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UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

2001
Fruit and Vegetable Crops Research Report

Kentucky Agricultural Experiment Station • University of Kentucky • College of Agriculture
Department of Horticulture • Lexington, Kentucky 40546

2001 Fruit and Vegetable Crops Research Report

Edited by Brent Rowell and John C. Snyder

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Front cover photo:
All-America Selections Winner Pumpkin 'Orange Smoothie'.

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Dewayne Ingram, Chair, Department of Horticulture

The faculty, staff, and students in the University of Kentucky's vegetable and fruit program are pleased to offer the 2001 Fruit and Vegetable Crops Research Report. This report is one way we share information generated from a coordinated research program involving contributions from several departments in the UK College of Agriculture. The University of Kentucky is your primary land-grant university and, as such, our interdisciplinary teams of faculty, staff, and students focus their efforts on the complex needs and opportunities facing fruit and vegetable growers in the state. The research areas on which we concentrate reflect stated industry needs, expertise available at UK, and the nature of research programs in neighboring states and around the world that generate information applicable to Kentucky. If you have questions or suggestions about a particular research project, please do not hesitate to contact us.

We are excited about our new leadership at the University of Kentucky and within the College of Agriculture. President Lee Todd is providing exceptional leadership both on campus and throughout the state. In the College of Agriculture, we have a new dean, Dr. Scott Smith, who assumed that role in January 2001 after the retirement of Dr. Oran Little. Dr. Nancy Cox was hired to fill the Associate Dean for Research position that was vacated by Dr. Smith. Dr. Cox was previously at Mississippi State University. In addition, Dr. Larry Turner recently accepted the position of Associate Dean for Extension after the retirement of Dr. Walter Walla. Needless to say, we are excited about working with these new leaders in helping further develop horticultural industries and new horticultural opportunities in Kentucky.

Although the purpose of this publication is to report research results, we have also highlighted some of our Extension program and undergraduate and graduate degree programs that are addressing the needs of the fruit and vegetable industries.

Extension Highlights

Extension programs targeting Kentucky's fruit and vegetable industries include both highly visible activities and some more subtle ones. The statewide and area educational conferences and seminars and the on-farm demonstrations shown during twilight farm tours are probably the most visible. Print publications, Web documents, videos, slide sets, newsletters, magazine articles, newspaper articles, radio spots, and television programs are important, visible elements of our Extension program. Activities that you may not see, however, are things like the horticultural training programs for County Extension Agents, the work of the UK Plant Disease Diagnostic Laboratory, and soil testing and interpretive services.

Although many facets of the Extension program are conducted by the team of subject matter specialists and county agents, this year we would like to highlight our revised publications on vegetable and fruit production. The *Vegetable Production Guide for Commercial Growers* is updated and printed every two years. The 2002-2003 edition should be available in February or March of 2002. This new edition includes a number of significant changes including nutrient recommendations for organic production, new fertigation recommendations for several crops, variety updates, extensive revisions to disease and pest control sections, and a comprehensive list of the best vegetable production information on the Web. Although periodic updates can be made for specific crops on the Web version, the complete publication will not be printed again until 2004. As you plan your 2002 crops, make sure you are reading the latest information. Our Web site is <www.uky.edu/Ag/Horticulture>. From this site you can link to the vegetable information sites at <www.uky.edu/Agriculture/Horticulture/veglinks.htm>. The latest production information will also be available through presentations and workshops at the Kentucky Vegetable Growers Association and the Kentucky State Horticultural Society's 2002 annual meetings in Lexington.

The fruit crop team of faculty and staff at UK have been cooperating with the surrounding states in the development of commercial fruit spray guides. This saves funds and efficiently combines the expertise of specialists from several states into more comprehensive publications. Two updated spray guides will be printed and available at the 2002 Fruit and Vegetable Crops Winter Meeting: the *Commercial Tree Fruit Spray Guide, 2002* and the *Commercial Small Fruit and Grape Spray Guide*. These publications also provide background information on the common pests and cultural practices to be used as part of a total pest management strategy.

Undergraduate Program Highlights

The department offers areas of emphasis in Horticultural Enterprise Management and Horticultural Science within a Plant and Soil Science Bachelor of Science degree. Here are a few highlights of our undergraduate program in 2001:

The Plant and Soil Science degree program had nearly 100 students in the fall semester of 2001, of which almost one-half were horticulture students and another one-third were turfgrass students. Eleven horticulture students graduated in 2001.

