceptability and low lodging percentage. Gorgeous Indian, American Pride, Earth Tones Dent, and Wilda's Pride are not recommended due to low commercial acceptability, as well as significantly lower yield.

Table 1. 2006 ornamental corn ear and plant characteristics and yield, Robinson Station, Quicksand, Ky.

Cultivar Name	Seed Source	Ear Color	Husk Color[1]	Ear Length (in.)	Ear Width (in.)	Tip Fill[2]	Lodging[3] (%)	Height to First Ear (in.)	Yield (doz/A)	Commercial Acceptability[2]
Gorgeous Indian	SG	Mixed	YW/P	8.6a	1.2bc	7.3b	3.8c	41.8bc	1195d	3.5d
American Pride	SG	Mixed	YW	8.9a	1.3ab	6.5c	8.8c	45.5ab	1452d	3.3d
Earth Tones Dent	H	Mixed	YW	6.0c	1.4a	5.8d	60a	40.5c	1573dc	3.0d
Wilda's Pride	H	Mixed	YW/P	7.6b	1.4a	5.0e	35b	43.0abc	1028d	1.6e
Little Miss Muffet	SG	Light purple	YW	4.8d	0.8d	7.4b	0.5c	43.3abc	4431a	9.6a
Autumn Explosion	SW	Mixed	YW/P	7.5b	1.3bc	7.0bc	5.0c	41.3bc	2798b	6.8c
Robust Ruby Red	SW	Red	YW	6.1c	1.2c	7.3b	0c	47.3a	2616bc	8.0b
Little Boy Blue	SG	Dark blue	W	3.8d	0.7d	9a	0c	44.8abc	3388ab	10a

[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.

Leafy Greens RACE Variety Trial (Conventional and Organic)

Derek Law, John Snyder, Brent Rowell, and Mark Williams, Department of Horticulture

Introduction

A Rapid Action Cultivar Evaluation (RACE) trial was designed to screen more than 70 varieties of leafy greens including arugula, broccoli raab, Chinese kale, collards, kale, mustard, turnip greens, endive, escarole, lettuce (butterhead, cos, and leaf), Swiss chard, and spinach,. The majority of varieties were grown both organically and conventionally on two separate areas of the University of Kentucky Horticulture Research Farm in Lexington, Kentucky, in 2006.

Materials and Methods

Spring Organic Production

Seeds of 78 varieties of lettuce, Swiss chard, turnip, kale, raab, mustard, collards, Chinese kale, endive, and escarole were planted by hand on 28 March into flats (120 cells per flat). Poor germination prompted a second planting of all organic varieties on 6 April into flats (200 cells per flat) using a vacuum seeder. Sunshine Organic Grow Mix amended with a small amount of Nature's Safe Fine 10-2-8 organic fertilizer (1 cup per 50 lb of media) was the potting medium used for both organic plantings. Seedlings were fertilized once in the greenhouse using Omega 6-6-6 and were hardened off on outside benches for one week prior to transplant. Seedlings were transplanted 24 April into ground that had lain fallow for three years prior to the experiment. Two locations in the field were planted with 20 plants of each variety for a total of 40 transplants of each variety in the trial. The plot was initially tilled on 27 March, fertilized with Nature's Safe 10-2-8 at a rate of 50 lb N/A and formed into raised beds covered with black plastic mulch on 8 April. Irrigation was supplied by drip irrigation lines underneath the black plastic mulch. A waterwheel setter was used for transplanting. Agri-Bon-19 row cover was placed over the planting beds following transplanting to exclude insects from the young plants. The row cover was left in place until first harvest on 22 May. Dipel 150 (Bt var. kurstaki), was applied twice after the row covers were removed to all varieties of the *Brassica* family to combat cabbage worms. Weed control between raised beds was performed using a small tractor-driven rotovator and wheel hoes. At harvest, all varieties were rated for appearance and vigor, and 20 full-sized plants, 10 from each separately planted area, were harvested for weight measurements. Chard, turnip, mustard, kale, raab, collards, and Chinese kale were all harvested in a way that allowed for multiple harvests. The lettuce, endive, and escarole were allowed to grow to maturity and harvested from their bases, precluding multiple harvests. Harvests in the spring organic trial were conducted on 22 and 30 May and on 7 and 15 June.

Spring Conventional Production

Due to mismanagement, these crops performed poorly, leading to unreliable data. This part of the report has been eliminated.

Fall Organic and Conventional Production

Seeds of 90 varieties of lettuce, Swiss chard, turnip, kale, raab, mustard, collards, Chinese kale, endive, spinach, and escarole were planted on 21 and 24 July into 200-cell flats using a vacuum seeder. On 1 August, 33 varieties that had germinated poorly were replanted using the same method. Planting media was the same as used for the spring organic production. Transplants were fertilized twice with Omega 6-6-6 prior to transplanting. The organic field plot was ground that had lain fallow for the past three years and was initially tilled using an Imants spader on 20 July. The organic plot was fertilized at a rate of 40 lb N/A using Nature's Safe 10-2-8 and was disked and formed into raised beds covered with black plastic mulch on 7 August. The conventional field plot was initially plowed early in the spring and had lain unused for the summer. It was re-plowed, disked, and fertilized at a rate of 40 lb N/A with ammonia nitrate and formed into raised beds covered with white plastic mulch on 14 and 15 August. Transplanting of the organic trial was performed on 25 August and 7 September and for the conventional trial, on 26 August and 8 September. A waterwheel setter was used. Twenty plants of each variety were planted in two separate locations in both organic and conventional field plots for a total of 40 plants of each variety. AgriBon-19 row cover was immediately applied to the organic plot following transplanting, and it has remained in place during the entire season except when weed control or harvest operations were conducted. One fertigation of the organic plots using Phytamin 6-0-0 at a rate of 10 lb N/A was applied on 20 September. Weed control between beds in the organic plots was performed using a small tractor-driven rotovator and wheel hoes. Following transplanting in the conventional plots, one spray of Sevin 80 S (1 lb/A) was applied to control flea beetles. Weed control between beds was performed using a tractor-mounted multivator tillage implement in the conventional plots. Harvest and evaluation procedures were identical to those for spring production. Harvest in the fall organic trial was conducted on 27 September and 20 October, and in the fall conventional trial, on 26 September and 20 October.

Results and Discussion

Both organically produced and conventionally produced greens performed very well with few problems. The use of row covers for insect exclusion in the organic trials protected the plants long enough that the worst insect pest, flea beetles, did little overall damage. Insect attack by cabbage looper and cabbage worm were managed effectively with Dipel 150. The spring planted trials appeared to have slightly more insect pressure than the fall planted trials, but the pressure was controllable when careful and attentive management practices were followed. Disease pressure was slight in both the spring and fall trials due possibly to the use of long fallowed ground and/or the fact that greens have not been grown on this farm for quite some time, thus providing a long crop rotation period.

Data relating to appearance, vigor, and harvested weights collected from this trial were used to make the following comparisons among crop types and varieties but will be not be included in this publication. These data are available from the authors upon request.

Arugula

Three varieties of arugula (Astro, Sprint, and Arugula [no varietal name]) were examined in this trial (Table 1). Astro and Arugula leaves look essentially the same, while Sprint has a narrower, more pinnatisect or heavily lobed leaf form. Sprint with its wavy, deeply lobed leaf form is the more interesting visually of the three, but all performed equally well under Kentucky growing conditions with appearance, vigor, and yield ratings being essentially the same.

Broccoli Raab

Three selections of broccoli raab (Spring Raab, Sessantina Grossa, and Zamboni) were examined in this trial (Table 1). The yield of Spring Raab was double that of the other two varieties in the spring, but all three selections yielded equally in the fall. Appearance and vigor scores ranked the three varieties equally, and all performed well under Kentucky growing conditions.

Chinese Kale

Two types of Chinese kale (Green Lance and Happy Rich) were included in this trial (Table 1). Green Lance performed poorly both seasons and under both production systems due to its propensity to bolt very quickly. Happy Rich consistently had better appearance scores, and harvest was much easier to conduct at the correct stage of growth.

Collards

Four varieties of collards (Champion, Flash, Vates, and Georgia/Southern) were included in these trials (Table 1). Organic/untreated seeds were not available for the Vates variety so it was not included in the organic trial, and the variety Champion had not reached harvest maturity when this report was written. Georgia/Southern had the highest consistent appearance score and was the highest yielding variety in both organic and conventional production. Champion, Vates, and Flash performed equally well, and all four varieties appeared to be suitable to Kentucky growing conditions.

Kale

Six varieties of kale (Winterbor, Darkibor, Redbor, Red Russian, Vates blue curled, and Toscano) were tested in both conventional and organic plots, while three additional varieties (Blue Ridge, Blue Armor, and Blue Knight) were tested only in the conventional plot. Kale as a group performed slightly better in the fall than in the spring, but neither appearance, vigor, nor yield ratings differed due to production system (Table 1). Red Russian and Toscano were rated as the most attractive varieties and were the highest yielders. All these varieties performed well and can be recommended for Kentucky growing conditions.

Mustard

Six mustards (Green Wave, Tendergreen, Old Fashioned, Florida Broadleaf, Red Giant, and Southern Giant) were grown for this trial. However, Old Fashioned suffered a crop failure in the spring organic trial. Southern Giant, Green Wave, and Old Fashioned are frilled leaf varieties, while Tendergreen and Florida Broadleaf are smooth varieties. Red Giant is a red/purple/green variety with frilled leaves. All varieties performed well, with similar appearance, vigor, and yield scores, regardless of production system, although yields were higher overall in both fall plantings than in the spring planting (Table 1). All varieties did well in this trial.

Swiss Chard

Four varieties of Swiss chard (Bright Lights, Fordhook Giant, Silverado, and Ruby Red were tested; however, Ruby Red was not ready for harvest in the organic fall plantings, and Fordhook Giant, Silverado, and Ruby Red were not ready for harvest in the conventional fall planting when this publication was written. From the data available (Table 2), however, all four varieties performed well with their appearance, vigor, and yield averages being very similar.

Turnip Greens

Three turnip greens varieties (Topper, Southern Green, and Seven Top) were tested in this trial (Table 2). Southern Green was only available in treated seed and was thus excluded from the organic trial, and it had not yet reached harvest maturity when this report was written, so no data are currently available. Topper and Seven Top performed well in both production systems, although both appeared to yield more in the fall season. The organically grown turnip green varieties were attacked by flea beetles after row covers were removed in the spring, making some leaves not marketable. Leaving the row covers on throughout the early season would likely lessen the extent of this problem. Both Topper and Seven Top varieties appeared to be good varieties for Kentucky growers.

Endive

Three endive varieties (Neos, Lorca, and Fine Green Curled) were examined in this trial (Table 2); however, crop failures eliminated Fine Green Curled from the fall conventional trial and Neos from the spring organic trial. Fine Green Curled scored poorly in the spring organic trial, but in the fall scored equally with the other varieties in all factors—appearance, vigor, and yield. Endive as a crop performed better in the fall than the spring, and all three of these varieties can do well in Kentucky.

Escarole

Two varieties of escarole (Natacha and Broadleaf Batavian) were grown and performed equally well under both production systems (Table 2). However, the conventional fall planting outyielded the spring and fall yields of the organic production systems, No explanation for this can be gleaned from the data set, and no particular insect or disease problems were observed in either trial that might account for the disparity. As with endive, escarole seemed to perform better in fall than in spring, but both of these varieties did well in Kentucky.

Table 1. General performance ratings for arugula, broccoli raab, Chinese kale, collards, kale, and mustard varieties tested in the 2006 RACE trial at the University of Kentucky Horticulture Research Farm, Lexington, Ky.

Type	Cultivar Name	Seed Source	NT/O	Performance Good	OK	Poor
Arugula	Astro	JS	Non-treated	x		
	Sprint	JS	Non-treated	x		
	Arugula	JS	Organic	x		
Broccoli Raab	Sessantina Grossa	JS	Non-treated	x		
	Spring Raab	JS	Non-treated	x		
	Zamboni	SN	Non-treated	x		
Chinese Kale	Green Lance	JS	Non-treated			x
	Happy Rich	JS	Non-treated	x		
Collards	Champion	JS	Non-treated	x		
	Flash	JS	Non-treated	x		
	Vates	SW	Treated	x		
Kale	Darkibor	SN	Non-treated	x		
	Redbor	JS	Non-treated	x		
	Toscano	JS	Non-treated	x		
	Vates(blue curled)	SN	Non-treated	x		
	Winterbor	JS	Non-treated	x		
	Red Russian	JS	Organic	x		
	Blue Armor	AC	Treated	x		
	Blue Knight	AC	Treated	x		
	Blue Ridge	SI	Treated	x		
Mustard	Florida Broadleaf	CF	Non-treated	x		
	Green Wave	JS	Non-treated	x		
	Old Fashioned	CF	Non-treated	x		
	Southern Giant	CF	Non-treated	x		
	Tendergreen	CF	Non-treated	x		
	Red Giant	JS	Organic	x		

Table 2. General performance ratings for Swiss chard, turnip greens, endive, and escarole tested in the 2006 RACE trial at the University of Kentucky Horticulture Research Farm, Lexington, Ky.

Type	Cultivar Name	Seed Source	NT/O	Performance Good	OK	Poor
Swiss Chard	Fordhook Giant	JS	Non-treated	x		
	Bright Lights	JS	Non-treated	x		
	Ruby Red	JS	Non-treated	x		
	Silverado	SW	Organic	x		
Turnip Greens	Seven Top	SST	Non-treated	x		
	Topper	SW	Non-treated	x		
Endive	Lorca	SN	Non-treated	x		
	Neos	JS	Non-treated	x		
	Fine Green Curled	RU	Non-treated		x	
Escarole	Broadleaf Batavian	HMS	Non-treated	x		
	Natacha	JS	Non-treated	x		

Lettuce

For presentation, the lettuces (Table 3) have been split into three groups: bibb/butterhead, romaine/cos, and leaf lettuces.

Bibb/Butterhead

Nine varieties of bibb/butterhead (Optima, Bennet, Ermosa, Esmeralda, Adriana, Redstar, Bibb, Buttercrunch, and Fireball) were examined in both the organic and the conventional trials, while one variety (Nancy) was grown only in the conventional trial. Four varieties stood out with consistently high ratings and yields: Optima, Bennet, Ermosa, and Esmeralda. Four types (Adriana, Nancy, Fireball, and Redstar) performed well but not equal to the best varieties, and two others (Bibb and Buttercrunch) consistently had relatively low vigor and yield and were very quick to bolt. Best bets for good bibb/butterhead production in Kentucky appear to be the varieties Optima, Bennet, Ermosa, Esmeralda, Adriana, Nancy, Fireball, and Redstar, while Bibb and Buttercrunch should be retested and grown with caution by producers.

Leaf Lettuce

Sixteen examples of leaf lettuce varieties (Baronet, Black Seeded Simpson, Grand Rapids, Green, Marin, New Red Fire, Red Sails, Royal Green, Tropicana, Aruba, Firecracker, Royal Oak, Tango, Two Star, and Waldmans) were grown in this trial, while one variety (Xena) was only produced conventionally. Only Firecracker was consistently poor in appearance and yield. Highest yielding varieties were Tropicana and Waldmans, while most attractive were Red Salad Bowl, Aruba, Red Sails, and Royal Oak. With the exemption of Firecracker, all of these leaf lettuces performed well.

Romaine/Cos

Eight types of romaine/cos lettuce (Green Forest, Triton, Winter Density, Green Towers, Jericho, Outredgeous, Parris Island Cos, and PIC 714) were grown in both organic and conventional trials, while two varieties (Ideal and Coastal Star) were exclusive to the conventional trial. All performed well except for Outredgeous, which was consistently the lowest yielding variety, and Coastal Star. However, the latter was only examined once. All other varieties scored high on appearance and vigor and yielded well in Kentucky growing conditions.

Spinach

Spinach varieties were planted only in the organic plot during the fall period of this trial and had not yet been harvested when this report was written. These spinach evaluations will be included in a future report.

Table 3. General performance ratings for lettuce varieties tested in the 2006 RACE trial at the University of Kentucky Horticulture Research Farm, Lexington, Ky.

		Seed		Performance		
Type	**Cultivar Name**	**Source**	**NT/O**	**Good**	**OK**	**Poor**
Bibb/Butterhead	Adriana	JS	Non-treated		x	
	Bennet	SW	Non-treated	x		
	Bibb	RU	Non-treated			x
	Buttercrunch	JS	Non-treated			x
	Fireball	JS	Non-treated		x	
	Optima	HMS	Non-treated	x		
	Red Star	JS	Non-treated		x	
	Ermosa	JS	Organic	x		
	Esmeralda	SI	Non-treated	x		
	Nancy	JS	Treated/ pellet		x	
Leaf	Baronet	JS	Non-treated	x		
	Black-Seeded Simpson	JS & RU	Non-treated	x		
	Grand Rapids	RU	Non-treated	x		
	Green	SW	Non-treated	x		
	Marin	JS	Non-treated	x		
	New Red Fire	JS	Non-treated	x		
	Red Sails	JS	Non-treated	x		
	Red Salad Bowl	JS	Organic	x		
	Royal Green	SW	Non-treated	x		
	Tropicana	JS	Non-treated	x		
	Aruba	JS	Organic	x		
	Firecracker	JS	Organic			x
	Royal Oak	JS	Organic	x		
	Tango	JS	Organic	x		
	Two Star	JS	Organic	x		
	Waldmans	JS	Organic	x		
	Xena	HR	Treated/ pellet	x		
Romaine/Cos	Green Forest	JS	Non-treated	x		
	Triton	SN	Non-treated	x		
	Winter Density	JS	Non-treated	x		
	Green Towers	SW	Non-treated	x		
	Jericho	JS	Organic	x		
	Outredgeous	JS	Organic			x
	Parris Island Cos	JS	Organic	x		
	PIC 714	JS	Organic	x		
	Ideal/Ideal Cos	SW	Treated	x		
	Coastal Star	JS	Treated/ pellet			x

Specialty Melon Variety Evaluations

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

Forty specialty melon varieties were evaluated in a replicated trial for their performance under Kentucky conditions. These included ananas, Asian, canary, casaba, crenshaw, galia, gourmet, hybrid, honeydew, Hungarian, eastern muskmelon, and Piel de Sapo melons.

Materials and Methods

Varieties were seeded on 25 April into Styrofoam plug trays (72 cells per tray) at the Horticulture Research Farm in Lexington. Plug trays were set on a greenhouse bench to germinate, and seedlings were subsequently thinned to one per cell. Plants were set into black plastic-mulched, raised beds using a waterwheel setter on 6 June. Each plot was 21 feet long, with seven plants set 3 feet apart within the row and 6 feet between rows. Each treatment was replicated four times in a randomized complete block design. Drip irrigation was used to provide water and fertilizer as needed.

One hundred 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 45 lb N/A as ammonium nitrate divided into seven applications over the season. One foliar Epsom salts spray was applied. The systemic insecticide Admire 2F was applied with a hand sprayer as a drench to the base of each plant after transplanting, using the maximum rate of 24 fl oz/A. Foliar insecticide applications included Sevin and Pounce. Weekly foliar fungicide applications included Maneb, Bravo, Pristine, Quadris, and Nova. Curbit and Sandea, preemergent herbicides, were 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 hot, and rainfall was frequent; consequently, disease pressure was high. No virus symptoms were observed. During most of the season, vine cover was thick, with no plant death. However, by the end of the season, foliar diseases were serious problems for a number of varieties despite a weekly spray schedule. Thus, this was a challenging season to evaluate melons under adverse growing conditions.

Fruit were generally harvested twice a week. Harvest and evaluation data for the replicated trial are in Tables 1 and 2. Most melon varieties evaluated previously performed well. Varieties are grouped by melon type and listed in order of declining yield within the grouping.