We believe that a significant portion of an undergraduate education in horticulture must come from outside the classroom. In addition to the local activities of the UK Horticulture Club and field trips during course laboratories, students have excellent off-campus learning experiences. Here are the highlights of such opportunities in 2001:

- A three-week study tour of New Zealand was led by Drs. McNiel, Dunwell, Geneve, and Anderson involving 14 students.
- Horticulture students competed in the 2001 Associated Landscape Contractors of America (ALCA) Career Day competition at Colorado State University in March (Drs. Robert McNiel and Mark Williams, faculty advisors).

- Students accompanied faculty to the following regional/national/international meetings: American Society for Horticultural Science Annual Conference, Kentucky Landscape Industries Conference and Trade Show, and the Southern Nursery Association Trade Show.

Graduate Program Highlights

The demand is high for graduates with M.S. or Ph.D. degrees in horticulture, entomology, plant pathology, agricultural economics, and agricultural engineering. Our M.S. graduates are being employed in the industry, the Cooperative Extension Service, secondary and postsecondary education, and governmental agencies. Graduate students are active participants in the UK research program in fruit and vegetable crops and contribute significantly to our ability to address problems and opportunities important to the fruit and vegetable industries. For example, graduate and undergraduate students present their research results at the Kentucky Fruit and Vegetable Winter Meeting and at regional and national horticulture conferences.

State and Federal Funding for Horticulture Infrastructure in Kentucky

The Kentucky Horticulture Council was organized in 1991 as an umbrella organization representing the breadth of Kentucky horticulture, including the fruit and vegetable industries. It is comprised of the president and a representative from each of 13 industry associations related to horticulture in the commonwealth. The current officers of the Council are C.A. "Ottie" Pantle, Jr. (Chair), Charles Wilson (Vice-Chair), and Will Southerland (Legislative Committee Chair).

Over the past ten years, the Horticulture Council has been developing a strategic plan for the industry in cooperation with the UK Horticulture program and the Marketing Division of the Kentucky Department of Agriculture. They have presented this strategic plan, the *Prospectus for Horticultural Opportunities in Kentucky,* to the state legislature and several agricultural leadership groups. In January 2001, the Council submitted a proposal for funding research, extension, and marketing infrastructure development to the Agriculture Development Board. The Agriculture Development Board has the responsibility to utilize Phase I Tobacco Settlement Funds to support the continued development of Kentucky's agriculture. In its September 2001 meeting, the Agriculture Development Board approved a revision of that proposal and authorized the Board staff to work with the Kentucky Horticulture Council to use $2.4 million in order to partially fund the proposal for a two-year period. The arrangements for this should be completed by the time this research report is in print. Details of the funded proposal will be available from the UK Horticulture home page <www.uky.edu/Agriculture/Horticulture> and will be discussed at the 2002 Fruit and Vegetable Winter Meeting.

In addition, Senator Mitch McConnell helped obtain a special grant from the USDA budget to establish the New Crop Opportunities Center in the UK College of Agriculture. The UK Horticulture Department is serving a leadership role in this center and has allocated research funds to support four research projects in horticulture. The fruit and vegetable projects include blackberry production/marketing and pepper production and disease resistance. There is already a significant amount of new information on alternative crops available through the center's Web page <www.uky.edu/Ag/NewCrops>. A display and informational materials about the New Crop Opportunities Center will be available at the Fruit and Vegetable Winter Meeting.

Getting the Most Out of Research Reports

Brent Rowell, Department of Horticulture

The *2001 Fruit and Vegetable Crops Research Report* includes results of 24 field and greenhouse trials that were conducted at four locations in Kentucky (see map, below). The research was conducted by faculty and staff from several departments within the University of Kentucky College of Agriculture, including Horticulture, Entomology, Plant Pathology, and Agronomy. This report also includes a trial conducted by faculty and staff at Kentucky State University. Most of these reports are of crop variety (cultivar) trials.

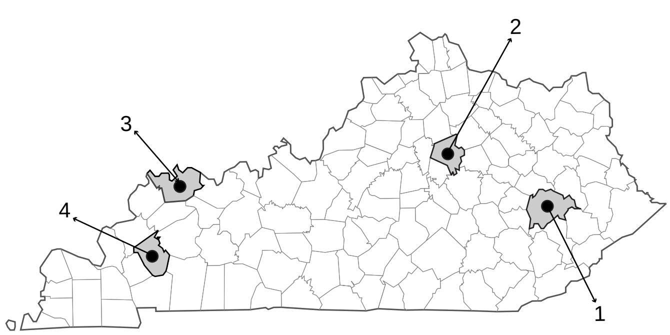
Growers usually put variety trials at the top of the list when rating projects at a public institution's research station. These trials provide a wealth of information not only to growers but also to Extension agents, researchers, and seed companies. The reports also provide us with much of the information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

The main purpose of variety evaluation is to provide growers with practical information to assist them in selecting the most suitable variety for a given location or market. Here are some guidelines for interpreting the results of fruit and vegetable variety trials:

Our Yields vs. Your Yields

Yields reported in variety trial results are extrapolated from small plots. Depending on the crop, our trial plot sizes range anywhere from 50 to 500 square feet. Yields per acre are calculated by multiplying these small plot yields by correction factors ranging from 100 to 1,000. These yields per acre may not be realistic, and small errors can be amplified when correction factors are used. For example, the calculations may overestimate yields because the plots harvested do not include empty spaces normally occupied by things such as drive rows in a grower's field. These empty spaces may result in a higher per acre yield from the research plots compared to a grower's yield.

In some cases research plots may be harvested more often than is economically feasible in a grower's field. So don't 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.



1. Robinson Station, Quicksand (Breathitt).
2. UK Horticulture Research Farm, Lexington (Fayette).
3. Henderson County Cooperative Extension Service, (Henderson).
4. UK Research and Education Center, Princeton (Caldwell).

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

Climatic conditions obviously differ considerably from one season to the next, and it follows that some varieties perform well one year and perform 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 while letting 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 9.

Making Sense of Statistics

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

In most reports we list the results in tables with varieties ranked from highest to lowest yielding (see Table 1 on page 25). Small differences in yield are often of little importance, and it is sometimes difficult to separate differences due to chance or error from actual differences in performance of varieties. The last line at the bottom of most data tables will usually contain a number that is labeled LSD, or Waller-Duncan LSD. LSD is a statistical measure that stands for “Least Significant Difference.”

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

Sometimes these calculations have already been made, and statistical comparisons among varieties are indicated by one or more letters (a, b, c, or A, B, C, etc.) listed after the yields in the tables (see Table 3 on page 36). If yields of two varieties are followed by one or more of the same letters, they are considered to be identical (statistically speaking, that is). Yields of two varieties are different if they have no letters in common. In this example, the average muskmelon fruit weight of ‘Eclipse’ and that of ‘Vienna’ are both followed by an “a,” so they are not different, while values for ‘Eclipse’ and ‘Athena’ have no letters in common, indicating that the difference between them is real (that is, statistically significant).

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

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

It is also true that our customary standard for declaring a statistically significant difference is quite high, or stringent. Most of the trial reports use a standard of 95 percent probability (expressed in the tables together with the LSD as $P < 0.05$ or $P = 0.05$). This means that there is a 95 percent 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, page 25) has been identified, growers should select varieties within this group that have the best fruit quality (often the primary consideration), best disease resistance, or other desirable trait for the particular farm environment and market outlet. One or more of these varieties can then be grown on a trial basis on your farm using your cultural practices.

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

RACE Trials

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

Since there are so many new marketing opportunities these days for such a wide variety of specialty crops, we have decided that this single-plot approach for varieties unlikely to perform well in Kentucky is better than providing no information at all. We hope that RACE trials, described on page 9, will help fill a need and best use limited resources at the research farms. The hot and specialty pepper trial on pages 26-30 and the specialty melon trial on pages 37-39 are examples of such trials.

Hybrid vs. Open Pollinated

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

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

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

Where to Get Seeds

A seed source is listed for each variety reported in the trials. Seed source abbreviations with company names and addresses are found in Appendix A at the end of this publication. Because seeds are alive, their performance and germination rate depend on how old they are, where and how they were collected, 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 than in our trials, especially under different management systems. Producers should test varieties for themselves by trying two to three varieties on a small scale before making a large planting of a single variety. This method will be the best means of determining how well suited a particular variety is for your farm and market.