Replicated Trial

Honeydew. None of the honeydews were exceptional. Surface checking and cracking, which are problems in wet seasons, were a problem this year. Rocio performed well and was the highest yielding melon in the trial. It had very little fruit cracking and checking and tasted good. Honey Brew, which has done well in previous trials, was rated as having the best flavor and had the highest sugar content. It has a problem with surface checking and foliage diseases in wet seasons.

Galia. Galileo was the top performing galia melon. It yielded very well and had very good flavor and fruit quality. Galia Max and Arava also were attractive and had very good eating characteristics. Gala Max is a very large melon and would be outstanding in a dry season.

Canary. Sugar Nut, a small melon, and Golden Beauty, a large one, again performed exceptionally well, producing high yields of high quality, attractive melons with few or no culls.

Table 1. Specialty melon variety trial yield and fruit characteristics, Lexington, Ky., 2006.

Variety	Melon Type[1]	Seed Source	Days to Harvest	Yield (cwt/A)[2]		Avg. No. Melons/ A	Avg. Wt./Fruit (lb)	Culls[3] (%)	Outside Measurements Length (in.)	Outside Measurements Width (in.)	Flesh Thickness (in.)	Seed Cavity Length (in.)	Seed Cavity Width (in.)
Rocio	HD	SW	85	1050	a	12,791	8.2	2	8.4	8.0	2.1	5.2	4.3
Silverado	HD	SY/RG	86	784	bcdef	9,161	8.6	0	8.3	8.2	2.1	5.2	4.0
Honey Brew	HD	SI	90	753	bcdef	8,873	8.5	7	9.2	7.7	2.0	5.6	3.6
Super Dew	HD	BU	80	745	bcdef	9,680	7.8	1	8.8	7.7	1.7	5.9	4.2
Honey King	HD	SY/RG	95	701	bcdefg	8,902	7.9	1	9.3	8.8	2.0	5.8	4.5
Silver Express	HD	SY/RG	85	698	bcdefgh	8,556	8.2	0	8.3	7.8	2.1	4.9	3.8
Galileo	GA	SY/RG	86	870	ab	20,224	4.3	1	6.0	6.1	1.7	3.2	2.6
Galia Max	GA	HL	82	790	bcde	9,248	8.3	3	8.4	7.2	2.2	5.5	2.9
Arava	GA	JS	77	769	bcdef	13,569	5.6	3	6.7	6.8	1.9	4.0	2.9
Vicar	GA	SY/RG	86	641	bcdefghi	16,940	3.8	2	5.6	5.8	1.8	3.0	2.1
Courier	GA	HL	85	611	cdefghi	12,014	5.1	1	7.2	6.4	1.9	4.3	2.7
Diplomat	GA	HL	75	510	ghi	8,816	5.9	11	7.3	6.7	2.2	4.7	2.7
Sugar Nut	CA	JS	77	840	abc	22,558	3.7	0	5.9	5.3	1.6	3.2	2.1
Golden Beauty	CA	JS	80	767	bcdef	9,766	7.9	1	10.3	7.3	1.9	6.9	3.5
Juane des Canaries	CA	CF	80	596	defghi	8,470	7.0	0	9.5	6.7	1.7	6.1	3.1
HSR 4290	MG	HL	80-85	809	bcd	17,804	4.5	1	6.4	6.3	1.8	3.8	2.6
HSR 4284	MG	HL	80-85	661	bcdefgh	14,088	4.7	9	7.8	6.5	1.8	4.9	2.9
HSR 4289	MG	HL	80-85	645	bcdefghi	17,977	3.6	1	5.8	5.7	1.7	3.5	2.2
Pixie	MG	HL	80	553	fghi	17,459	3.2	4	5.5	5.5	1.6	3.1	2.3
Lilly	CR	JS	78	760	bcdef	8,038	9.4	3	10.5	7.1	1.9	6.8	3.3
Bolero	CR	SI	95-100	421	ij	3,457	12.1	0	10.6	8.9	2.2	7.4	4.5
Sunrise	SP	EV	72	732	bcdefg	18,323	4.0	0	5.8	5.8	1.5	3.5	2.6
Bartlett	SP	BU	88	701	bcdefgh	7,721	9.4	0	8.5	8.0	2.0	5.3	4.2
Napoli	SP	EV	72	654	bcdefgh	20,138	3.3	1	5.4	5.4	1.7	3.1	2.2
Orange Sorbet	SP	BU	82	620	cdefghi	9,853	6.3	0	7.5	7.1	2.0	4.8	3.0
HSR 4272	MM	HL	79	719	bcdefgh	9,939	7.3	0	8.6	6.9	2.1	5.5	2.6
Wrangler	MM	HL	80-85	701	bcdefgh	14,866	4.7	5	7.1	5.8	1.8	4.7	2.5
HSR 4280	MM	HL	75	662	bcdefgh	10,371	6.4	2	7.4	6.6	1.9	4.3	2.9
Athena	MM	SW	79	617	cdefghi	8,766	6.3	1	8.0	6.7	1.9	5.2	3.0
Carousel	MM	HL	85	595	defghi	8,124	7.3	2	9.4	7.0	1.9	6.1	2.7
Strike	MM	HL	80-85	590	defghi	9,853	6.1	1	8.6	6.9	2.1	5.5	2.8
Duke	AN	HL	88	661	bcdefgh	11,236	5.9	0	8.5	6.5	1.8	5.5	3.1
Tamara	AN	HL	95	639	bcdefghi	9,766	6.6	1	8.6	7.2	2.0	5.5	3.5
San Juan	AN	JS	78	569	efghi	10,487	5.5	2	7.1	6.9	2.0	4.1	3.0
Sprite	AS	CF	90	594	defghi	44,424	1.3	1	4.8	4.1	1.0	3.2	2.0
Sakata's Sweet	AS	SE	85-95	248	j	22,904	1.1	6	3.8	4.1	0.8	2.6	2.5
Honey I Dew	CS	GU	84	793	bcde	10,717	7.3	1	9.1	6.8	2.0	6.0	3.1
Sancho	PS	SY/RG	90	660	bcdefgh	7,346	9.0	0	11.9	7.2	2.1	7.9	2.7
Sensation	GO	HL	80	508	ghi	8,297	6.2	2	7.1	7.1	1.8	4.0	3.4
Haogen	HU	SV	73	483	hi	13,137	3.7	1	6.0	5.8	1.6	3.6	2.6

[1] Melon type: AN = ananas, AS = Asian melon, CA = canary, CR = crenshaw, CS = casaba, GA = galia, GO = gourmet, HD = honeydew, HU = Hungarian, MG = muskmelon galia cross, MM = Eastern muskmelon, PS = Piel de Sapo, 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.
[3] Cull percent by weight.

Table 2. Specialty melon trial fruit characteristics, Lexington, Ky., 2006

Variety	Flavor (1-5)[1]	Sugar (%)	Interior Color[2]	Rind Color[3]	Fruit Shape	Net Type[4]	Comments
Rocio	4.0	13.4	cr. gr.	cr.	round	na	Flesh crunchy with a slightly grainy texture, little or no surface checking, harvest when rind turns slight beige color
Silverado	3.5	12.9	cr.gr.	cr.	round	na	Some surface checking, difficult to determine when ripe, some odd shaped fruit
Honey Brew	4.4	14.8	cr. gr.	cr. gr.	oblong	na	Slightly crisp, excellent flesh, surface checking in wet season, vines don't hold up in wet weather
Super Dew	3.6	13.5	lt gr.	cr. wh	slightly oblong	na	Coarse, crunchy flesh, some surface blemishes, splits in rain, difficult to determine ripeness, vines killed by disease
Honey King	4.1	13.0	cr. gr.	cr.	oblong	na	Some surface checking, soft to crunchy flesh, harvest when tan color develops on top of melon. Cracks badly when overripe, spotting on rind, vines did not hold up
Silver Express	4.1	12.9	cr. gr.	cr. gr.	round	na	Flesh crunchy, harvest when beige and waxy
Galileo	4.0	13.5	gr.	gr. yl.	round	hv	Harvest at ½ slip, firm flesh, easy to pick
Galia Max	3.9	14.8	gr.	str.	oblong	hv fi	Very large melon, firm flesh, some stem end and surface cracking in wet weather, attractive, vanilla aftertaste, harvest at ½ slip
Arava	4.0	11.4	gr.	gr. yl.	round	md	Slight vanilla aftertaste, soft flesh, harvest at first sign of yellow
Vicar	3.8	13.8	gr.	str.	round	hv	Firm, musky flesh
Courier	3.5	10.9	lt. gr.	str.	oblong	md	Harvest as rind turns straw color, slightly firm flesh, vines held up well
Diplomat	3.4	11.6	lt. gr.	str.	oblong	md	Soft texture, musky, cracking at stem end, harvest as rind turns straw color
Sugar Nut	4.2	13.5	lt gr.	by.	oblong	na	Cotton candy sweet, firm crunchy flesh, harvest when dark yellow, vines held up well
Golden Beauty	4.5	14.0	lt. gr.	by.	football	na	Soft smooth flesh, harvest when dark yellow
Juane des Canaries	3.2	12.8	lt. gr.	by.	football	na	Coarse, fibrous texture, harvest when bright yellow, vines highly susceptible to disease
HSR 4290	4.4	14.6	or.	gr. cr.	round	md-hv	Firm flesh, good aroma, harvest when yellow highlights appear in rind and ground spot is yellowish, vines did not hold up late in season
HSR 4284	4.3	12.3	or.	cr. gr.	oblong	hv.	Very firm flesh, harvest when skin creamy green, some off types
HSR 4289	4.3	16.0	or.	gr. yl.	round	varies	Slightly spicy, firm flesh, cracks in rain, harvest when yellow highlights appear in rind
Pixie	4.2	14.9	or.	gr. yl.	round	hv. co.	Very firm flesh, harvest when rind turns yellow with a green cast, some off types
Lilly	3.1	11.4	salmon	cr.	oblong	na	Coarse flesh, squash taste when underripe, foliage did not hold up to disease, many fruit decayed in field
Bolero	3.9	12.8	lt. or.	dg. wh flecks	oblong	na	Some surface checking and sunburn, harvest when ground spot is yellow, soft flesh, serious leaf loss to disease
Sunrise	4.5	14.8	or.	str.	round	hv. co.	Attractive, excellent taste, soft flesh, harvest at first sign of yellow
Bartlett	4.0	14.8	lt. gr.	by.	round	na	Very attractive exterior and interior, slightly crunchy flesh, harvest when bright yellow
Napoli	4.8	16.0	cr. gr.	cr. gr.	round	hv. fi.	Excellent flavor, soft smooth flesh, does well in wet years, harvest at first slip
Orange Sorbet	3.9	13.9	or.	cr.	round	na	Firm crunchy flesh, lots of surface checking
HSR 4272	3.6	12.0	or.	str.	oblong	hv. co.	Medium, firm flesh, harvest at ½ slip, checks badly in rain
Wrangler	4.6	13.3	or.	str.	oblong	hv. fi.	Attractive dark green sutures, attractive interior, harvest at full slip, some off types
HSR 4280	4.2	12.0	or.	str.	oblong	hv.	Very thick flesh, small cavity, harvest at full slip, melons crack in wet weather
Athena	3.8	11.7	or.	str.	oblong	hv	Attractive firm flesh, harvest at full slip, industry standard
Carousel	3.5	11.1	or.	str.	oblong	md.	Firm melting flesh, attractive dark green sutures, harvest at ½ slip
Strike	3.2	11.0	or.	str.	oblong	hv. co.	Medium firm flesh, harvest at full slip
Duke	4.1	11.9	cr.	yl. or.	oblong	md	Soft melting flesh, attractive exterior, cracks at stem if overripe, short harvest window
Tamara	4.1	11.5	cr.	str.	oblong	md	Soft melting flesh, short harvest window, harvest at full slip
San Juan	4.3	12.5	cr. pk.	str.	round	md.	Soft melting flesh, cracks at stem end when overripe, harvest at full slip
Sprite	4.4	16.8	cr.	cr.	oval	na.	Attractive, crisp flesh, harvest when rind gets yellowish tinge
Sakata's Sweet	3.3	16.0	cr. gr.	lg. yl.	pumpkin shape	na	Granular, soft textured flesh, tender skin, harvest at slight yellow skin color, attractive to mice
Honey I Dew	4.4	13.7	lt. cr. gr.	by.	football	na	Non slip, harvest when bright yellow
Sancho	4.7	12.7	dk. gr.	lt. gr. or	football	na	Slightly crunchy flesh, harvest when ground spot is dark yellow, some longitudinal checking when ripe
Sensation	4.9	14.5	cr.	cr.	round	lt. co.	Excellent flavor, soft melting flesh, vines have good disease resistance, harvest at slip
Haogen	3.0	11.7	gr.	mottled yl. gr.	round	na.	Soft flesh, slight green, pepper flavor, harvest at light yellow color, does not slip

Muskmelon Galia crosses. All of the melons of this type had very attractive, excellent-tasting, very firm orange flesh. Assessing harvest maturity based on subtle differences in rind color was a challenge between the four selections because of variation among selections. Pixie, the one named variety, was attractive externally and was an excellent small melon. It was also one of the easier ones to assess for harvest maturity. HSR 4290 was rated as having the best flavor and produced very nice melons, although the vines did not hold up quite as well in the rain. HSR 4284 also looked very promising.

Crenshaw. Neither Crenshaw variety was acceptable this season. Bolero was the biggest disappointment. In the 2005 trial, it was the top yielder and one of the better tasting melons. This year, it had the lowest yield because the vines collapsed due to disease, and many of the melons did not ripen.

Specialty melon. These melons do not seem to fit into any of the melon classes. Sunrise and Napoli resemble small tightly netted cantaloupes on the exterior, but they do not have the musky flavor of cantaloupes, and Napoli has light green flesh. Melon flavor and flesh texture are excellent; in fact, Napoli was rated the second best tasting melon in the trial. The fruit of both varieties 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. Bartlett is very attractive and resembles bright yellow honeydew. The flesh is slightly crisp and very good.

Eastern muskmelon. Wrangler, HSR 4280, and Athena were the top eastern muskmelons in this trial. Athena is the industry standard. Wrangler is very distinctive in that it has very attractive green sutures. Both Wrangler and HSR 4280 were superior to Athena in flavor and sugar content.

Ananas. Both Duke and Tamara were very similar in yield, quality, and appearance. Both were very nice ananas melons. San Juan was superior in flavor and sugar content to Duke and Tamara and had fewer days to maturity. It seemed to have a little more of a fruit cracking problem. Ananas melons should be harvested daily because of their rapid ripening, short harvest window, and short storage life.

Asian. Sprite is an outstanding Asian melon and has been consistent in our trials over the years. It is a small, cream-colored melon with crisp flesh that has a strong consumer following.

Casaba. Honey-I-Dew is an excellent bright yellow casaba melon and also did well in last years trials.

Piel de Sapo. Sancho is a very high quality, excellent-tasting melon. Toward the end of the harvest season, several of these melons cracked in the rain and were not harvested. It has performed well in past years.

Gourmet. Sensation is an outstanding melon in terms of appearance, flavor, and sugar content and was rated as the best tasting melon in the trial. It has a relatively long harvest period for this type of melon.

Hungarian. Haogen is an heirloom melon. It is colorful and attractive but has a slight green pepper flavor that only one individual on the farm crew liked.

Acknowledgments

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Evaluation of Fungicide Programs for Management of Gummy Stem Blight of Watermelon

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Introduction

Gummy stem blight, caused by *Didmyella bryoniae*, is one of the most destructive diseases of watermelon in the southeastern United States and causes serious losses in some years in Kentucky. Leaves, petioles, stems, and vines are affected, causing death of vines and complete defoliation in severe cases. Loss of photosynthetic area results in reduced fruit number, size, and quality. Defoliation also exposes fruits to direct sunlight, resulting in scalding.

Cultural practices and fungicides are useful tools for management of gummy stem blight. The cultural practices most commonly recommended include crop rotation and removal (or incorporation into soil) of crop residues. Watermelon cultivars with resistance to gummy stem blight are not available.

Gummy stem blight can be controlled with regular application of fungicides. Relatively inexpensive protectant materials (multi-site inhibitors) such as chlorothalonil (Bravo, Echo, Equus) or mancozeb (Dithane, Penncozeb, Manzate) are labeled for watermelon but may not provide adequate control under heavy disease pressure. Newer fungicides such as strobilurins (Quadris, Cabrio) are effective against gummy stem blight, as is Pristine, a product that combines pyraclostrobin (strobilurin) and boscalid (carboximide). Fungicides with specific modes of action, such as strobilurins and carboxamide, tend to be more effective than multi-site inhibitors when conditions are highly favorable for disease but also are more expensive. Along with high cost, products such as Quadris and Pristine are more likely to select for fungicide resistance in pathogen populations than multi-site inhibitors.

In dry years or when conditions are unfavorable to disease development, it is possible to apply less expensive protectants to suppress diseases such as gummy stem blight. However, more costly products must be included in the spray program in wet years or when the environment is conducive to disease. This report describes an experiment designed to evaluate fungicide programs using either mancozeb (Dithane DF) or chlorothalonil (Bravo WeatherStik) as their basis and alternated with Quadris or Pristine for control of gummy stem blight of watermelon.

Materials and Methods

The experiment was conducted at the Robinson Substation located in Quicksand, Kentucky. The watermelon cultivar Sangria was transplanted on 17 May. Between-plant spacing was 36 in., and bed spacing was 9 ft. Plots consisted of a single, 20-ft row, and a 5-ft buffer separated each plot. An untreated, single-row border surrounded the plots. The experimental design was a randomized complete-block design with four replications. Overhead irrigation was supplied as needed, and all management practices (weed and insect control, fertility) were implemented according to recommendations of the University of Kentucky Cooperative Extension Service.

Fungicides (Table 1) were applied on 28 June, 10 July, 18 July, 26 July, 7 August, and 17 August beginning prior to disease development; all sprays were discontinued when untreated plots were completely defoliated. The first three applications were made with a CO_2-powered backpack sprayer equipped with a three-nozzle hand boom fitted with TX-18 hollow-cone nozzles (20-in. spacing), and a four-nozzle boom was used for the last three sprays. Application volume was 40 GPA, and sprayer pressure was 56 psi.

Disease was evaluated four times over the course of the experiment (18 July, 27 July, 7 August, and 21 August). The severity of gummy stem blight was rated as the percentage of leaf area with disease (DLA) at each evaluation date. Values for percent DLA were used to calculate the area under the disease progress curve (AUDPC) for each treatment; AUDPC values are a measure of the season-long level of disease for a given treatment. Plots were not harvested. All data were subjected to analysis of variance, and means were separated using Fisher's protected least significant difference (LSD) test.

Results and Recommendations

Supplemental, overhead irrigation and rainfall created conditions that were highly conducive for development and spread of gummy stem blight. Severity of disease, particularly later in the season, was high.

In general, Bravo WeatherStik (3 pt/A) was more effective than Dithane DF against gummy stem blight (Table 1). Dithane DF, applied six times, did not differ from the untreated check in terms of severity at the last evaluation date (21 August) or total-season severity (AUDPC). The performance of Dithane DF, alternated with Quadris 2.08SC (15.4 fl oz/A) after the second application, was similar to the Dithane-only program. Six applications of Bravo WeatherStik significantly reduced severity of gummy stem blight at the last evaluation date and in the AUDPC, compared to the untreated check, and did not differ from the Bravo/Quadris program. Programs containing Pristine (18.5 oz/A) had the lowest levels of gummy stem blight but did not differ significantly from the Bravo-only program or the Bravo/Quadris program.

Table 1. Effect of chlorothalonil- or mancozeb-based spray programs on the severity of gummy stem blight of watermelon—2006, Quicksand, Ky.

Treatment	Application		Severity of Gummy Stem Blight			
	Rate/A	Timing[1]	% DLA (8/21/06)[2,4]		AUDPC[3,4]	
Untreated check	--	--	97	ad	9.3	ab
Bravo WeatherStik	3 pt	ABCDEF	17	b	1.8	c
Dithane DF	3 lb	ABCDEF	86	a	7.4	b
Bravo WeatherStik alt.	3 pt	ABDF	13	b	1.5	c
w/Quadris 2.08SC	15.4 fl oz	CE				
Dithane DF alt.	3 lb	ABDF	98	a	9.8	a
w/Quadris 2.08SC	15.4 fl oz	CE				
Bravo WeatherStik alt.	3 pt	ABDF	7	b	1.2	c
w/Pristine 38WG	18.5 oz	CE				
Dithane DF alt.	3 lb	ABDF	5	b	0.8	c
w/Pristine 38WG	18.5 oz	CE				
LSD (P ≤ 0.05)			16		2.0	

1 Application dates: A = 28 June, B =10 July, C =18 July, D = 26 July, E = 7 August, and F =17 August.
2 Percentage of leaf area in each plot (% DLA) with symptoms of gummy stem blight at the time the experiment was terminated (8/27/06).
3 AUDPC = area under the disease progress curve calculated from disease ratings taken on 18 July, 27 July, 7 August, and 21 August.
4 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test (P ≤ 0.05).

Data from the trial indicate that it is possible to manage gummy stem blight with Bravo WeatherStik, a relatively inexpensive product. Alternation of Bravo with Quadris did not result in increased efficacy, although rotation of Bravo with Pristine (18.5 oz/A) did result in a non-significant increase in disease suppression.

It appears that Dithane DF (or any mancozeb-containing product) is not an effective tool by itself for suppression of gummy stem blight. Alternating Dithane with Quadris did not improve the performance of the Dithane spray program. It is likely in this situation that disease levels had built up significantly prior to the first application of Quadris and leading to higher end-of-season and AUDPC values for the Dithane/Quadris program. Alternation of Dithane with Pristine resulted in disease control that did not differ from the Bravo or Bravo/Quadris programs. Despite its poor performance in this trial, Dithane can still play an important role in a watermelon fungicide program. Dithane is less expensive per application than Bravo and has greater efficacy against anthracnose; however, if used, Dithane should be alternated with a fungicide such as Pristine to ensure adequate protection against gummy stem blight.

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Effect of Transplant Size on Yields and Returns of Bell Peppers

Nathan Howard and John C. Snyder, Department of Horticulture

Introduction

Vegetable growers across Kentucky have produced bell peppers in large acreage over the past few years. Markets have included cooperatives, farmers' markets, roadside stands, and wholesale avenues. Growers have consistently produced good crops of peppers that exceeded 1,000 11/9 bushel boxes per acre, but a lot of thought has centered on reaching yields closer to 2,000 boxes per acre. In 2005, we found that, compared to smaller transplants, using a large transplant (72-cell) would allow the grower to harvest one week early and lead to higher yields overall for the season. Large transplants were well worth their cost. We repeated the study in 2006 using the same treatments as last year to determine if these results would hold up under a different growing season.

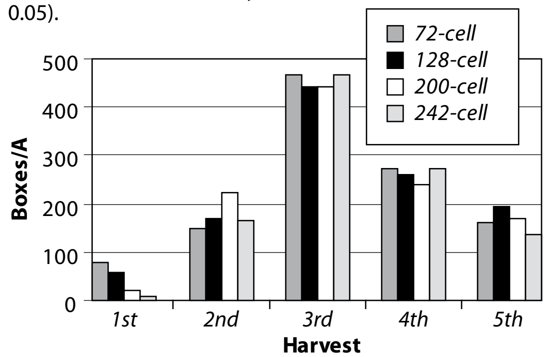
Materials and Methods

The trial was conducted again with Triple E Farms in Henderson County. Four cell sizes were used for transplant production: 72-, 128-, 200-, and the standard 242-cell tray. The variety used was Aristotle, donated by Seedway Inc. Each treatment was seeded in the greenhouse on 13 March. The plants were transplanted on 2 May after being hardened off for three days. The plants were transplanted into raised beds with black plastic mulch with drip irrigation. 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 in. apart from center to center, resulting in 12,672 plants per acre. The trial was arranged in a randomized complete block design with four replications. In 2005, the growing conditions for peppers were almost ideal with average to above-average temperatures that allowed for great early plant growth. This year the temperatures in May were unseasonably cool, with very windy conditions, and the rest of the growing season was very hot and wet. After transplanting, the plants literally sat in the ground for two weeks without much growth.

The grower/cooperator managed the trial plot in the same manner as the rest of the field. Phosphorus and potassium were applied pre-plant according to soil test results and current University of Kentucky recommendations. Nitrogen was applied pre-plant at a rate of 40 lb/acre, with the remaining 110 lb/acre sidedressed (fertigated) through the drip irrigation system.

Fungicides (manex and copper) were applied on a weekly basis for disease prevention, and insecticides (Mustang Max and Orthene) were used as needed. The trial plot was harvested five times between 3 July and 7 August. Peppers were counted and weighed, and the data were then analyzed for statistical differences.

Figure 1. Effects of transplant cell size (no. cells/tray) on early and late bell pepper yields at five harvest dates, 2006; data are means of four replications. Yields among transplant cell sizes for a harvest were not significantly different as determined by the Duncan-Waller LSD (P = 0.05).



Results and Discussion

Because of the early season stress, we were able to make an interesting observation during the first few weeks. Over the entire plot, the survival rate for plants was related to cell size as follows: 72-cell, 100% survival; 128-cell, 99%; 200-cell, 97%; and 242 cell, 96%. The dead plants were replaced after this evaluation was made. In the 2005 study, the 72-cell transplants were the only plants that had enough fruit to justify the first harvest on 29 June. The 72-cell transplants also had higher yield over the entire season. This year, peppers were not ready for first harvest until 3 July. All treatments were harvested on this date, but the 72- and 128-cell transplants had higher yields than the others (Figure 1). Over the next four harvests, yields for all treatments were similar. Consequently, total yields were similar for all treatments (Figure 2). The yield differences that were present in 2005 were absent in the 2006 study. Overall, the yields were lower in the 2006 plot, averaging 1,100 boxes/acre compared to 1,400 in 2005.

Transplant production costs were determined by the local vegetable producer and are listed in Table 1. To pay for the largest cell size (72-cell), the net return to the growers would have to be $1,323 more than the income from the 242-cell transplants. After net income was calculated, the actual income difference was -$57. The other two treatments (128- and 200-cell) were able to generate more income per acre then the 242-cell but were not able to pay for the switch to larger cell sizes.

Table 1. Costs per acre, based on a plat population of 12,672 plants/A, per acre yield differences, breakeven point, and per acre income differences for four transplant yield sizes.

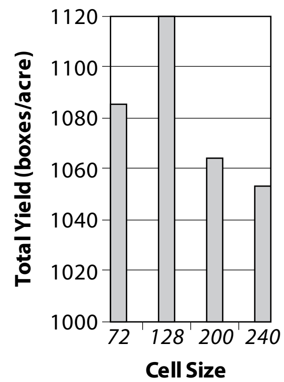
Cell Size	Cost/A	Yield Difference from 242-Cell (boxes/A)	Income Needed to Break Even	Income Difference from 242-Cell
72	$2,318	-32	$1,323	-$57
128	$1,742	67	$747	$278
200	$1,171	40	$176	$35
242	$995	--	--	--

In conclusion, we saw many differences in the two-year study. 2005 clearly showed a significant difference in yield and income by taking a larger transplant to the field. 2006 showed a yield increase numerically, but these increases were not significant. Also in 2006, the cost analysis was not as clear as in 2005. It was determined that none of the treatments could justify for the cost of transplant production, compared to the 242-cell transplants. It is recommended to look at data over multiple years to account for any differences in environment. Another factor to consider is early prices. This season bell pepper prices were different from most seasons (Table 2). The highs were not seen until midway through the season. Typically, in Kentucky, high prices are seen before the Fourth of July. After completing this study, there is no doubt there is a benefit of having a larger root ball and a larger, stronger transplant that will be able to survive early season stresses better. Smaller growers can usually justify the cost of larger transplants by obtaining higher retail prices for peppers. Wholesale growers should test different transplant sizes for themselves to determine the benefit.

Table 2. Average daily North Carolina shipping point prices (per 32-lb box) for bell peppers from July 3 to August 7, 2006.

Harvest Date	$/Box
3-Jul	$8.25
10-Jul	$10.00
18-Jul	$16.35
25-Jul	$14.35
7-Aug	$8.43

Figure 2. Effects of transplant cell size (no. cells/tray) on total marketable yields of bell peppers in 2006. 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).



IR-4 Insecticide Evaluation for Stink Bug Control on Peppers

Michael Seagraves, Entomology Post-Doctoral Researcher; Ric Bessin, Extension Entomologist

Stink bugs are serious pests of some horticultural crops including tomatoes, peppers, apples, peaches, blackberries, okra, and sweet corn. Damage can be particularly severe in years following mild winters, as stink bugs overwinter in the adult stage in wooded areas near crop land. Relatively high levels of damage can be caused by low numbers of stink bugs in these crops. In Kentucky, we have two species that are horticultural pests, the brown stink bug, *Euschistus servus* (Say), and the green sting bug, *Acrosternum hilare* (Say). While both cause the same type of damage, the brown stink bug is more difficult to manage as it is less sensitive to the insecticides that are available for its control.

Stink bugs feed with piercing-sucking mouthparts They inject enzymes into the fruit to liquefy plant material for ingestion.

These enzymes cause yellow corky areas to form around the feeding sites just under the skin of tomatoes and peppers. As the fruits ripen and turn color, these 1-cm corky areas do not; they remain as visible, yellow spots under the skin. They are often referred to as "cloud spots" and reduce the marketability of the fruit if common.

Because stink bug control can be difficult and the number of effective materials to manage them is limited, a study was conducted at the University of Kentucky Horticultural South Farm to screen several new insecticides for stink bug activity. As this project was funded in part through the IR-4 Project Southern Region, many of the insecticides screened are considered bio-rational alternatives to existing products.

Some of the products included in this report are not registered for use on pepper. This report does not recommend, encourage, or endorse their use on peppers or other crops until they have obtained the necessary EPA Section 3, Section 24(c), or Section 18 approval for use. Always read and follow pesticide label directions.

Procedure

Pepper transplants were started in the greenhouse (without insecticide use) and transplanted into the field after seven weeks on 23 May. The bell pepper variety was Aristotle as this is bacterial leaf spot resistant and commonly used by growers in Kentucky. A double-row plasticulture system was used with raised beds on 6 foot centers, two rows of peppers per bed with the trickle tube between the rows, and 15 inches between transplants in the row. Each experimental plot was 27 feet of bed (including both rows of peppers). The field was arranged similar to a checkerboard such that each plot had an untreated bed on either side and at either end. There were five replications of each treatment. Insecticides were applied with a CO_2 sprayer at 30 psi with one nozzle over the top and drop nozzles on sides of the row.

The trial was conducted twice. For the first evaluation, all the foliar insecticide treatments (Table 1) were applied on 19 July and again on 31 July. However, the soil drench of dinotefuran was applied on 20 June. Plants were stripped of mature fruit, and a second evaluation of the same treatments was initiated after the first trial. The second round of treatments was applied on 24 August and 1 September.

Each week two sets of three plants in each plot were carefully beaten next to a ground cloth to dislodge stink bugs. While the beat sheet may be the best sampling tool for stink bugs in peppers, it is not very efficient, and care must be taken to avoid plant breakage, particularly when the plants are laden with fruit.

Fifty random, mature peppers were sampled from each plot from August 15 through August 21 (first round evaluation) and September 13 (second round evaluation) and then evaluated for stink bug injury. The number of stink bug "cloud spots" were recorded for each pepper. If the damage was questionable, the skin was carefully peeled back to examine for the character-

Table 1. Insecticides and rates evaluated for stink bug control on peppers.

Treatment	Active Ingredient	Rate	Method
Untreated	-	-	-
Prev Am	Sodium tetraborohydrate decahydrate	0.4%	Foliar spray
Prev Am Venom 20 SG	Sodium tetraborohydrate decahydrate Dinotefuran	0.4% 14 oz	Foliar spray
Venom 20 SG	Dinotefuran	21 oz	Soil drench
Venom 20 SG	Dinotefuran	14 oz	Foliar spray
Battalion	Deltamethrin	11.5 fl oz	Foliar spray
Novaluron	Novaluron	12	Foliar spray
Battalion Novaluron	Deltamethrin novaluron	11.5 fl oz 6 oz	Foliar spray
Flonicamid	Flonicamid	2.8 oz	Foliar spray
Flonicamid	Flonicamid	4.15 oz	Foliar spray
Bug oil	modified citrus oil	4 gal./ 200 gal.	Foliar spray
Agricure	potassium bicarbonate	5 lb/100 gal.	Foliar spray
Warrior	Lambdacyhalothrin	2.56 fl oz	Foliar spray
Clutch 50 WDG	Clothianadin	6 oz	Foliar spray
Assail 30 WDG	Actetamiprid	4 oz	Foliar spray

Table 2. Incidence and severity of stink bug damage to peppers following two foliar applications (July 19 and 31) of various insecticides.

Treatment	Percent Stink Bug Damaged Fruit	Stink Bug "Cloud Spots" per Fruit	Percent Control
Untreated	49.2	4.1	0.0
Prev Am	38.0	2.8	21.5
Prev Am Venom 20 SG	27.6*	1.0	43.0
Venom 20 SG[1]	26.8*	2.4	44.6
Venom 20 SG	23.2*	0.9*	52.1
Battalion	34.0	2.4	29.8
Novaluron	42.4	3.4	12.4
Battalion Novaluron	37.6	2.5	22.3
Flonicamid	27.6*	1.6*	43.0
Flonicamid	29.0*	2.3	40.1
Bug oil	33.6	2.4	30.6
Agricure	30.4*	2.0	37.2
Warrior	26.4*	2.0	45.5
Clutch 50 WDG	24.8*	1.3*	48.8
Assail 30 WDG	25.2*	1.9	47.9

* Significantly different from the control damage for this measurement (Dunnett's test).
[1] This one treatment was applied only once as a soil drench on June 20.

istic corky tissue. When a pepper was found to have any signs of stink bug injury, it was considered damaged. Some of the damaged fruits would not have been considered culls. The data were subjected to analysis of variance and treatments means compared to the damage in the control treatment by Dunnett's test. Percent control is based on the reduction in the number of stink bug-damaged peppers.

Results

Based on the beat sheet samples throughout the summer, there was approximately an equal number of brown and green stink bugs. What was surprising was the high amount of stink bug damage caused by the low numbers of adults observed in the first round evaluation. The high level of damage early with the low numbers of adult stink bugs observed may be attributed to the low efficiency of sampling for stink bugs on pepper plants.

First Trial

In general, there was considerable damage to the pepper fruit in the control treatment with nearly half of the peppers displaying stink bug injury (Table 2). The neonicotinoid insecticides (Clutch, Assail, and Venom), Warrior, Flonicamid, and Agricure demonstrated the greatest reduction in stink bug damage to the peppers relative to the control. The foliar and soil applications of Venom were similar with respect to damaged fruit, but the soil application was not different from the control in terms of reducing the number of cloud spots per fruit. While one pyrethroid, Warrior, showed good control of stink bug damage, another, Battalion, failed to demonstrate significant difference from the control peppers, indicating practical differences within that class of chemistry.

Second Trial

The incidence of stink bug-damaged peppers was reduced in the second round of testing, which in some respects can make the data less reliable (Table 3). Damage in the control treatment was less than half that observed with the first harvest. Clutch was the only treatment different from the control in terms of reducing the percentage of stink bug-damaged fruit. With the shorter interval between treatments and between treatments and harvest, improved performance was expected with these products, but the reduced damage may have reduced the sensitivity of the test.

Recommendations

While several of the insecticides and combinations were not significantly different from the control, it is possible that their use at different rates, intervals, and/or frequencies could improve performance. Several of these new insecticides show promise for stink bug control, and further evaluation on peppers as well as on other high-value horticultural crops is warranted.

Table 3. Incidence and severity of stink bug damage to peppers following two foliar applications (Aug 24 and Sep 1) of various insecticides.

Treatment	Percent Stink Bug Damaged Fruit	Stink Bug "Cloud Spots" per Fruit	Percent Control
Untreated	18.4	2.1	-
Prev Am	8.4	1.2	54.3
Prev Am Venom 20 SG	7.6	0.3	58.7
Venom 20 SG[1]	11.6	3.1	37.0
Venom 20 SG	9.6	1.0	47.8
Battalion	10.4	1.6	43.5
Novaluron	17.6	3.4	4.3
Battalion Novaluron	16.0	1.8	13.0
Flonicamid	11.6	1.7	37.0
Flonicamid	12.8	1.4	30.4
Bug oil	15.2	1.7	17.4
Agricure	11.6	1.6	37.0
Warrior	8.8	0.9	52.2
Clutch 50 WDG	5.2*	0.9	71.7
Assail 30 WDG	9.2	2.3	50.0

* Significantly different from the control damage for this measurement (Dunnett's test).
[1] This one treatment was applied only once as a soil drench on June 20.

Winter Squash and Pumpkin Variety Evaluations

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

Introduction

Twenty-four winter squash and pumpkin varieties were evaluated in a replicated trial under Kentucky conditions. These included acorn, buttercup, butternut, cushaw, decorative, Hubbard, Kabocha, pumpkin, and storage types.

Materials and Methods

Varieties were seeded on 15 April into Styrofoam plug trays (72 cells per tray) at the Horticulture Research Farm in Lexington. Plug trays were set on a greenhouse bench to germinate. Plants were set into black plastic-mulched, raised beds using a waterwheel setter on 1 June. Most plots were 24 feet long, with six plants set 4 feet apart within the row and 6 feet between rows. Bush squash plots were also 24 feet long, but plants were set 2 feet apart in the row. Each treatment was replicated four times in a randomized complete block design. Drip irrigation provided water and fertilizer as needed.

One hundred pounds of N/A as ammonium nitrate were incorporated into the field prior to bed shaping and planting. The plot was fertigated with a total of 24 lb N/A as ammonium nitrate divided into four applications over the season. The systemic insecticide Platinum 2 SC was applied with a hand sprayer as a drench at the base of each plant after transplanting using the maximum rate of 8 fl oz/A. Foliar insecticide applications included Sevin and Pounce. Weekly foliar fungicide applications included Maneb, Bravo, Quadris, and Pristine. Curbit and Sandea preemergent herbicides were applied and incorporated between the rows, just as the vines began to grow off the plastic mulch. One fruit from each replication was measured for dimensions and evaluated for flavor, skin, and interior color.

Results

The growing season was hot and very wet resulting in severe disease pressure. Vine cover was thick, with no plant death. Fruit were harvested at the end of the season. Harvest and evaluation data are in Tables 1 and 2.

Butternut. Argonaut is a high yielding, very good-tasting large processing butternut. It had a very solid straight long neck. The squash exterior is covered with a heavy white bloom or wax layer and is not as attractive as Atlas, but it yielded 9,100 pounds more per acre than Atlas.

Cushaw. Cushaw Green Stripe was far superior to the two other cushaws in yield and appeared to be superior in fruit density, but it did not taste quite as good. Cushaw Orange Stripe and the Autumn Colors varieties were attractive but may not have pollinated as well during the hot summer, as fruit did not contain many seeds. Autumn Colors did not maintain much green coloration, and most were completely orange like the Cushaw Orange

Table 1. Winter squash and pumpkin variety trial yield and fruit characteristics, Lexington, Ky., 2006.