Variety Information Online

This publication is available online at <http://www.ca.uky.edu/agc/pubs/pr/pr452/pr452.pdf>. Other useful sources of information for commercial vegetable growers can be found by following the links at <http://www.uky.edu/Agriculture/Horticulture/veglinks.htm>. In addition, results of some pepper and blackberry trials will are posted on UK's New Crops Opportunities Center Web site under current research at <http://www.uky.edu/Ag/NewCrops>.

Auburn University publishes a variety trial report twice a year in cooperation with several other universities. The 2000 reports have been posted in PDF (Acrobat) format at <http://www.ag.auburn.edu/aaes/information/publications/fruitsnutsvegs.html>. Auburn has also provided a good comprehensive database of thousands of vegetable varieties that can be found at <http://www.aces.edu/department/com_veg/esimonne/vegetabl.htm>.

Rapid Action Cultivar Evaluation (RACE) trials are:

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

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

- RACE trials are planted on the best and most uniform plot ground and are well maintained, sprayed, irrigated, etc. They do not serve as guard rows in other replicated trials.
- Crops are harvested at the appropriate time, with accurate record keeping, yield data, and quality information. Results are reported/published, as are replicated trial results.
- Whenever possible, products are evaluated with assistance from and standards of 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 ones from further testing and make recommendations about a group of cultivars that can be put into further trials by growers themselves.

On-Farm Commercial Vegetable Demonstrations

Dave Spalding and Brent Rowell, Department of Horticulture

Introduction

Eight on-farm commercial vegetable demonstrations were conducted in Central Kentucky in 2001. Grower/cooperators were from Boyle, Casey, Clark, Garrard, Marion, Montgomery, Nelson, and Powell counties. The grower/cooperator in Clark County grew 1 acre of bell peppers, the cooperator in Montgomery County grew 2 acres of bell peppers, and the cooperator in Nelson County grew 2 acres of bell peppers and 2.5 acres of staked tomatoes. In Boyle County, the cooperator grew 0.5 acres of staked tomatoes, while the cooperator in Casey County grew 1 acre of staked tomatoes. The grower/cooperator in Marion County grew 1 acre of muskmelons. In Garrard County, the grower/cooperator grew 0.5 acres of mixed vegetables (tomatoes, peppers, squash, green beans, melons, and cucumbers), and the cooperator in Powell County grew 1 acre of mixed vegetables (sweet corn, green beans, cucumbers, okra, and summer squash) for local farmers' markets.

Materials and Methods

As in previous years, grower/cooperators were provided with black plastic mulch and drip irrigation lines for up to 1 acre and the use of the Horticulture Department's equipment for raised bed preparation and transplanting. Due to reductions in the program's operating budget, only selected cooperators could be provided with transplants, while the others provided their own transplants. 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.

The staked tomato demonstration plots were transplanted with the varieties 'Mountain Spring' and 'Mountain Fresh'. Tomatoes were transplanted into 6-inch-high raised beds covered with black plastic with drip lines under the plastic. Plants were transplanted 18 inches apart in single rows; raised beds were spaced 6 feet apart from center to center.

Tomatoes were pruned, staked, and tied using the Florida weave system. 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 bell pepper demonstration plots were transplanted using three different bacterial spot-resistant varieties: 'Lexington', 'Enterprise', and 'Aristotle'. Peppers were transplanted into 6-inch-high raised beds covered with black plastic and drip lines under the plastic in the center of the beds. Plants were transplanted 12 inches apart in an offset manner in double rows that were 15 inches apart. Raised beds were 6 feet from center to center.

Results and Discussion

The summer of 2001 was similar to the previous year after a relatively cool and wet start. Most plots were transplanted in a timely manner, but cool and damp conditions early in the growing season delayed maturity by about seven to 10 days.

The grower/cooperators who grew staked tomatoes sold most of their production locally at a better price than most tomato producers in the state even though their yields were not exceptionally high. Bacterial and fungal diseases seemed to be the biggest problem for the tomato growers in the program. In spite of these problems, tomato growers' returns were very high, ranging from $4,140 to $7,130 on a per-acre basis (Table 1).