Variety	Squash Type[1]	Seed Source	Days to Harvest	Yield (cwt/A)[2]	Avg. No. Fruit/A	Avg. Wt./Fruit (lb)	Culls (%)[3]	Outside Measurements Length (in.)	Outside Measurements Width (in.)	Seed Cavity Length (in.)	Seed Cavity Width (in.)
Argonaut	Bn	SI	140	389 A	4719	8.4	0.0	15.8	5.9	4.8	4.0
Atlas	Bn	SW	110	298 abcd	5536	5.3	1.8	13.0	6.0	3.8	3.7
Cushaw Green Stripe	Cu	RU	110	339 abc	2360	14.8	5.8	17.1	9.6	6.6	7.5
Cushaw Orange Stripe	Cu	SW	110	192 defghi	2087	9.3	4.6	15.9	8.8	6.7	6.8
Autumn Colors	Cu	SI	105	162 fghi	1543	12.2	50.8	20.1	9.8	6.9	7.5
Sweet Mama	Ka	SW	85	235 cdefgh	5082	4.6	0.5	4.5	8.0	2.5	5.3
Special Export	Ka	SI	90-95	152 hi	6080	2.9	0.0	3.5	7.0	2.2	5.0
Eclipse	Ka	RU	85	114 I	3267	3.5	0.0	4.1	6.6	2.4	4.5
T133	Ka	SW	92	108 I	3358	3.2	0.0	4.3	7.1	2.6	5.1
Orange Cutie	Bc	ST	95	197 defghi	8621	2.3	0.0	3.7	6.4	2.1	4.3
Orange Dawn	Bc	RU	90	190 defghi	9075	2.1	0.0	4.0	6.0	2.3	3.9
Autumn Cup	Bc	SW	95	185 efghi	5763	3.2	0.0	4.4	6.9	2.9	4.1
Ambercup	Bc	SW	74	178 fghi	4764	3.3	0.0	4.6	7.1	2.4	4.9
Thunder	Bc	RU	85	157 ghi	4628	3.2	0.0	4.4	6.8	2.7	4.4
Sunshine	Bc	ST	95	156 ghi	4129	3.8	0.0	4.6	7.2	2.9	4.1
Sun Spot	Bc	RU	75	156 hi	7895	1.9	0.0	4.6	5.5	2.4	3.4
Bon Bon	Bc	ST	81	151 hi	4311	3.5	9.7	4.8	6.6	2.5	4.1
Red Warty Thing	De	SW	110	377 ab	1724	22.1	0.0	9.6	11.8	5.7	8.3
Lakota	De	SW	105	137 hi	2223	6.2	0.0	8.0	8.3	4.2	5.5
Hubba Hubba	Hu	SI	95	291 abcde	9710	2.9	0.0	7.7	7.9	4.9	5.6
La Estrella	Ca	SW	70-100	273 bcdef	2632	10.2	6.7	7.7	9.8	4.4	6.3
One Too Many	Pu	SW	110	252 cdefg	1225	20.3	26.9	9.2	12.3	5.5	8.9
Grey Ghost	St	SI	100	229 cdefgh	3040	7.4	0.0	5.6	8.9	3.0	5.4
Autumn Delight	Ac	SW	70	163 fghi	10482	1.5	1.5	4.4	4.5	2.5	2.4

1 Squash type: Ac = acorn; Bc = buttercup; Bn = butternut; Ca = Calabash; Cu = cushaw pumpkin; De = decorative; Hu = Hubbard; Ka = Kabocha; Pu = pumpkin; St = storage

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.

3 Cull percent by weight.

Stripe. The large number of culled Autumn Colors fruit was due to the presence of off-type fruit that were pumpkin-shaped. This may have resulted from a mixture of two seed types. All varieties showed some fruit splitting or cracking.

Kobocha. Sweet Mama was the highest yielding of this squash type as in past trials. Special Export and Eclipse were notable for their eating quality. Kabocha squash are known for their dry, sweet flesh and excellent eating characteristics.

Buttercup. Statistically there were no yield differences between these varieties, indicating that there was quite a bit of variation in yield between replications. Orange Cutie and Orange Dawn tended to have the highest yields, but the skin on these varieties was dull and judged to be not as attractive as the bright orange skin of Ambercup, Sunshine, and Sun Spot. Sunshine was the best tasting of the orange buttercups. Sun Spot was notable as being a very attractive, petite, orange buttercup. Autumn Cup and Thunder were the best of the green buttercup squash, tending to have higher yields and excellent flavor. All of the green buttercups were very attractive. Bon Bon was the only buttercup tested that still retained the typical buttercup acorn shape, with the cap and button on the bottom.

Miscellaneous types. Red Warty Thing was a very attractive, large, ornamental squash that yielded well and is recommended for growers. It had some variation in the amount of wartiness between fruits. Hubba Hubba, a small, bright orange, bush-type Hubbard squash was attractive and productive. Internally, it was not as attractive as many of the other squash types. La Estrella is a calabash, calabaza, or Cuban pumpkin that is very productive with thick, fine-grained, very bright orange, attractive, excellent-tasting flesh. This pumpkin has an unusual, attractive exterior that stands out. Grey Ghost is a winter storage squash that has an attractive gray exterior and burnt orange interior. It is a heavy dense squash with excellent eating characteristics. Lakota is a very attractive orange squash with variable dark green skin patterns. It is a nice addition for ornamental arrangements. Autumn Delight, an acorn squash, was very attractive, uniform in size, and productive, and it has powdery mildew resistance. It has a mild flavor but had a little internal fiber. One Too Many is a white-to cream-colored pumpkin with orange veins on the surface that is very attractive. However, it is very variable in shape and size. With the wet season, a large number of these cracked in the field and also cracked after harvest when exposed to rain.

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Table 2. Winter squash and pumpkin fruit characteristics, Lexington, Ky., 2006.

Variety	Flavor (1-5)[1]	Interior Color[2]	Skin Color[2]	Comments
Argonaut	4.3	dk br. or.	tan w/gy. bloom	Attractive internally, v. dense, straight solid necks
Atlas	3.7	br. or.	tan	Solid neck, high density
Cushaw Green Stripe	3.3	yl. whitish	wh. w/gr. mottled stripes	Some fruit cracking
Cushaw Orange Stripe	4.2	lt. or. yl	cr. wh. w/or. mottled stripes	Lightweight, fine-grained, slightly stringy, may not have been pollinated well, some fruit cracking
Autumn Colors	4.0	cr. or.	wh. w/or. yl. stripes, gr. bottom stripes	Did not maintain gr. color well, not very dense, some fruit cracking, off-type pumpkins in seed lot
Sweet Mama	4.1	br. or.	dk. gr. w/sage stripes	Fine-grained, moist
Special Export	4.4	burnt or.	dk. gr. w/sage stripes	Attractive exterior and interior
Eclipse	4.7	burnt or.	dk. gr. w/sage stripes	Very dry, fine-textured, sweet flesh
T133	4.2	burnt or.	dk. gr. w/sage stripes	Dry, not as sweet as the other kabochas, v. fine texture
Orange Cutie	4.3	burnt or.	br. or.	Sweet taste, dull exterior, some dark green skin spotting
Orange Dawn	4.0	or.	dull or. w/tan stripes	Dull exterior color, attractive, greenish layer beneath skin
Autumn Cup	4.7	cr. or.	dk. gr.	Fine-grained, dry, sweet taste, nice orange color when cooked
Ambercup	4.1	or.	br. or. w/tan stripes	Very attractive, moist/sweet, flesh not as fine-textured as the other buttercups
Thunder	4.7	burnt or.	dk. gr. w/sage stripes	Dry sweet flesh, fine-grained
Sunshine	4.8	burnt or.	burnt or.	Very attractive
Sun Spot	4.3	dk. or.	br. or. w/tan stripes	Very attractive, fine-grained, slightly moist, sweet flesh
Bon Bon	4.5	or. yl.	dk. gr. w/tannish, greenish stripes	Fine-grained, fairly sweet and dry, smooth texture
Red Warty Thing	3.5	br. dk. or.	red/warty	Attractive internally, stringy fibrous texture, variability in amount of wartiness
Lakota	3.6	yl. or.	br. or. w/dk. gr. mottled striping	Attractive, variable color
Hubba Hubba	3.5	br. or. yl.	br. or. w/tan stripes	A little stringy, attractive exterior, internal flesh has green cast and not as attractive
La Estrella	4.5	br. or. yl.	gr. to tan w/wh. blotches	Fluorescent orange interior color, flesh moist, fine-grained, smooth
One Too Many	3.3	yl. or.	wh. w/or. veins	Very variable in shape, many fruit cracked when rained on
Grey Ghost	4.3	burnt or.	gy.	Moist, fine-grained flesh, attractive exterior
Autumn Delight	3.1	cr. or.	dk. gr.	Mild, moist taste, slightly fibrous

1 Flavor: 1 = poor, 5 = excellent. Based on two samples that were microwaved under plastic wrap and evaluated without any seasonings.
2 Interior and skin color: or = orange; cr = cream; yl = yellow; gr = green; gy = gray; wh = white; lt = light; dk = dark; br = bright.

Pumpkin Cultivar Trial in Eastern Kentucky

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

Introduction

More than 50 percent of Americans spend $50.00 or more on Halloween and fall decorations. Pumpkins are not only a way to enter a niche in an ever-growing holiday market but also a way to extend the marketing season. A pumpkin trial was conducted at the University of Kentucky Robinson Station, in eastern Kentucky. Twenty-one cultivars were evaluated, nine small varieties (under 10 pounds), 10 large varieties (more than 10 pounds), and two squash varieties.

Methods

Seeds were planted directly into the field on 5 June. Each cultivar was replicated four times in a randomized complete block design. Each replication consisted of a single row 20 feet long containing four plants. Seeds were hand-sown 4 feet apart in the row with 11.5 feet between rows of the large pumpkin and squash cultivars, and 10 feet between rows of the smaller pumpkin cultivars. Seeds were planted about 1 inch deep. One hundred pounds per acre of K_2O was added preplant to the plot containing the small pumpkins, with 39 lb N/A sidedressed in late June. In late May, 60 lb/A of P_2O_5 and 200 lb/A K_2O were applied preplant to the plot used for the larger varieties and squash. In late June, 52 lb N/A were added as a sidedress to the planting. Pest control sprays were followed as outlined in ID-36, *Vegetable Production Guide for Commercial Growers.* Trickle irrigation using drip tape was used throughout the season. The weather during the growing season was hot and dry. The extremely hot temperatures delayed fruit formation on some of the cultivars resulting in a higher than desired percentage of immature green fruit at harvest in early October.

Results and Discussion

Seven of the large fruited jack-o-lantern cultivars showed no statistically significant difference in fruit number/A (Table 1). The three top yielding large pumpkin varieties were Merlin,

Table 1. Seed source, fruit number per acre, yield, average weight, and quality evaluations for large pumpkin cultivars, 2006.

Cultivar	Seed Source	Mature Fruit[1] (No./A)	Immature Fruit[1] (No./A)	Avg. Wt.[1] (lb)	Shape[2]	Smooth[3]	Ribbing[4]	Color	Stem Quality[5]
Merlin	HS, Ru	4072a	1231b	14.6f	3,1	4.5ab	4.0ab	orange	2.9a
Sorcerer	SW, HS, Ru	3835a	189de	14.4f	1	4.3b	3.5c	orange	2.9a
Magic Lantern	HM	3456ab	758bc	15.4ef	1	4.5ab	3.6bc	orange	3.0a
Fairytale	HM	4119a	1799a	27.0b	F	5.0a	1.0e	greenish-tan	2.9a
18 Karat Gold	Ru	3030abc	426cde	17.5def	1,3	4.3b	3.5c	orange	2.8a
Gold Challenger	Ru	3172abc	616cd	17.4def	1,3	4.0b	3.0d	orange	3.0a
Spartan	Sw	3125abc	663cd	17.1def	1	4.3b	3.3cd	orange	2.8a
Howden Biggie	HM	1989cd	284cde	24.9bc	1	4.3b	3.5c	orange	2.5a
Full Moon	Sw	900d	0e	38.2a	1	3.9bc	4.3a	white	2.5a
Super Herc	HM	2525bc	442cde	22.6bcd	1	4.0b	3.0d	orange	3.0a
One Too Many	Ru	3125abc	284cde	20.8bcde	Hv	3.3c	3.0d	white-pink-yellow	2.8a
Red Warty Thing	Ru	2983abc	284cde	21.1bcde	Hv	1.0d	3.0d	dark red-orange-green	3.0a

[1] Means followed by the same letter are not significantly different as determined by LSD (P = 0.05).
[2] 1 = oblate, 2 = blocky, 3 = round, 4 = flat, hv = highly variable.
[3] 1 = rough, warty skin, 5 = very smooth.
[4] 1 = heavy ribbing, 5 = smooth.
[5] 1 = poor stem quality , 5 = excellent stem quality.

Table 2. Seed source, fruit number per acre, yield, average weight, and quality evaluations for small pumpkin cultivars, 2006.

Cultivar	Seed Source	Mature Fruit[1] (No./A)	Immature Fruit[1] (No./A)	Avg. Wt.[1] (lb)	Shape[2]	Smooth[3]	Ribbing[4]	Color	Stem Quality[5]
Kandy Korn	SW	13776a	0c	1.0e	3	5.0a	4.5a	orange	2.8a
Apprentice	HM	16389a	4138a	1.0e	1,3	4.8ab	4.5a	orange	3.0a
Bat Wings Mix	HM	8930bc	708bc	0.9e	3	4.5ab	4.4a	black bottom, orange top	3.0a
Lil'Pump-Ke'-Mon	HM	13558a	1470bc	0.7e	f	4.0b	2.8d	white-yellow-green	2.8a
Iron Man	HM	6970cd	1797b	3.5c	3	4.3ab	3.3c	orange	3.0a
Touch of Autumn	SW	12687ab	1633b	2.1d	3	4.3ab	4.1ab	orange	3.0a
Cannon Ball	HM	5336cd	1960b	3.9c	1,3	4.3ab	4.1ab	orange	3.0a
Hybrid Pam	SW, Ru	5881cd	871bc	5.2b	3	4.0b	3.0cd	orange	3.0a
Cotton Candy	Ru	3104d	0c	6.4a	1	4.8ab	3.8b	white	3.0a

[1] Means followed by the same letter are not significantly different as determined by LSD (P = 0.05).
[2] 1 = oblate, 2 = blocky, 3 = round, 4 = flat, hv = highly variable.
[3] 1 = rough, warty skin, 5 = very smooth.
[4] 1 = heavy ribbing, 5 = smooth.
[5] 1 = poor stem quality , 5 = excellent stem quality.

Sorcerer, and Fairytale. Each of these had more than 3,500 fruit per acre. Fairytale produced significantly more immature fruit than any other cultivar (44%). Higher temperatures may have delayed fruiting on this heirloom cultivar. Merlin (30%) and Magic Lantern (22%) also had a large proportion of immature fruit. Sorcerer, the second highest yielding large fruited cultivar, had only 5% immature fruit. Magic Lantern, 18 Karat Gold, Gold Challenger, Spartan, and One Too Many yielded more than 3,000 fruit per acre. Full Moon had the largest fruit (38.2 lb), but the yield/A was so low (900 lb) that economically it was not desirable. Howden Biggie was the largest jack-o-lantern pumpkin (24.9 lb), followed by Super Herc (22.6), then 18 Karat Gold (17.5), Gold Challenger (17.4), and Spartan (17.1). The pumpkins in this large pumpkin variety trial ranged from 14 pounds to 38 pounds. All the large fruited pumpkin cultivars had good stem quality.

In the small pumpkin trial, Kandy Korn, Apprentice, and Lil'Pump-Ke'-Mon produced more than 13,000 pumpkins per acre (Table 2). Among those, Kandy Korn had no immature fruit at picking. Apprentice (25%), Cannon Ball (36.7), and Iron Man (25%) had more immature green fruit than the other small pumpkin cultivars. Bat Wings Mix and Touch of Autumn both produced more than 8,000 fruit per acre. The small pumpkin varieties ranged in size from 0.7 pounds to 6.4 pounds. Stem quality was good and not significantly different among any of the small-fruited cultivars.

Fall Pumpkin Trial—Northwestern Kentucky

Nathan Howard and John C. Snyder, Department of Horticulture

Introduction

Over the past few years, fall pumpkin sales have increased all across the area. Producers have been raising pumpkins for direct and wholesale markets. Growers have been using progressive production techniques including plasticulture, no-till as well as conventional practices. The most popular production method has been planting behind wheat into straw. This gives the producer a higher income potential instead of traditional double-cropped soybeans and a better pumpkin fruit because of the clean surface that it develops on. Many different pumpkin cultivars have been grown in the area to satisfy different market tastes. We conducted a trial in McLean County to test some of these pumpkin varieties and compare their yields and quality.

Materials and Methods

Eleven cultivars were evaluated. Nine were traditional jack-o-lantern cultivars, one was a pie pumpkin, and another, One Too Many, was a specialty pumpkin. The plot was fertilized according to soil test results and University of Kentucky recommendations in ID-36, including 100 lb N/A preplant. The plot was then disked and sprayed with the herbicide Strategy at 2 qts/acre and shallowly incorporated. The plot was then seeded 13 June by hand. Three seeds per hill were planted and subsequently thinned to two seedlings. Each hill was planted 4 feet apart in the row, with 6 feet from one row middle to the next. Five hills were seeded per treatment, and the plot was set up as a randomized complete block design with four replications. The plot was cultivated, and nitrogen was sidedressed at 50 lb N/A when vines began to run. Fungicides were applied on a weekly basis throughout the season, and insecticides were applied when needed. At harvest, fruit were counted, weighed, and evaluated for shape, color, smoothness, and stem quality.

Results and Discussion

The pumpkin growing season was a bit of a roller coaster for producers. Most pumpkins were seeded on time in the area, and all got off to an excellent start. Very hot and dry weather began in mid-July and continued through most of August, resulting in reduced fruit number per acre and fruit size. Then, heavy rains resulted in one of the wettest Septembers on record. This led to greater disease including fusarium on many fruit across the area. The plot yield and pumpkin size were a little lower than expected due to the hot, dry weather (Table 1). One of the most noticeable differences was the powdery mildew resistance. Of the varieties tested, four (Touch of Autumn, Aladdin, Spartan, and Magic Lantern) claimed to have some level of powdery mildew tolerance, a common disease in this area. The plot had powdery mildew in July, and these varieties held up very well to that pressure. The pie pumpkin, Touch of Autumn, had fruits that averaged about 3 pounds and had good quality ratings. Compared to the other varieties, Sorcerer had more fruit number per acre (3,100 per acre). The other jack-o-lanterns ranged from 2,360 to 1,360 fruit per acre and were

Table 1. Seed source, fruit number per acre, average weight, and quality evaluations for pumpkin cultivars, McLean County, 2006.

Cultivar	Seed Source	Fruit No./A[1]		Avg. Wt. (lb)[1]		Shape[2]	Smooth[3]	Color[4]	Stem Quality[5]
Touch of Autumn	SW	3,358	a	3	c	3.0	4.0	lo	3.0
Sorcerer	HM	3,086	a	11	ab	2.5	3.0	do	3.0
Gold Challenger	RU	2,360	ab	11	ab	3.0	4.0	do	3.0
Super Herc	HM	2,360	ab	11	ab	2.0	3.5	lo	2.5
20 Karat Gold	RU	2,178	ab	9	bc	2.5	4.0	mo	3.0
Aladdin	HM	2,087	ab	11	ab	2.5	3.5	mo	3.0
Gold Standard	SW	2,087	ab	10	ab	2.8	2.5	do	3.0
Spartan	SW	2,087	ab	10	ab	2.5	3.0	mo	2.8
Magic Lantern	HM	1,906	ab	11	ab	2.5	3.5	do	2.5
Gold Medal	RU	1,361	ab	13	ab	3.0	2.5	do	2.5
One Too Many	RU	545	b	14	bc	2.0	2.0	w	2.0

1 Means followed by the same letter are not significantly different as determined by LSD (P = 0.05%).
2 1 = oblate or flat, 2 = blocky, 3 = round.
3 1 = rough skin, 5 = very smooth.
4 lo = light orange, mo = medium orange, do = dark orange, w = white.
5 1 = weak, small, breaks off; 3 = strong, large.

not significantly different. One Too Many was a white type pumpkin, with multicolor stripes running through it. It was later than the other varieties, and its yield was significantly less than the other varieties, 550 fruit per acre, although the average size was 14 pounds per fruit. Most varieties had acceptable shape and smoothness ratings. The stem quality was very good in this experiment as well, as most varieties had strong green stems at harvest. Yields were lower than expected, probably due to hot, dry weather and close plant spacing.

Based on the data, several conclusions can be offered. Sorcerer had a nice average fruit size and produced more than 3,000 pumpkins per acre. Of the varieties tested, this one had the best performance and is a very good variety for direct market and wholesale. All other jack-o-lanterns did not perform quite as well and had similar yields, fruit size, and quality ratings. We recommend that producers test these varieties for themselves on a small scale to determine those that fit a particular market.

Evaluation of Fungicide Programs for Management of Downy Mildew of Winter Squash

Kenny Seebold and Ed Dixon, Department of Plant Pathology

Introduction

Downy mildew of cucurbits, caused by *Pseudoperonospora cubensis*, is a common disease where susceptible hosts are grown in the southeastern United States. Moderate-to-warm temperatures and long periods of leaf wetness (foggy mornings, overcast days) favor development and spread of downy mildew, and disease progress can be rapid under ideal conditions. Foliage is affected, and severe cases can cause significant (sometimes total) crop loss. In Kentucky, downy mildew is found on cucurbits typically in late summer or early fall. Because *P. cubensis* is an obligate parasite that does not produce overwintering structures, transport of inoculum (sporangia) from out-of-state sources into Kentucky must occur for infections to begin on cucurbits. This is due to the buildup of inoculum in southern (and more recently northern) states early in the season and later-season airborne transport of sporangia into Kentucky in August or September.

Cultural practices and fungicides are useful tools for management of downy mildew. The cultural practices most commonly recommended include site selection (good air movement/areas not prone to heavy fogs) and host resistance (where available).

Downy mildew can be managed with regular application of fungicides. Protectant materials (multi-site inhibitors) such as chlorothalonil (Bravo, Echo, Equus) or fixed coppers (Kocide, Cuprofix, Champ) are labeled for control of downy mildew on cucurbits; however, these materials may not provide adequate protection when conditions are highly favorable to disease or when multiple pathogens are active in a field. Strobilurin fungicides and other quinone-outside inhibitors (QoI fungicides), such as Quadris, Cabrio, and Reason are known to be efficacious against downy mildew. In recent years, however, reduced sensitivity to the QoI class of fungicides has been reported in the United States, lessening the efficacy of these materials and increasing the risk of heavy losses to downy mildew when these compounds are used to excess.

The purpose of the experiments detailed in this report was to evaluate fungicide programs for management of downy mildew on winter (acorn) squash and to determine if QoI-insensitive strains of the downy mildew pathogen were active in Kentucky.

Materials and Methods

Two experiments were conducted at the University of Kentucky's South Farm in Lexington. Acorn squash (cv. Taybelle PM) was transplanted on 22 August into plastic-mulched, raised beds. Between-plant spacing was 18 in., and bed spacing was 6 ft. Plots consisted of a single, 15-ft row (10 plants), and a 5-ft buffer separated each plot. The design for both experiments was a randomized complete-block with four replications. Irrigation water, as well as fertilizer, was delivered through a single drip tape installed in beds prior to covering with plastic mulch. Management practices (weed and insect control, fertility) were conducted according to recommendations of the University of Kentucky Cooperative Extension Service. Nova 40WP (5 oz/A) was applied on 20 September, and an experimental fungicide from Dow AgroSciences was applied 27 September to control powdery mildew in the trials.

Fungicides (Table 1) were applied on 1, 13, 20, and 27 September, beginning prior to the first occurrence of symptoms. Spray programs were discontinued after 27 September due to severe symptoms of downy mildew observed in untreated plots on 3 October. The first application was made with a CO_2-powered backpack sprayer equipped with a three-nozzle hand boom fitted with TX-18 hollow-cone nozzles (20-in. spacing); a four-nozzle boom fitted with TSX-26 nozzles was used for the last three sprays. Application volume was 40 GPA, and sprayer pressure was 56 psi (three-nozzle boom) or 54 psi (four-nozzle boom).

Disease was evaluated on 5 October. The severity of downy mildew was rated as the percentage of leaf area with disease (DLA). Plots were harvested on 13 October, and the number of squash and total weight were recorded. All data were subjected to analysis of variance, and means were separated using Fisher's protected least significant difference (LSD) test.

Results and Recommendations

Conditions were generally favorable for the development and spread of downy mildew during the test period; however, disease occurred relatively late in the season. Powdery mildew was observed in both trials on 13 September, and severity was high by 20 September despite the advertised resistance to the disease in the cultivar Taybelle PM. Severity of powdery mildew was reduced by two applications of fungicide, but symptoms were still present when downy mildew was first observed.

In the first experiment (Trial 1), greatest suppression of downy mildew was observed in plots treated with Bravo WeatherStik (2 pt/A) or a tank-mix of Forum (6 fl oz/A) and Kocide 2000 (1.5 lb/A) (Table 1). Ranman SC (2.75 fl oz/A) plus the surfactant Silwet L-77 (2 fl oz/A) and a tank-mix of the phosphite fungicide ProPhyt (4 pt/A) and Kocide 2000 had significantly higher levels of disease than Bravo or Forum + Kocide but significantly less than the untreated control. No differences in fruit number or weight (total) per plot were found among treatments.

In the second experiment (Trial 2), all fungicide treatments reduced the severity of downy mildew in comparison with the untreated control (Table 1). Greatest suppression of disease was observed in plots treated with Previcur Flex (19.1 fl oz/A), Bravo WeatherStik (2 pt/A, 7-day schedule), Bravo WeatherStik (2 pt/A, 14-day schedule), Bravo WeatherStik alternated with Reason SC (5 fl oz/A), and Bravo alternated with Quadris (12 fl oz/A). Reason SC (5.5 fl oz/A) and Quadris (12 fl oz/A) applied four times gave better control than the untreated check but had more disease than previously mentioned treatments. No differences in fruit number or weight (total) per plot were found among treatments.

Table 1. Effect of fungicide programs on the severity of downy mildew on Taybelle PM squash—2006, Lexington, Ky.

Treatment	Application		Disease Severity	Marketable Yield per Plot	
	Rate/A	Timing[1]	(% DLA)[2]	No. of Fruit	Weight (lb)
Test 1					
Untreated check	--	--	69 a[3]	13 a	24 a
ProPhyt +	4 pt	ABCD	27 c	12 a	23 a
Kocide 2000 DF	1.5 lb	ABCD			
Bravo WeatherStik	2 pt	ABCD	20 d	13 a	25 a
Forum SC +	6 fl oz	ABCD	19 d	13 a	24 a
Kocide 2000 DF	1.5 lb	ABCD			
Ranman SC +	2.75 fl oz	ABCD	39 bc	14 a	24 a
Silwet L-77	2 fl oz	ABCD			
Test 2					
Untreated check	--	--	91 a	13 a	22 a
Previcur Flex	19.1 fl oz	ABCD	28 c	14 a	24 a
Bravo WeatherStik	2 pt	ABCD	24 c	13 a	24 a
Bravo WeatherStik	2 pt	AC	26 c	13 a	24 a
Reason SC	5.5 fl oz	ABCD	62 b	13 a	23 a
Bravo WeatherStik alt.	2 pt	AC	27 c	14 a	25 a
w/Reason SC	5.5 fl oz	BD			
Quadris SC	12 fl oz	ABCD	53 b	14 a	20 a
Bravo WeatherStik alt.	2 pt	AC	28 c	16 a	28 a
w/Quadris SC	12 fl oz	BD			

1 Application dates: A = 1 September, B =13 September, C = 20 September, D = 27 September.
2 Percentage of leaf area in each plot (% DLA) with symptoms of downy mildew on 5 October.
3 Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).

Fungicides such as Forum (a flowable formulation of dimethomorph, also sold as Acrobat50W), and Previcur were as effective as Bravo against downy mildew in these trials. However, these fungicides lack Bravo's broad spectrum of activity and should be tank-mixed or alternated with Bravo or another broad-spectrum product to provide protection against important, and more common, diseases such as powdery mildew or anthracnose. When applied alone, the QoI fungicides used in these experiments, Quadris and Reason, did not provide acceptable levels of control of downy mildew. Quadris and Reason typically demonstrate greater efficacy against *P. cubensis* than Bravo. Moreover, Reason and Quadris alternated with Bravo (seven-day spray schedule) were no more effective than Bravo applied on a 14-day schedule; indicating that the greatest suppression of downy mildew in these programs resulted from Bravo. Therefore, it is likely that the strain of the downy mildew pathogen present in these trials was insensitive to QoI fungicides. For this reason, products in this class should not be relied upon for management of downy mildew in Kentucky and should be tank-mixed or alternated with multi-site inhibitors such as Bravo.

Acknowledgments

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Weed Control in No-Till Pumpkin—UKREC

Joseph Masabni, Dwight Wolfe, Department of Horticulture

Introduction

Pumpkin production has recently increased in Kentucky. Some growers benefit by double cropping their fields, planting pumpkins after winter wheat. They not only gain a second crop, but they also benefit from the wheat stubble left after harvest, which serves as a natural weed control barrier. Other growers may sacrifice fall-planted rye or wheat with an herbicide kill, push the dead straw down, and no-till plant pumpkins into the heavy straw stubble. An advantage of stubble is that expensive herbicides have to be used only in the planting strip instead of the whole field.

Materials and Methods

In order to evaluate this system, an experiment was started in fall 2005 with the drill seeding of winter wheat at about 90 lb/A. Wheat was burned down with Gramoxone on 10 June 2006, which was later rolled down to provide a thick cover.

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 level to obtain good spray overlap and complete weed coverage.

Plots were 10 ft x 35 ft long. 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.

Preemergence herbicide treatments were applied on 19 June 2006, five days after seeding pumpkins using a no-till tobacco transplanter to cut the stubble mulch and disk the planting strip. Postemergence herbicide treatments were applied on 11 July. Two varieties of small-fruited pumpkins were planted in each plot: Cotton Candy (white) and Hybrid Pam (orange).

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

Table 1. Crop injury ratings and overall weed control effectiveness, 17 days after preemergence treatments.

Treatment No. and Name		Rate lb Ai/A	Cotton Candy Rating	Hybrid Pam Rating	Weeds Overall Rating
1	Untreated control	-	3	3	1
2	Strategy	1.5	3	3	10
3	Outlook	0.66	3	3	10
4	Outlook	1.32	5	6	10
5	Spartan	0.19	4	4	10
6	Spartan	0.38	9	9	10
9	Prowl	0.825	7	7	10
	Sandea	0.031			
10	Sandea	0.047	6	7	6
LSD (P = 0.05)			2.5	2.7	2.7
Standard deviation			1.5	1.5	1.6
CV			19.1	30.8	22.35

Results

About two weeks after preemergence application, weeds were completely controlled by all treatments, except Sandea 0.047 lb ai, with only 60% control efficacy (Table 1). Weeds in this treatment consisted of grasses, which is expected since Sandea has no grass control effectiveness. In terms of injury to the two pumpkin cultivars, significant visual injury ratings were observed with the following treatments: Outlook high rate (1.32 lb ai), Spartan high rate (0.38 lb ai), Prowl + Sandea combination, and Sandea 0.047 lb ai.

The labeled herbicide Strategy had a stand and vigor level of the pumpkins comparable to the control plots. Similar results were seen with the non-labeled herbicide Outlook at 0.66 lb ai rate.

In Table 2, visual injury ratings for postemergence herbicides apply for treatments 7 and 8 only. The visual injury ratings for all other treatments are for the preemergence treatments and would be equivalent to ratings taken 36 days after PRE application.

At 36 days after PRE application (treatments [Trt No.] 2-6, 9-10), crop injury was still observed for only Spartan high rate (0.38 lb ai). All other treatments that showed injury at 14 days after treatment (DAT), namely 4, 9, and 10, did not show any further injury at 36 DAT and appear to be safe on both cultivars at this date.

At 14 days after postemergence application, treatments 7 and 8 showed significant injury ratings on Cotton Candy pumpkin but not statistically different from the control for Hybrid Pam. The addition of Chateau to V-10142 significantly improved the overall weed control effectiveness.

At harvest, only Hybrid Pam was harvested. All Cotton Candy fruit had rotted due to a severe powdery mildew infection. Table 3 shows data for Hybrid Pam only. Of the treatments that had a significant injury at 17 DAT (namely treatments 4, 6, 9, 10), only treatments 6, 9, and 10 had effects on yields at harvest, even though visual injury symptoms had disappeared by 36 DAT (see table 2). Outlook 1.32 lb ai had no residual effect, did not affect yields at harvest, and was similar to the rate of 0.66 lb ai. Yields of Outlook plots were similar to the Strategy plots. Significant yield reduction was observed with treatments 6 through 10 (Table 3), both in terms of number of pumpkins per plot and total weight per plot.

At this stage, it appears that V-10142 is not safe for use on pumpkins as a directed postemergence herbicide. Neither is Sandea alone nor in combination with Prowl, nor Spartan at the high rate of 0.38 lb ai. Spartan at low rate of 0.19 lb ai (active ingredients/acre) and Outlook appear to be safe for use as a preemergence herbicide in no-till pumpkins.

Table 2. Crop injury ratings and overall weed control effectiveness, 14 days after postemergence treatments.

Treatment No. and Name		Rate Lb ai/A	Cotton Candy Rating	Hybrid Pam Rating	Large Crabgrass Rating	Redroot Pigweed + Horsenettle Rating
1	Untreated control		1	2	1	4
2	Strategy	1.5	1	2	9	10
3	Outlook	0.66	1	1	5	10
4	Outlook	1.32	1	1	9	10
5	Spartan	0.19	3	4	7	10
6	Spartan	0.38	8	9	9	10
7	V-10142	0.3	4	4	2	7
	COC	1%				
8	V-10142	0.3	3	4	7	10
	Chateau	0.096				
	COC	1%				
9	Prowl	0.825	2	3	8	10
	Sandea	0.031				
10	Sandea	0.047	2	4	4	4
LSD (P = 0.05)			1.9	2.6	2.7	3.8
Standard deviation			1.1	1.5	1.5	2.2
CV			40.09	43.25	25.36	26.48

Table 3. Harvest—92 days after preemergence treatment.

Treatment No. and Name		Rate Lb ai/A	Hybrid Pam Yield No./Plot	Hybrid Pam Yield KG/Plot
1	Untreated control	-	18	28
2	Strategy	1.5	30	60
3	Outlook	0.66	28	48
4	Outlook	1.32	30	63
5	Spartan	0.19	21	57
6	Spartan	0.38	12	18
7	V-10142	0.3	14	22
	COC	1%		
8	V-10142	0.3	16	19
	Chateau	0.096		
	COC	1%		
9	Prowl	0.825	17	27
	Sandea	0.031		
10	Sandea	0.047	13	16
LSD (P = 0.05)			14.9	37.3
Standard deviation			8.7	21.8
CV			43.53	60.61

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

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

Introduction

Kentucky growers produce approximately 1,200 acres of staked, vine-ripe tomatoes for local and national sales. Kentucky tomatoes have an excellent reputation for quality among produce buyers. This trial evaluated new and existing cultivars of tomatoes to identify those that might produce well in the late summer and fall. Cultivars were evaluated for yield, appearance, and potential return to growers.

Table 1. Tomato cultivars, descriptions, and reported disease resistance, grown at Quicksand, Ky., 2006.

Variety Name (Company)	Comments/Description[1]
Mountain Fresh Plus (HS, SW)	Determinate, red, 77 days, resistant to 1,2,3,4
Mountain Crest (HM, SW)	Determinate, red, 74 days, resistant to 1,2,3
Amelia (HM, SW)	Determinate, red, 80 days, resistant to 7,8
Crista [NC 0256] (HM)	Determinate, red, 75 days, resistant to 1,2,3,4,7,8
BHN 543 (S, SW)	Determinate, red, 72 days, resistant to 1,2,3,4
Indy (R, SW)	Determinate, red, 69-80 days, resistant to 1,2,3
BHN 640 (S)	Determinate, red, 69-80 days, resistant to 1, 2, 3, 8
Phoenix (SM)	Determinate, red, crack resistant, resistant to 1,2,3, tolerance to 6
Sunleaper (R)	Determinate, red, 69 days, unknown resistance
Solar Fire (HM)	Determinate, red, early, resistant to 1,2,3,7, intermediate resistant to 6
FLA 91 (R)	Determinate, red, 72 days, resistant to 2,3,5

[1] 1 = Verticillium wilt, 2 = Fusarium wilt R1, 3 = Fusarium wilt R2, 4 = Nematode tolerant, 5 = Alternaria Stem Canker tolerant, 6 = Stemphylium tolerant, 7 = Fusarium wilt R3, 8 = Tomato Spotted Wilt Virus.

Materials and Methods

Eleven fresh-market, red-fruited tomato cultivars were evaluated at Quicksand, Kentucky (Table 1). Based on soil test results, the plot received 50 lb N/A, 180 lb/A P_2O_5, and 180 K_2O/A. An additional 76 lb N/A were 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.

Plastic 72-cell trays were seeded in the greenhouse at Quicksand 31 May. FLA 91 was seeded on 5 June. Ten tomato cultivars were transplanted 25 June, and the FLA 91 were set on 30 June. Cultivars were replicated four times with eight plants per replication. Plants were spaced 18 in. within rows. Rows (bed centers) were 11.5 ft apart to allow a harvest aid to be driven between beds.

Seven harvests were made 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 2006 (Table 3). An early season frost on Oct. 13 ended the trial earlier than expected.

Results and Discussion

The 2006 growing season was drier and warmer than normal in June, July, and August but cooler and wetter than normal in September and October. Rainfall totals for July, August, September, and the first 13 days of October were 3.87, 3.69, 6.39, and 1.38 inches, respectively.

The tomato cultivars BHN 543, Sunleaper, and Indy were not significantly different in total marketable yield or income produced per acre (Table 2). However, BHN 543 did produce significantly higher yields and income than the other seven cultivars. Indy produced the most pounds of extra large fruit per acre,

Table 2. 2006 fresh-market tomato late-season yields at Quicksand, Ky. Data are means of four replications. Cultivars arranged in descending order according to income per acre.

Cultivar	Income ($/A)		Total Market (lb/A)[1,2]		Extra Large Weight (lb/A)[2]		Boxes of Jumbo and Extra Large (no./A)[2]		Percent Jumbo and Extra Large (%)[2]		Average Fruit Weight (oz/fruit)[2]		Pounds No. 2 (lb/A)[2]		Percent Culls (%)[2]	
BHN 543	27464	a	31186	a	16398	cd	1215	a	97	ab	10.6	a	1941	a	7	abc
Sunleaper	25087	ab	28566	ab	21093	ab	1068	ab	93	b	8.5	c	1547	a	5	bc
Indy	23189	abc	27264	abc	21590	a	1043	ab	96	ab	8.7	c	1073	a	7	abc
Mt. Fresh Plus	22684	bcd	25457	bcd	16295	cd	990	bc	97	ab	9.7	ab	1602	a	6	bc
BHN 640	22483	bcd	25647	bcd	19270	abc	1006	abc	98	a	9.3	bc	1539	a	7	abc
Solar Fire	20516	cd	23311	cd	18087	bc	880	bc	94	ab	8.8	c	1697	a	7	abc
Crista	20049	cd	23295	cd	13502	de	907	bc	97	ab	10.1	ab	1941	a	5	c
Phoenix	19039	cd	22135	cd	13502	de	872	bc	98	a	9.8	ab	1444	a	8	abc
Amelia	18158	d	20896	d	12871	ef	815	c	97	ab	9.7	b	2052	a	9	abc
Mt. Crest	12008	e	13163	e	10085	f	439	d	84	c	7.3	d	1539	a	11	ab
FLA 91	11415	e	11845	e	6676	g	454	d	96	ab	9.9	ab	908	a	12	a

[1] Includes all grades except culls.
[2] Means within a column, followed by the same letter are not significantly different, as determined by Duncan-Waller LSD (5%).

Table 3. Prices used to calculate incomes—actual farm gate prices paid by Fairview Produce Auction 2006.[1]

Week	No. 1 Jumbo & Extra Large
Average price/pound	
8/28	$0.65
9/5	0.53
9/12	0.77
9/19	0.92
9/26	1.02
10/3	0.95
10/11	0.98

[1] Yields of Jumbo, Extra Large, and Large No. 1 fruit were multiplied by the price for the appropriate harvest date, and then these incomes were summed to calculate "income per acre" for each cultivar.

followed by Sunleaper and BHN 640. BHN 543 had the greatest average fruit weight, followed by Mt. Fresh Plus, Crista, Phoenix, and FLA 91, which were not significantly different from each other. Mt. Crest had the smallest average fruit weight. There was no significant difference in percent culls between the 11 cultivars.

Tomatoes brought a premium price late in the season (Table 3.) The average price received in September was $0.81 a pound at the Fairview Produce Auction, with a high of $1.02 a pound. The tomatoes would have continued to be picked past October 11, but the area experienced an early killing frost on October 13, 2006.

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

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

Brent Rowell, Janet Pfeiffer, Terry Jones, Katie Bale and John C. Snyder, Department of Horticulture

Introduction

Currently, Kentucky growers produce approximately 1,200 acres of staked, vine-ripened tomatoes, which they sell at both local and national markets. Kentucky-grown tomatoes have an excellent quality reputation among produce buyers. Therefore, we continue to test new and existing commercial fresh-market tomato varieties in order to identify varieties that can be marketed as a premium "Kentucky tomato." We evaluated cultivars for yield, appearance, and potential producer income and compared these with Mountain Spring and Mountain Fresh, which are two well-established cultivars.

Materials and Methods

Fourteen determinate red-fruited tomato varieties were evaluated at the Horticulture Research Farm in Lexington, Kentucky. Mountain Spring and Mountain Fresh, two popular varieties, were included as a comparison with newer cultivars (Table 1). Mountain Fresh Plus was also included. Mountain Fresh Plus is essentially the same as the older variety, Mountain Fresh, except it has root knot nematode resistance. All trial cultivars were seeded in the greenhouse on 20 March and transferred to 38 cell plastic trays. Cultivars were transplanted 10 May. The experiment was a randomized complete block design with four replications. Each plot consisted of eight plants spaced 18 inches apart in a single row. Rows (bed centers) were spaced 6.5 feet apart. Plants were grown on black plastic mulch with drip irrigation.

Drip irrigation was applied when needed using tensiometers to monitor soil moisture. All plants were staked and tied using a Florida weave system. Plants were pruned to two main stems. 148 lb/A of nitrogen and 130 lb/acre of potassium (K_2O) were applied to the field preplant. 81 lb/A of supplemental nitrogen was fertigated in nine applications during the season. Plots were sprayed weekly with protectant fungicides (fixed copper and Maneb were sprayed on alternating weeks with either fixed copper and Bravo or fixed copper and Quadris; Actigard was applied twice early in the growing season). There was only one application of the insecticide Pounce to control Colorado potato beetle and tobacco hornworm.

Table 1. Actual USDA food distribution prices (per 25 lb box).[1]

Week Ending	No. 1 Jumbo, X-Large, and Large ($/box)
22 Jul	9.45
29 Jul	8.95
5 Aug	6.95
12 Aug	8.90
19 Aug	10.95
26 Aug	10.85

[1] Box yields of No.1 jumbo, extra large, and large tomatoes were multiplied by these prices for the appropriate harvest dates to calculate "income per acre" for each cultivar.

Table 2. Yields, fruit size, and income from staked tomato cultivars at Lexington, Ky., 2006. All data are means of four replications.

	No. 1 Jumbo + X-Large[1]		X-Large	Thousand lbs/A		Culls	Average[5]	Income
Variety (Seed Co.)	**Boxes/A**	**%**	**Weight/A**	**Total Market[2]**	**No. 2s[3]**	**(%)[4]**	**Fruit Wt. (oz.)**	**($/A)**
Crista (SW)	1546 a	81 fg	9798 a	47.3 ab	3.2 abc	25 de	13 e	16661 ab
Phoenix (SW)	1278 ab	72 de	10622 a	43.3 a	5.2 abc	29 e	11 bcde	17273 a
HMX 5826 (SW)	1232 ab	71 ef	11798 a	43.2 abc	4.3 bc	24 cde	11 bcde	12460 abcd
Biltmore VFF (SW)	1209 ab	77 cde	8494 a	38.7abc	4.6 ab	28 de	12 bcd	15159 abc
Mtn. Fresh Plus (SW)	1204 ab	63 g	11457 a	47.3 abc	4.3 c	20 de	10 e	15868 abc
Amelia (SW)	1109 abc	63 de	11691 a	43.6 c	6.0ab	24 a	11 cde	8619 d
BHN 444 (SW)	1090 abc	77 a	9983 a	35.8 a	7.8 bc	33 cde	12 a	16830 ab
BHN 543 (SW)	917 bc	67 abc	7615 a	34.9 abc	5.3 a	33 abc	11 ab	12147 abcd
Mtn. Spring (SW)	841 bc	47 bcde	8413 a	44.8 abc	4.6 abc	23 abc	9 bc	11771 abcd
Mtn. Crest (SW)	802 bc	57 f	6461 a	35.0 abc	3.6 a	28 bcd	10 ed	11254 bcd
Sunshine (SW)	655 c	62 ab	7146 a	26.6 abc	6.5 abc	42 cde	10 b	13885 abcd
Sunguard (SW)	648 c	37 ef	8799 a	44.0 bc	2.2 abc	24 ab	9 ecd	10153 abcd
RFT 6153 (SW)	646 c	56 abcd	8586 a	28.4 abc	4.4 abc	38 cde	10 bcd	16005 abc
Indy (SW)	644 c	49 abcd	7123 a	32.4 abc	7.7abc	31 de	10 bcd	15604 abc

[1] Yields of USDA No. 1 fruit of jumbo (> 3.5 in. diameter) plus extra large (> 2.5 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 = 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.

Tomatoes were harvested nine times between 18 July and 23 August. Fruit was sorted into the following size classes prior to weighing: jumbo (> 3.5 in. diameter), extra-large (> 3.0 in. but < 3.5 in.), large (> 2.5 in. but < 3.0 in.), small (< 2.5 in.), and culls. Fruit were also sorted using the U.S. No. 1 and No. 2 grades. Total marketable yield reported includes only large and above size categories. Yields of medium-sized tomatoes are reported with smalls because they are not considered marketable by most growers/shippers in the state. All the yields reported are of tomatoes that were rated as a No. 1, while yields of No. 2's are reported separately. Means of all variables measured were compared using the Waller-Duncan's K-ratio T-test (P = 0.5).

Income per acre. In addition to reporting yields in pounds or boxes per acre, we also expressed variety performance as income per acre. In order to estimate income, we used 2006 USDA Food Distribution prices (Table 2). These market prices were multiplied by yields from the different size classes for each variety. Early- and late-maturing varieties may be favored due to higher prices received early and late in the season. Yields of No. 2 tomatoes were not used in calculations of expected income.

Fruit quality ratings. All ripe fruit of each variety harvested on 23 August (final harvest) were laid out on a table and photographed. All cultivars were rated for overall appearance as well as blotchy ripening.

Results and Discussion

The 2006 growing season was wet and relatively cool early in the season. This year, although plants were seeded/transplanted on virtually the same day as last year, it is notable that the first fruit harvest of 2006 (18 July) was a week later than that of 2005 (11 July). This may in part be due to cooler temperatures early in the season. Although the season was very wet, there was no discernible disease pressure.

Yields and incomes/acre were much higher this year for all varieties retested from the 2005 tomato trial (Sunshine, Mountain Fresh Plus, Biltmore, Amelia, Crista, Mountain Spring, Sunguard, Indy, Mountain Crest, BHN 543, BHN 444). This is most likely due to the lack of disease pressure in the 2006 trial that occurred in 2005. This year the highest yielding variety was Crista, but this yield did not significantly differ from Phoenix, HMX 5826, Biltmore VFF, Mountain Fresh Plus, Amelia, or BHN 444 (Table 2). Crista also had the highest marketable yield (47,260 lb); however, this yield did not significantly differ from 11 of the other cultivars in the trial. Crista also had the largest average fruit weight (13.5 oz), and this was significantly different from all of the other cultivars except BHN 444. The main season variety Mountain Fresh Plus had the fifth highest yield of jumbo and extra-large fruits and the sixth highest income. Incomes ranged from $17,273/A for Phoenix to $10,153/A for Sunguard. Sunshine, which had the highest yield in the 2005 growing season, performed poorly in this year's trial, having one of the lowest yields and highest cull percentage (41.6).

Table 3. Overall tomato fruit appearance ratings and rating of blotchy ripening from staked tomatoes from Lexington, Ky., 2006.

Variety	Visual Rating	Blotchy Ripening (1 = none, 5 = severe)
RFT 6153	A- (a little cracking)	1.5
Mt Fresh Plus	B+	1.5
Biltmore VFF	B+	1.5
Mountain Crest	B+ (a few water cracks)	2
Mountain Spring	B+ (a little cracking)	2
HMX 5826	B+ (some cracking)	2
Sunguard	B	2.5
Phoenix	B-	2.5
Crista	C+ (overwatered, cracked)	2
Indy	C (overwatered, cracked)	2
BHN 543	C (severe cracking)	2.5
Sunshine	C (rough fruit, cracking)	3
Amelia	D (overwatered, cracked)	2
BHN 444	D- (overwatered, cracked)	2

Among the group of varieties exhibiting highest yields and incomes, Mountain Fresh Plus and Biltmore VFF had the highest ratings for both overall appearance and lack of blotchy ripening (Table 3). Crista, which was the second highest in total income and exhibited the highest fruit weight and number of jumbo and extra-large fruit, had a fairly poor rating for overall appearance and occurrence of blotchy ripening. Other varieties with high appearance scores (B or above) were Mountain Spring, HMX 5826, Mountain Crest, Phoenix, and Sunguard. Amelia and BHN 444 exhibited the worst overall visual rating but did not have the highest blotchy ripening rating. In terms of fruit quality and appearance, Sunguard, which again had a high fruit quality rating, performed well in 2003, 2004, and 2005 (see 2003, 2004, and 2005 Research Reports). Mountain Crest, which exhibited a higher rating for fruit appearance this year, also rated highest for fruit appearance in 2004 and 2005.

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

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Introduction

Sustainable pest management practices for high value horticultural crops are emerging as viable alternatives to traditional pesticides, primarily with the adoption of integrated pest management (IPM). One component of IPM is biological control using supplemental releases of natural enemies to control key pests. This can result in a reduction in pest populations and is generally compatible with other natural enemies of insect pests in the field.

The European corn borer (ECB), *Ostriniae nubilalis*, presents a unique problem to pepper production in Kentucky, as it is 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 this pest using pesticides or biological control; thus, timing is crucial for all management options. Control must occur in the egg stage or in early instar larvae prior to tunneling. The major damage is caused by the second and third generation ECB larvae in early July through late August.

As part of an ongoing study of *Trichogramma ostriniae*, a parasitic wasp imported to control ECB, the University of Kentucky continued release experiments to test its use for biological control of ECB in bell peppers. Previous studies have shown significant declines of ECB-infested fruit. This two-year study evaluated the effects of habitat modification on the performance of *T. ostriniae*, by providing a pollen and nectar source (buckwheat) for the wasps within the crop, as well as attracting other natural enemy populations into the field.

Materials and Methods

This study was conducted at five sites at University of Kentucky research farms in Lexington, Kentucky. In 2006, all replicates were located at the Spindletop Research Farm (North Farm). For 2005, four replicates were located at North Farm and one replicate at South Farm. A bacterial spot-resistant cultivar, Aristotle, was used for the experiment. Seeds were sown in the greenhouse at South Farm on 14 March 2006. Peppers were transplanted into raised beds with black plastic mulch with drip irrigation on 1 June at North Farm. Beds were 6 ft from center to center and 50 ft in length. Each bed held two rows of 35 pepper plants, spaced 15 in. apart in the row with 15 in. spacing between rows. Each plot consisted of two pepper subplots of five beds (10 rows) separated by 16 rows of sweet corn in the center and four rows on each end of the plot. Sweet corn was planted on 8 May, as a lure to attract ECB to the peppers and to buffer the effects of the treatments. One set of subplots had 20 buckwheat (*Fagopyrum esculetum* Moench) plants direct seeded on 3 ft of plastic at both ends of the pepper beds; the other had no flowers planted. The buckwheat was planted on 7 June and flowered within four weeks and continued to flower throughout the experiment until the last harvest. Buckwheat was chosen for the flower treatment because of the small flower size, growth habit, and its beneficial effects on the soil habitat.

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 included either buckwheat flowers or no flowers at the ends of the rows. The two main plots in each replicate were separated by at least 1,000 ft to reduce movement of *T. ostriniae* into non-release plots from release plots. Release plots were located downwind from control plots whenever possible. 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 12 June and continued until the week of the final harvest on 13 September. Sticky card insect traps were placed in the center of each subplot to gauge beneficial insect activity and determine if the flowers influenced beneficial insect levels.

Trichogramma ostriniae (*T.o.*) used in the release plots were obtained from Cornell University. They were shipped overnight in parasitized *Ephestia kuehniella* eggs on cards divided for each subplot. Each card contained roughly 16,000 parasitized eggs, and each subplot (0.017 acre) received one card per release date. The release rate was roughly 464,000 *T.o.*/acre/release. Cards were placed in the center of the plots enclosed in Petri dish cages with fine mesh to allow for emergence but to protect the *T. ostriniae* from predation. Five 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. Additional releases were made in coordination with the degree-day target for 25% and 75% completion of egg laying and two later releases since ECB activity was still considered steady. The release dates, respectively, were 15-17 July, 28-31 July, 9-11 August, 25-28 August, and 6-8 September. Four releases were implemented in 2005.

Sentinel ECB egg masses were used to monitor *T.o.* parasitism levels in the subplots during the release period. ECB egg masses were provided by the USDA Corn Insects and Crop Genetics Research Laboratory at Iowa State University. Ten egg masses were placed on the underside of pepper leaves at regular intervals on each of the outer border rows of each subplot. The egg masses were in place at the time of *T.o.* releases and collected within 48 to 72 hours to ensure that no sentinel ECB larvae emerged within the plots. After removal from the field, these were stored in gelatin capsules for later determination of percent parasitism.

Peppers were harvested twice during the season. The center three beds of each subplot were harvested and separated by both control and release plots as well as flower and non-flower subplots. Marketable and unmarketable yields were recorded, and marketable fruits were counted, weighed, and graded according to USDA standards. Insect-damaged fruits were carefully dissected to confirm ECB damage, and numbers of infested fruits were recorded as well as the number of ECB larvae found.

Total marketable yields were compared among treatments. Numbers of infested fruits were compared to evaluate the effect of wasps and flowers and the effect of combining wasps and habitat modification. The data were subject to analysis of variance tests, and the arc sine of the square root transformation was used to analyze percentage of infested fruits. Yield data were combined for both years of study, and egg parasitism data are given for both per year and combined year releases.

Results and Recommendations

The overall percentage of fruits infested with European corn borer and the actual number of infested fruits per acre were significantly lower in the release plots than in the control plots when data were combined for both years. Additionally, plots with flowers had significantly lower infestations of ECB than plots without flowers (Table 1).

Plots containing both wasp and flower treatments had significantly lower infestations than those with one or without either treatment. This result is considered statistically additive in effect, in that the two treatments are working independently of each other but, when combined, produce a significant reduction in both number of ECB-damaged fruits as well as percentage of ECB-damaged fruit than either treatment alone (Table 1). No synergism or antagonism was observed between the wasps and the flower treatments. This suggests that the flowers do not directly influence the wasps but may be enhancing other beneficial insect activity.

Total marketable yields did not differ significantly between treatments within or among each year (Table 1).

The overall reduction in percent infested fruit is 7% when the flower treatments are compared to non-flower treatments and 18% for the wasp treatment compared to the no-wasp treatment. When both treatments are combined, the reduction is 45% compared to no-wasp and non-flower treatments (Table 1).

Egg parasitism data demonstrate higher parasitism among both release plots compared to control plots and plots with flowers compared to plots without flowers. Those plots containing both treatments show an overall higher percentage of parasitized eggs compared to other treatment combinations (Table 2). Treatments with wasps showed significantly higher parasitism rates compared to those without wasps. Flower plots only showed significantly higher parasitism for the 2006 release dates (Table 2).

Additional testing of *T.o.* compatibility with reduced risk insecticides approved for use on bell peppers is currently under way. Evaluations of beneficial insect populations present in each subplot, collected on sticky card traps to identify the influence of habitat modification on other natural enemies, is still under way.

Table 1. Yields and ECB-infested fruit per treatment, 2005-2006.

Treatment	Marketable Yield (tons/acre)	Unmarketable Yield (tons/acre)	ECB-Infested Fruit[1] %	ECB-Infested Fruit[1] No./A
No Wasps + Flower	9.6	8.5	4.1	1960
No Wasps + No Flower	10.1	8.0	4.4	2350
Wasps + Flower	10.5	7.8	2.4	1240
Wasps + No Flower	9.2	7.5	3.6	1480

[1] ANOVA indicated significant differences for wasps, flowers and a wasp by flower interaction for percent ECB-infested fruit/acre and number of ECB-infested fruit/acre.

Based on the data from this study and previous studies concerning *T.o* used for biological control of ECB, it is apparent that use of this management technique will produce a reduction in ECB overall damage. This reduction is likely enhanced when combined with other cultural and physical controls, such as habitat modification. According to our results for this study, combining *T.o.* releases with habitat modification will decrease overall ECB-damaged fruits in commercial pepper production. These treatments can also be used in conjunction with periodic pesticide applications if pest pressure is high.

T.o. wasps and habitat modification have applications in both conventional and organic production systems. The cost of *T.o.* wasps is comparable to organic-approved insecticides but less cost-effective than traditional insecticides. However, the benefits gained from retaining beneficial insect populations in the system can be motivation for the additional expense. As demand for biological control increases, the cost of implementing this type of management technique will likely decrease over time.

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Table 2. Sentinel egg parasitism, 2005-2006.

Year	Treatment	% Parasitism
2005	Wasps + Flower[1]	5.1
	Wasps + No Flower[1]	13.7
	No Wasps + Flower	0.1
	No Wasps + No Flower	0.1
2006	Wasps + Flower[1,2]	4.6
	Wasps + No Flower[1]	3.6
	No Wasps + Flower[2]	1.2
	No Wasps + No Flower	0.0
2005-2006	Wasps + Flower[1]	4.8
	Wasps + No Flower[1]	8.7
	No Wasps + Flower	0.1
	No Wasps + No Flower	0.1

[1] ANOVA indicated significant differences for wasps on percent parasitism of egg masses.
[2] ANOVA indicated significant differences for flower treatment on percent parasitism of egg masses.

Evaluation of Haygrove High Tunnels for Season Extension in Organic Vegetable Production

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Introduction

High tunnels are non-permanent or removable structures covered with a single layer of 6-mil plastic. Although used extensively throughout Europe for vegetable crop production, high tunnels are just gaining popularity in the United States. They are used for season extension, reduction of disease and insect pressures, and increasing crop quality and yield. Haygrove tunnels, manufactured by Haygrove Inc., were assembled at the University of Kentucky Horticulture Research Farm (South Farm) for this experiment.

Materials and Methods

Four 25 ft wide x 100 ft long Haygrove tunnels were constructed on a quarter acre at the end of July 2006. Tunnels were positioned into prevailing winds (east-west) to maximize ventilation effects from the wind blowing lengthways down the tunnels rather than sideways. The tunnels were constructed on land that had been fallow until 20 July when it was spaded using an Imants spader machine. A second spading took place on 27 July, and 25 lb N/A were applied to all the plots with Nature Safe 10-2-8 organic fertilizer. Three varieties of peppers, tomatoes, and melons were sown in the organic greenhouse at South Farm and transplanted into raised beds covered with black plastic mulch on 2 August. Strawberries were transplanted on 18 September. Pepper varieties included Gourmet, Red Knight, and Early Sunsation; tomato varieties consisted of Cobra, Tami G, and Brandywine; melon varieties included Savor, Sensation, and Edonis. The two strawberry varieties were Chandler and Camarosa. Plants inside the tunnels were replicated on a quarter-acre plot located adjacent to the tunnels to allow evaluation of season extension, temperature variations, and insect and disease pressure differentials. Drip irrigation was used to provide water as needed. All plants were fertigated twice: in September with Phytamin 6-0-0 and in October with Omega 1-5-5. Melons located inside the tunnels and on outside plots were covered with Reemay at transplanting for insect and disease control. Row covers were removed 1 September. Weekly sprays of sulfur and copper hydroxide were applied to melons to combat fungal disease after the row covers were removed. Plots were cultivated on an as-needed basis with a wheel hoe or rototiller. The Haygrove tunnels required much less cultivation than the plots located outside the tunnels due to less weed pressure.

WatchDog temperature loggers were installed in each tunnel to monitor the temperatures on an hourly basis for the duration of the experiment. Four loggers were also located on the outside plots for temperature comparison.

Venting the Haygrove tunnels was based on minimum/maximum thermometers installed in each bay. When temperatures reached 60°F and above, the end doors on each bay were opened for ventilation. End doors were closed and the tunnel was sealed when nightly temperatures dropped below 60°F, beginning in late September.

Results and Discussion

Plants located inside the Haygrove high tunnels grew more rapidly due to more sheltered conditions. Peppers transplanted in beds outside the tunnels suffered from black plastic mulch burn due to high August temperatures, while pepper plants inside the tunnels did not. Pepper plants inside the tunnels grew large rapidly and had to be staked, while the outside plants did not. The tomato plants inside the tunnels were also significantly larger then the plants located on outside plots. Melons located on the outside plots suffered from anthracnose and eventually died with no yield data collected, while melons in the tunnels continued to be harvested at the end of October. The plants located in outside plots were subjected to near-freezing conditions in mid-October and were mostly dead by 18 October. Little to no yield data were collected, while the plants inside the Haygrove tunnels continued to produce at the end of October. Yield data are currently being collected.

Hot Pepper Extracts for Cabbage Looper Control

George F. Antonious, Janet E. Meyer, and Jami A. Rogers, Department of Plant and Soil Science, Kentucky State University

Introduction

Farmers are expected to meet the food, feed, and fiber needs of growing populations as well as the demands of diverse consumer groups, while preserving ecosystems, health, and biodiversity. This requires modern, highly effective plant protection products. These products must be safe for the environment, wildlife, and consumers. Organic products have become increasingly popular in recent years, as consumers have grown more health conscious and environmentally aware. Farmers are in need of insect pest management strategies that are effective, affordable, and environmentally sound.

The cabbage looper, *Trichopulsia ni* Hübner, can be a very damaging insect primarily to cole crops. Larvae consume three times their weight in plant material daily [1]. Many studies have indicated the potential ecological damage due to widespread use of synthetic pesticides [2, 3]. Basic and applied research to provide alternative pesticides with low impact on human health and environmental quality is needed. Dried plants or their extracts have been used by farmers in many developing countries to protect food and fiber from insects. Chili pepper powder deterred oviposition of the onion fly, *Delia antiqua* [4]. Capsaicin in hot pepper has been reported to reduce larval growth of the spiny bollworm, *Earias insulana* [5], and the use of oleoresin from *Capsicum* as a repellent against cotton pests has been reported [6].

This investigation is a continuation of our previous work on natural products for pest control and was designed to: 1) test the toxicity of hot pepper fruit extracts to cabbage looper larvae, and 2) select candidate hot pepper accession(s) having toxicity against cabbage looper larvae for use as a pest control agent.

Materials and Methods

Seeds of *Capsicum* accessions were obtained from the USDA/ARS Plant Introduction Station, Tifton, Georgia, and planted at the Kentucky State University Research Farm in the greenhouse in the spring and transplanted to the field in June. Five *C. chinense* Jacq. (PI-594139, PI-438643, PI-438614, PI-435916, and PI-224448); six *C. frutescens* L (PI-241675, PI-239703, PI-586675, PI-439506, PI-257069, and PI-257051); six *C. baccatum* L (PI-260434, PI-281340, PI-238061, PI-439381, PI-370004, and PI-267729); five *C. annuum* L (PI-438649, PI-310488, PI-593566, PI-547069, and PI-246331); and one *C. pubescens* Ruiz & Pav (GRIF-9354) were selected to represent the five pepper cultivated species and a cross section of the geographic range of origin. Plants were fertilized with Peters (NPK fertilizer) at 200 ppm and watered twice a week using drip irrigation; no pesticides were used.

After harvest, fruit were dried in an oven at 65°F for 48 h to a constant weight, ground using a mortar and pestle, and sieved to pass through a No. 18 (1 mm) mesh screen. Hot pepper fruit extracts were prepared by shaking 20 g dried fruits of each accession with 100 mL of water for 1 h using Lab-Line Multi-Wrist Shaker. The mixture was passed through a double layer of cheesecloth and squeezed manually. The extract was then vacuum filtered.

Cabbage looper eggs were obtained from the University of Kentucky, Department of Entomology, and reared on artificial diet [7]. To validate the bioassay used in this study, 4 methylketones (2-undecanone, 2-dodecanone, 2-tridecanone, and 2-pentadecanone), known organic insecticides [8, 9], were tested against the third instar cabbage looper larvae and used for comparison purposes.

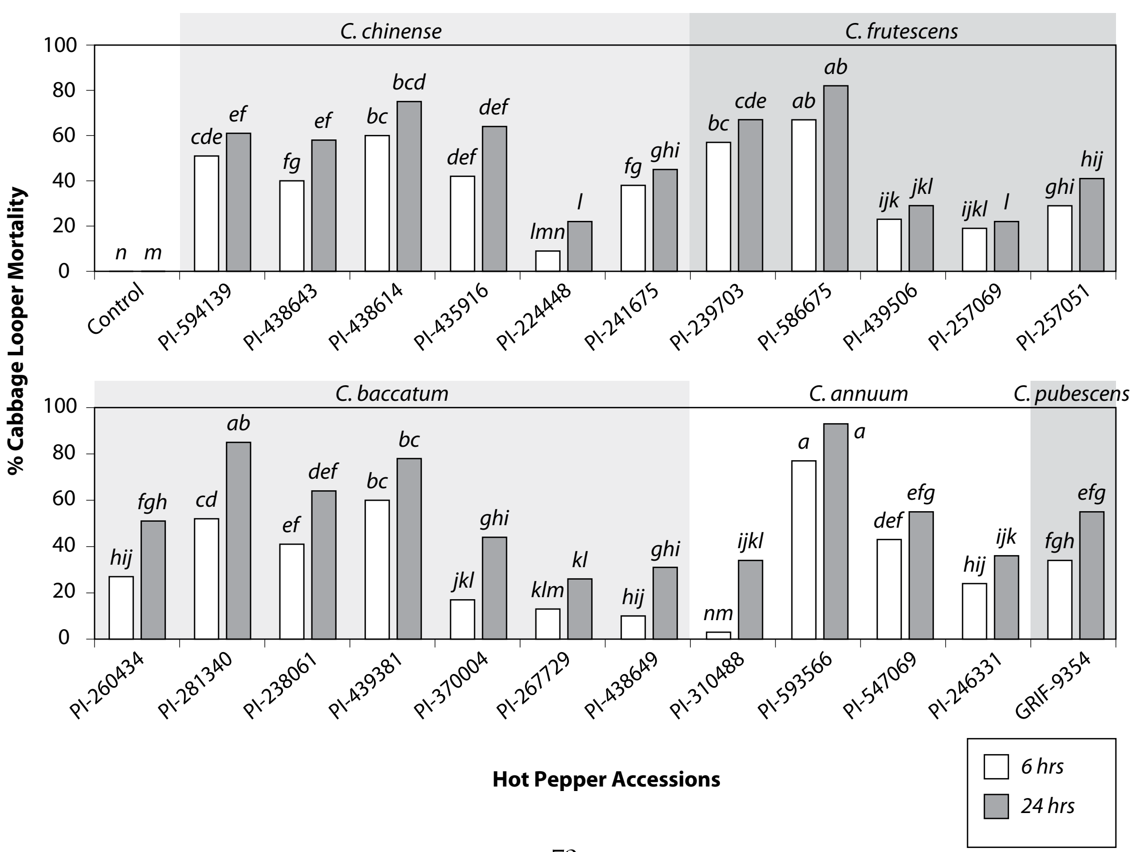
Ten replicates of 10 third instar larvae were sprayed with hot pepper extract with a fine mist sprayer held approximately 6 inches from a 9 cm glass Petri dish. This treatment essentially saturated larvae. Each replicate (10 larvae) was sprayed and transferred to plastic Petri dishes (60 × 20 mm) supplied with 3 g of artificial diet and covered with lid. Mortality was recorded at 6 and 24 h. Larvae showing no movement when probed were recorded as dead. A control set of 10 replicates of 10 larvae each were sprayed with distilled water (100 ml distilled water with 10 drops of 2% sodium dioctyl sulfosuccinate [Sur-Ten] obtained from Aldrich Chemical Company, Milwaukee, WI).

Results and Discussion

Accession PI-593566 of *C. annuum* was highly toxic to the cabbage lopper larvae (Figure 1). Accessions PI-438641, PI-438643, and PI-438649 produced the greatest fruit weight, while PI-632921 produced the lowest fruit weight (data not shown).

Hot pepper producers look for varieties that yield large quantities of high quality peppers. Characteristics of interest

Figure 1. Mortality of third instar larvae of cabbage looper, *Trichoplusia ni* Hübner, sprayed with hot pepper fruit extracts prepared in water from 23 pepper accessions. Bars accompanied by different letter(s) for each exposure period indicated significant differences (P > 0.05) using ANOVA procedure.



included yield, fruit size, and shape [10]. Accessions PI-593566 and PI-438649 of *C. annuum* might be incorporated into plant breeding programs to produce fruits with greatest weight and high concentration of insecticidal agents for cabbage looper control. The results suggested that crude extracts from pepper fruits can be explored for developing natural products for use as biodegradable alternatives to synthetic insecticides.

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Mitigation of Herbicide Mobility under Field Conditions

George F. Antonious, Department of Plant and Soil Science, Kentucky State University, and John Snyder, Department of Horticulture

Introduction

As much as $25 billion every year is spent in the United States for soil care. Losses of all kinds caused by soil erosion are reported at $40 billion each year in the United States. One reason for so much soil erosion is that techniques for control are not thoroughly known and/or are greatly underutilized [1]. Degraded soil can and must be vastly improved to achieve sustainability and maximize crop production. On the other hand, the landfill crisis and other environmental concerns have resulted in a surge in recycling wastes as a means for using and detoxifying wastes and recovery of nutrients needed at all levels of life. Sustainable agricultural systems are resource conserving. In 1988 in the United States, there were 7,924 landfills with available disposal space, and by 1994, the number had dropped to 3,558 [2]. Landfill space shortage, objections to ocean dumping of sewage sludge, and clean air laws have all combined to create changes in approaches to waste management. A central hope in all of these concerns is that wastes can become useful.

Runoff from agricultural watersheds carries enormous amounts of pesticides [3]. Rainfall intensity and flow rate are critical factors in determining pesticide movement from application site into surface runoff, rivers, and streams. Accordingly, environmentally and economically viable agriculture requires the use of agrochemicals and cultivation practices that maximize agrochemical efficacy while minimizing off-site movement of pesticides. Soil management practices that reduce runoff and pesticide movement are vital to sustainable crop production. Many studies have indicated the potential ecological damage due to the widespread use of synthetic pesticides [4, 5]. New soil management practices related to the fate and transport of agrochemicals are needed. Trifluralin `Treflan', a tertiary aromatic amine and dinitrotoluene derivative, is widely used as a preemergence herbicide on a variety of field crops, fruits, vegetables, and ornamentals for control of annual grasses and broadleaf weeds. Due to its high vapor pressure (1.99×10^{-4} mm Hg at 29.5°C) and sensitivity to photochemical degradation, trifluralin has to be incorporated into the soil before seeding or transplanting in order to avoid undesirable loss under field application [6]. Trifluralin has low solubility in water [7], 0.22 mg L^{-1} at pH 7, and is relatively highly toxic to fish. Napropamide Devrinol is a preemergent herbicide used to control annual and perennial grasses and certain annual broad-leaved weeds. Napropamide has a water solubility of 74 mg L^{-1} at 20°C and is one of the commonly used herbicides in Kentucky. The main objective of this investigation was to study the impact of soil amendments on pesticide mobility under field conditions.

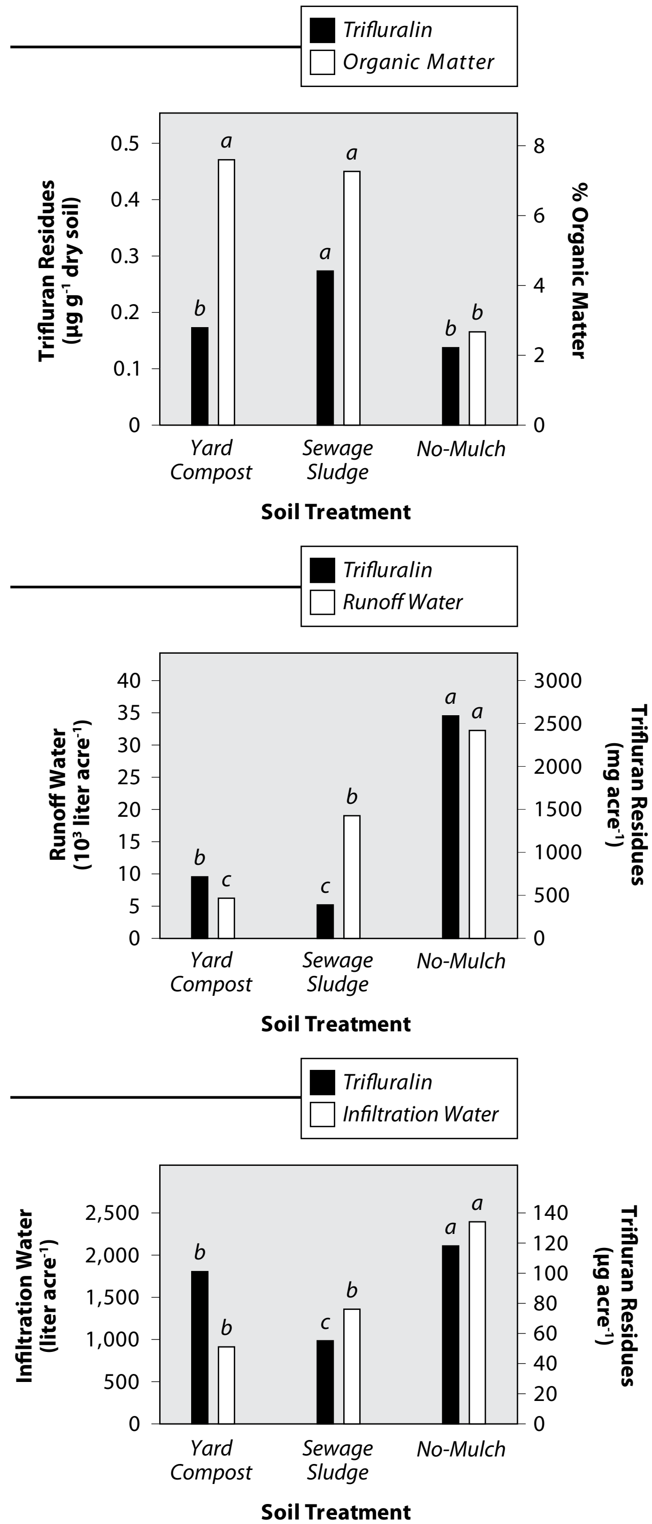
Materials and Methods

A field study was conducted on a Lowell silty loam soil (2.8% organic matter, pH 6.9) located at Kentucky State University Research Farm, Franklin County, Kentucky. The soil has an average of 12% clay, 75% silt, and 13% sand. Eighteen plots of 22 × 3.7 m each were established on a soil of 10% slope. Plots were separated using metal borders 20 cm above ground level to prevent cross contamination between adjacent treatments. Three soil management practices were used: 1) sewage sludge (obtained from Nicholasville Wastewater Treatment Plant, Versailles, Kentucky) was mixed with native soil at 30 t acre^{-1} (on dry weight basis) with a plowing depth of 15 cm; 2) yard waste compost made from yard and lawn trimmings, and vegetable remains (obtained from Kentucky State University Research Farm, Franklin County) was mixed with native soil at 30 t acre^{-1} (on dry weight basis) with a plowing depth of 15 cm; and 3) a no-mulch (NM) control treatment (roto-tilled bare soil) was used for comparison purposes. In year 1, potato (*Solanum tuberosum* cv. Kennebec) seed pieces were planted in 10 rows plot^{-1} (10 plants row^{-1}). Plots were irrigated by drip tape, and no fertilizer was applied. Trifluralin (Treflan; 430 g liter^{-1} EC) was sprayed on the soil surface at the rate of 0.75 lb acre^{-1} and incorporated into the soil. Spraying was carried out using a portable backpack sprayer (Solo) equipped with one conical nozzle operated at 40 p.s.i. In year 2, napropamide (Devrinol 50-DF; 4 lb formulated product acre^{-1}) was sprayed on soil as a preemergent herbicide. Sweet pepper (*Capsicum annuum* L. cv. Aristotle-X3R) seedlings were planted at 10 rows plot^{-1} along the contour of the land slope at 10 plants row^{-1}. In year 3, napropamide was also used, and broccoli (*Brassica oleracea* L. cv. Packman F1) seedlings were planted at 10 rows plot^{-1} along the contour of the land slope at 10 plants row.$^{-1}$

Soil samples were collected up to 35 d after herbicide application to a depth of 15 cm from field plots using a soil core sampler. Samples were air-dried in the dark and then sieved to a size of 2 mm. To extract trifluralin residues, 50 g soil were shaken with 100 mL mixture of acetonitrile-water (99:1 v/v) for 1 h. To extract napropamide, soil samples were shaken with acetone for 1 h. The extracts were filtered and concentrated. Final cleanup was achieved with solid phase extraction.

Runoff water was collected and quantified at the lower end of each plot using a tipping-bucket runoff metering apparatus. To monitor trifluralin residues in runoff water, the pH of water was adjusted to 2.2 to 2.3 extracted with CH_2Cl_2 by liquid-liquid partition. Napropamide residues were similarly extracted from runoff water with acetone-CH_2CL_2 (1:1). Total runoff water per runoff event, per each 0.02-acre plot, was used to determine mass of herbicide lost per acre. To monitor the presence of trifluralin and napropamide residues in the vadose zone (the unsaturated water layer below the plant roots), pan lysimeters were used. Infiltration water was collected and filtered. Trifluralin and napropamide residues were extracted as described for runoff water. Trifluralin and napropamide quantification was achieved using a gas chromatograph. Quality control samples included three field blanks to detect possible contamination during sampling, processing, and analysis. Three sets of duplicate samples and three sample-matrix spikes were used to evaluate potential

Figure 1. Average concentrations of trifluralin residues and organic matter content in soils collected from the rhizosphere of potato (upper graph) and volume of runoff water and trifluralin residues detected in runoff water (middle graph) and volume of infiltration water and trifluralin residues detected in infiltration water (lower graph) from potato field under three soil management practices. Statistical comparisons were done among the three soil management practices. Bars accompanied by the same letter are not significantly different (P < 0.05) using the ANOVA procedure.



bias of the data collected and the ability of the analytical procedure to recover the analyte from field samples.

Results and Discussion

Addition of soil amendments increased soil organic matter content. Residues of trifluralin were significantly higher in sewage sludge compost treatments compared to yard waste and unamended soil treatments (Figure 1, upper graph). Previous results have indicated that the sorption of pesticide was greatest in soils with greatest content of organic matter [8, 9]. Adsorption of trifluralin also could be attributed to differences in elemental composition. High concentrations of Ca, Cu, and Zn were found in soil where sewage sludge was applied (data not shown). Regardless of mechanism of retention, greater retention in sludge-amended soil resulted in lower concentrations of trifluralin in runoff water (Figure 1, middle graph) and may have reduced pesticide leaching into the vadose zone (Figure 1, lower graph) and groundwater.

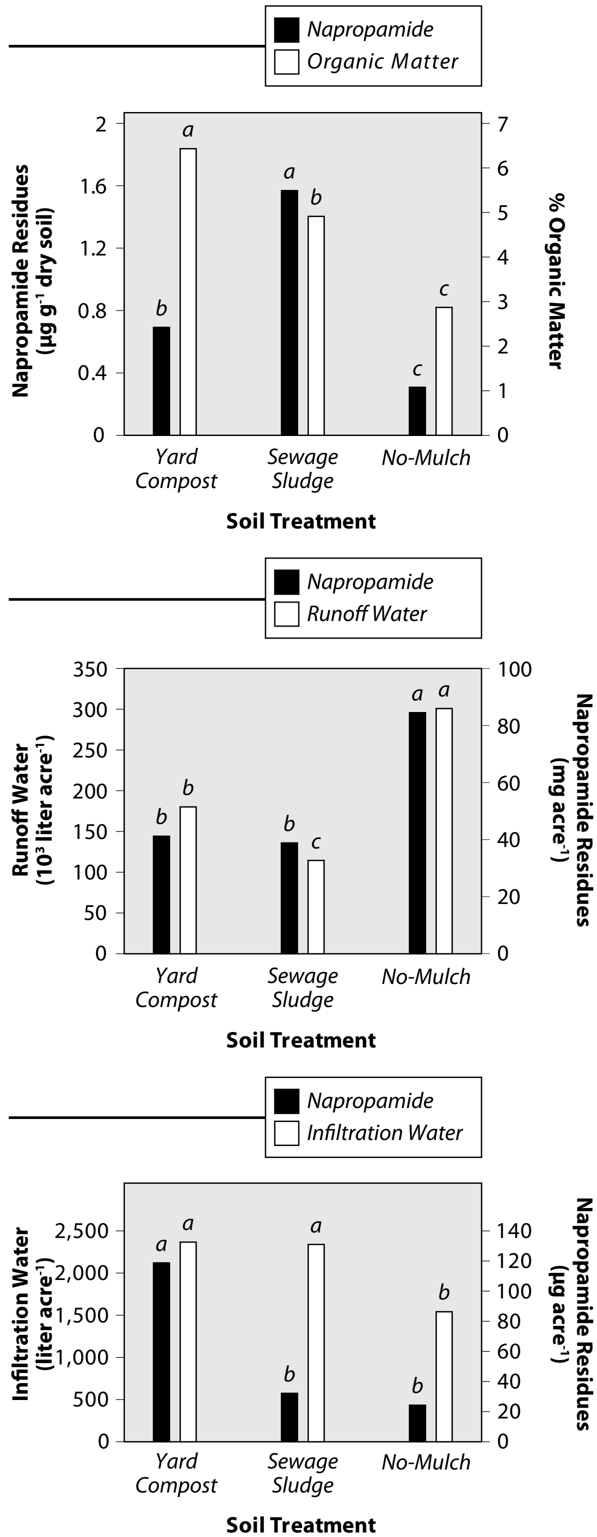
The amount of runoff water collected from the no-mulch (NM) soil was significantly greater than that from plots treated with sewage sludge or yard waste compost. Napropamide residues were significantly higher in runoff water from NM soil compared to yard waste and sewage sludge treatments (Figure 2, middle graph). A substantial amount of runoff and napropamide in runoff was retarded by the two soil amendments (sewage sludge and yard waste compost) that would otherwise have been transported into streams and rivers. Yard waste compost amendment was associated with increased water infiltration and napropamide residue in the vadose zone. Napropamide residues in the vadose zone were 0.3 mg $acre^{-1}$ in the NM treatment compared to 1.4 mg $acre^{-1}$ in yard waste compost treatment. The increased napropamide movement through the soil mixed with yard waste compost into the vadose zone (Figure 2, lower graph) could be attributed to reduced bulk density and increased soil particle interspaces after addition of yard compost. Napropamide seeping into the vadose zone was lowest in NM soil. This is because a large fraction of napropamide mass moved horizontally on the soil surface of the NM soil in runoff water compared to yard waste or sewage sludge mixed soils (Figure 2, middle graph), reducing the concentration of napropamide in infiltration water.

There is an urgent need to develop long-term, low-energy, biological, self-sustainable systems of farming. Recycling wastes from processing operations for production of high-quality amendments is simple, inexpensive, energy conserving, and effective for erosion control and nutrient recycling. The use of sewage sludge in land farming can become a useful technique for trapping pesticides such as trifluralin and napropamide and may reduce surface and groundwater contamination by these two commonly used herbicides.

Acknowledgments

We thank KSU farm crew for maintaining the runoff plots. This investigation was supported by a grant from USDA/CSREES to Kentucky State University under agreements No. KYX-10-03-37P.

Figure 2. Average concentrations of napropamide residues and organic matter content in soils collected from the rhizosphere of broccoli (upper graph) and volume of runoff water and napropamide residues in runoff water (middle graph) and infiltration water and napropamide residues in infiltration water (lower graph) collected from the vadose zone of broccoli plants grown under three soil management practices. Bars accompanied by the same letter are not significantly different (P < 0.05) using the ANOVA procedure.



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Impact of Incorporating Sewage Sludge into Native Soil on Herbicide Mobility

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Introduction

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 have 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 aeration 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.

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 objectives of this study were: 1) to study movement of napropamide (the herbicide devrinol) into runoff and infiltration water from a broccoli field that has 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

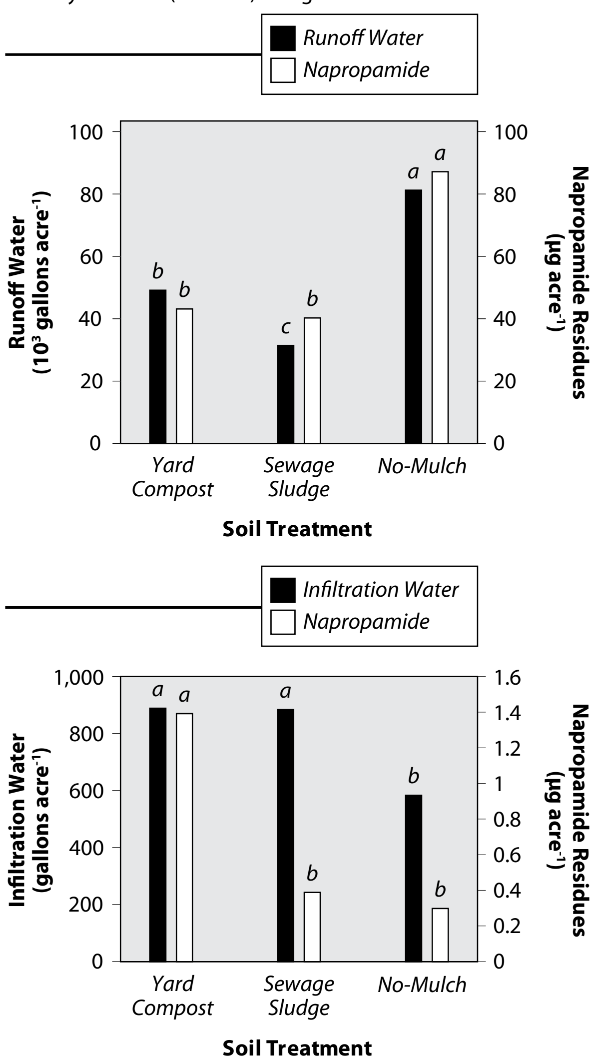
Eighteen plots (72 x 12 ft each) were separated using metal borders 8 in. above the ground level to prevent contamination between plots. Three soil management practices, replicated six times, were used: 1) municipal sewage sludge treated with lime and pasteurized for land farming (class-A biosolids obtained from Nicholasville Wastewater Treatment Plant, Nicholasville, KY) was mixed with native soil at 50 t/acre on dry weight basis; 2) yard waste compost made from yard and lawn trimmings, and vegetable remains (produced at Kentucky State University Research Farm, Franklin County, Ky.) was mixed with native soil at 50 t/acre on dry weight basis; and 3) no-mulch (NM) treatment (roto-tilled bare soil) was used for comparison purposes.

Devrinol 50-DF, also known as Napropamide [N, N-diethyl-2-(1-naphthyloxy) propionamide], was sprayed and incorporated into the soil surface as a preemergent herbicide at the rate of 4 lb of formulated product/acre. Broccoli (*Brassica oleracea* L. cv. Packman F1) seedlings of 45 d old were planted on April 15, 2003 (spring broccoli), and August 13, 2003 (fall broccoli), at 10 rows/plot along the contour of the land slope at 10 plants/row. During the growing season, runoff water from irrigation and/or rain 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 land 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 cabbage worm (*Pieris rapae* L.) larvae. Data were statistically analyzed using the ANOVA procedure.

Results and Discussion

The volume of runoff water collected from plots treated with sewage sludge was significantly less than 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 the notion 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.

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 letter are significantly different ($P < 0.05$) using Waller LSD test.



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 complexation 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 the growers with acceptable and marketable yield in order for them to use this agricultural practice. 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 DOM content of municipal waste before land application. This will protect water quailty from off-site movement of pesticides.

Acknowledgments

This investigation was supported by a grant from USDA/CSREES to Kentucky State University under agreement No. KYX-10-03-37P.

Table 1. Quality of spring and fall broccoli grown under three soil management practices at Kentucky State University Research Farm (Franklin County, Ky.).[1]

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	0.2 ab
No mulch	6.7 a	4.0 ab	1.5 ab	1.0 c	0.3 a

[1] 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, Sara Long, Kenny Seebold, and John Hartman,Department of Plant Pathology

Introduction

Diagnosis of plant diseases and providing recommendations for their control are important activities of the University of Kentucky College of Agriculture Cooperative Extension Service and Agricultural Experiment Station 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 to 15% are commercial fruit and vegetable plant specimens (1). Moreover, the annual number of such specimens diagnosed has more than doubled in recent years. However, because of their complexity and diversity, the time needed to diagnose them has more than just doubled.

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 and Southern Plant Diagnostic Network funds to help defray some of these additional laboratory operating costs. The growers are not charged for plant disease diagnoses at UK.

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 more than 1,100 digital consulting cases through October 2006, approximately 23% involved fruit and vegetable diseases and disorders.

Materials and Methods

Diagnosing fruit and vegetable diseases involves a great deal of investigation 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, nematode extraction, or soil pH and soluble salts tests. Diagnoses that require consultation with UK faculty plant pathologists, entomologists, and horticulturists and that need culturing, PCR, and ELISA assays 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 canker, bacterial leaf spot, bacterial speck, bacterial wilt, Phytophthora blights, Pierces disease, powdery mildews, and yellow vine decline. 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 2006 growing season in Kentucky provided mostly normal temperatures and below-normal rainfall until very late in the season. However, these observations varied by location. Average temperatures were warmer than normal statewide in January (+12°F) and April (+4°F). In Eastern Kentucky, temperatures were well above normal for the entire season, whereas in Central and Western Kentucky, temperatures remained pretty much near normal. The coldest temperatures occurred on February 19, dropping to 5°F following temperatures in the 60s and 70s in January. Temperatures dropped to 28°F on April 9, well after fruit crops had broken dormancy and may have caused some injury. Rainfall in Central and Western Kentucky was near normal during most months and was well below normal in Eastern Kentucky with some areas reporting a shortfall of 10 inches of rain until September. In September, record-setting high levels of rain occurred statewide. The percentage of days with rain in Central and Western Kentucky averaged 40 to 50% during April and May. Thus, there were ample opportunities for rain-based plant disease development.

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.
- Apple leaf blotch caused by *Alternaria alternate.*
- Peach fruit rot caused by a species of *Colletotrichum.*
- Persimmon “Kaki sudden death” is a new and unsolved problem.
- Cucurbit yellow vine disease caused by *Serratia marsescens.*
- Downy mildew of cucurbits, caused by *Pseudoperonospora cubensis*, 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.
- Soybean rust occurred for the first time in Kentucky 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. Wet spring weather promoted apple scab (*Venturia inaequalis*) and cedar rusts of apple (*Gymnosporangium juniperi-virginianae, G. clavipes,* and *G. globosum*). Apples also showed symptoms of twig canker and frogeye leaf spot (*Botryosphaeria obtusa*). Powdery mildew (*Podosphaera leucotricha*) appeared early and sooty blotch (*Peltaster fructicola, Geastrumia polystigmatis, Leptodontium elatius,* and other fungi) and flyspeck (*Zygophiala jamaicensis*) appeared later in the season along with bitter rot (*Colletotrichum acutatum* and *C. gloeosporioides*). 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 February cold period. Peach leaf curl (*Taphrina deformans*), brown rot (*Monilinia fructicola*), and scab (*Cladosporium carpophilum*) were common. Plum black knot (*Apiosporina morbosum*) symptoms were widespread, possibly due to favorable infection conditions the year before.

Persimmons. "Kaki sudden death," a disease of unknown etiology, was killing Oriental persimmons grafted to native persimmon rootstock.

Small Fruit Diseases

Grapes. Black rot (*Guignardia bidwellii*), and anthracnose (*Elsinoe ampelina*) were widespread, and downy mildew (*Plasmopara viticola*), Phomopsis cane and leaf spot (*Phomopsis viticola*), powdery mildew (*Uncinula necator*), and crown gall (*Agrobacterium vitis*) were also observed. No new cases of Pierces disease (*Xylella fastidiosa*) were found.

Brambles. Blackberry rosette or double blossom (*Cercosporella rubi*) was widespread this year. Cane blight and canker diseases (*Leptosphaeria coniothyrium, Botryosphaeria dothidea*) were also observed on blackberry. Raspberry and blackberry sterility were seen and are possibly related to virus infections.

Blueberries. Root rots caused by *Phytophthora* spp. and *Pythium* spp. were diagnosed.

Strawberries. Leaf spot (*Mycosphaerella fragariae*) was frequently observed. Bacterial angular leaf spot (*Xanthomonas fragariae*) and southern blight (*Sclerotium rolfsii*) were also diagnosed.

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 bacterial soft rot (*Erwinia* spp.) was observed.

Tomatoes. Early blight (*Alternaria solani*) and Septoria leaf spot (*Septoria lycopersici*) were very common and damaging to unsprayed tomato plantings. Commercial tomato plantings were affected by several bacterial diseases, especially bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*) but also bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), and bacterial speck (*Pseudomonas syringae* pv. *tomato*). Southern stem blight (*Sclerotium rolfsii*) and timber rot (*Sclerotinia sclerotiorum*) were found at several locations. Blossom end rot was the major fruit problem, but ripe rot (*Colletotrichum coccodes*) also occurred. Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*), root knot nematode (*Meloidogyne* sp.), and tomato spotted wilt virus appeared in several tomato fields.

Peppers. Bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria*) remains an important problem.

Cucurbits. Anthracnose (*Colletotrichum* spp.), gummy stem blight/black rot (*Didymella bryoniae*), and Alternaria leaf spot (*Alternaria cucumerina*) were found at serious levels in fields of several different cucurbit crops. Powdery mildew (*Erysiphe cichoracearum*) caused losses for all cucurbit crops, and Fusarium fruit rot of pumpkin (*Fusarium* sp.) also caused losses. Downy mildew (*Pseudoperonospora cubensis*) was observed. Bacterial wilt (*Erwinia tracheiphila*) was serious in 2006, but cucurbit yellow vine decline caused by *Serratia marsescens* was not. Numerous cases of viral diseases (virus complex) were reported on squash and pumpkins.

Other vegetables. Anthracnose (*Colletotrichum lindemuthianum*) was very widespread on beans this year, and angular leaf spot (*Phaeoisariopsis griseola*) also occurred. Bean root rots (*Rhizoctonia solani*), (*Pythium* spp.), and (*Fusarium solani* f.sp. *phaseoli*) were also problematic. Potato scab (*Streptomyces scabies*) was also reported.

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 new chemicals 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.

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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
HMS .... High Mowing Organic Seeds, 76 Quarry Rd., Wlacott, VT 05680
HN..................... HungNong Seed America Inc., 3065 Pacheco Pass Hwy., Gilroy, CA 95020
HO..................... Holmes Seed Co., 2125-46th St., N.W., Canton, OH 44709
HR...................... Harris Seeds, 60 Saginaw Dr., P.O. Box 22960, Rochester, NY 14692-2960
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 El Dorado Place, Suite D-440, Tucson, AZ 85715
MB..................... Malmborg's Inc., 5120 N. Lilac Dr., Brooklyn Center, MN 55429
MK .... Mikado Seed Growers Co. Ltd., 1208 Hoshikuki, Chiba City 280, Japan 0472 65-4847

ML .... J. Mollema & Sons Inc., Grand Rapids, MI 49507
MM .... MarketMore Inc., 4305 32nd St. W., Bradenton, FL 34205
MN .... Dr. Dave Davis, 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, P.O. Box 9200, Paris, TX 75460
PG .... The Pepper Gal, P.O. Box 23006, Ft. Lauderdale, FL 33307-3006
PL .... Pure Line Seeds Inc., Box 8866, Moscow, ID
PM .... Pan American Seed Company, P.O. Box 438, West Chicago, IL 60185
PR .... Pepper Research Inc., 980 SE 4 St., Belle Glade, FL 33430
PT .... Pinetree Garden Seeds, P.O. Box 300, New Gloucester, ME 04260
R .... Reed's Seeds, R.D. #2, Virgil Road, S. Cortland, NY 13045
RB/ROB .... Robson Seed Farms, P.O. Box 270, Hall, NY 14463
RC .... Rio Colorado Seeds Inc., 47801 Gila Ridge Rd., Yuma, AZ 85365
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/SG .... Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503
SK .... Sakata Seed America Inc., P.O. Box 880, Morgan Hill, CA 95038
SN .... Snow Seed Co., 21855 Rosehart Way, Salinas, CA 93980
SO .... Southwestern Seeds, 5023 Hammock Trail, Lake Park, GA 31636
SST .... Southern States, 6606 W. Broad St., Richmond, VA 23230
ST .... Stokes Seeds Inc., 737 Main St., Box 548, Buffalo, NY 14240
SU/SS .... Sunseeds, 18640 Sutter Blvd., P.O. Box 2078, Morgan Hill, CA 95038
SV .... Seed Savers Exchange, 3094 North Winn Rd., Decorah, IA 52101
SW .... Seedway Inc., 1225 Zeager Rd., Elizabethtown, PA 17022
SY .... Syngenta/Rogers, 600 North Armstrong Place (83704), P.O. Box 4188, Boise, ID 83711-4188
T/TR .... Territorial Seed Company, P.O. Box 158, Cottage Grove, OR 97424
TGS .... Tomato Growers Supply Co., P.O. Box 2237, Ft. Myers, FL 33902
TS .... Tokita Seed Company, Ltd., Nakagawa, Omiya-shi, Saitama-ken 300, Japan
TT .... Totally Tomatoes, P.O. Box 1626, Augusta, GA 30903
TW .... Twilley Seeds Co. Inc., P.O. Box 65, Trevose, PA 19047
UA .... 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