Wholesale bell pepper prices were moderate early in the harvest season; however, heavy and persistent rains at peak harvest resulted in a lot of peppers being harvested wet, which contributed to stem rot and bacterial soft rot in most growers' harvests. As a result, most major wholesale buyers shunned Kentucky fresh market peppers for the rest of the summer. The Clark County cooperator did not control weeds and was not able to irrigate the crop properly, which resulted in extremely low yields. The Montgomery County cooperator was not able to market peppers through the Central Kentucky co-op after his second picking, and this is reflected in the low yield and returns (Table 2). On the other hand, the Nelson County cooperator sold mainly to a local wholesale distributor and was not affected as much as other growers by the rejections of Kentucky peppers; he netted about $3,250 per acre.

Table 1. Staked tomato costs and returns, 2001.

Inputs	Boyle Co. (0.5 acre)	Casey Co. (1 acre)	Nelson Co. (2 acres)
Plants	168.00	875.00	450.00
Fertilizer	82.00	27.20	112.00
Black plastic	73.00	126.00	260.00
Drip lines	90.00	140.00	290.00
Fertilizer injector	55.00*	55.00*	55.00*
Stakes	120.00*	160.00*	480.00*
Twine	20.00	30.00	55.00
Herbicide	60.00	7.38	52.00
Insecticide	54.20	74.48	164.00
Fungicide	178.10	135.35	285.00
Water	260.00** (290,000 gal.)	340.00** (560,000 gal.)	610.00** (1,100,000 gal.)
Labor	1,065.00*** (460 hrs.)	1,020.00*** (270 hrs.)	5,150.00 (860 hrs.)
Machine	68.88 (14 hrs)	73.80 (15 hrs.)	177.12 (36 hrs.)
Total expenses	2,294.18	3,064.21	8,140.12
Yield	23,600 lb	28,600 lb	68,000 lb
Income	5,859.00	8,238.80	16,420.00
Net income (Loss)	3,564.82	5,174.59	8,279.88
Net Income/acre	**7,129.64**	**5,174.59**	**4,139.94**
Dollar return/ Dollar input	2.5	2.7	2.0

* Costs amortized over 3 years.
** Includes the cost of fuel and 5-year amortization of irrigation system.
*** Does not include the cost of unpaid family labor.

Table 2. Bell pepper costs and returns, 2001.

Inputs	Clark Co. (1 acre)	Montgomery Co. (2 acres)	Nelson Co. (2 acres)
Plants	780.00	1,520.00	1,480.00
Fertilizer	334.74	112.00	134.00
Black plastic	125.00	250.00	250.00
Drip lines	140.00	280.00	280.00
Fertilizer injector	55.00*	55.00**	55.00*
Herbicide	46.60	28.00	34.00
Insecticide	80.00	84.00	104.00
Fungicide	100.00	140.00	112.00
Water	210.00** (140,000 gal.)	800.00 (320,000 gal.)	560.00** (410,000 gal.)
Labor	543.00*** (147.0 hrs.)	1,400.00 (234 hrs.)	4,740.00*** (790 hrs.)
Machine	39.36 (8 hrs.)	137.76 (28 hrs.)	369.00 (75 hrs.)
Total expenses	2,453.70	4,806.76	8,118.00
Yield	4,980 lb	27,090 lb	66,250 lb
Income	533.46	3,589.76	14,625.00
Net income (Loss)	(1,920.24)	(1,217.00)	6,501.00
Net Income/acre	**(1,920.24)**	**(608.50)**	**3,253.50**
Dollar return/ Dollar input	0.2	0.7	1.8

* Costs amortized over 3 years.
** Includes the cost of fuel and 5-year amortization of irrigation system.
*** Does not include the cost of unpaid family labor.

Table 3. Muskmelon and mixed vegetable costs and returns, 2001

Inputs	Marion Co. (1 acre)	Garrard Co. (0.5 acre)	Powell Co. (0.33 acre)
Plants/Seeds	326.00	110.00	15.00
Fertilizer	48.00	12.50	14.00
Black plastic	126.00	73.00	42.00
Drip lines	140.00	90.00	46.00
Fertilizer injector	55.00*	28.00	35.00*
Herbicide	28.00	-0-	-0-
Insecticide	42.00	24.00	11.00
Fungicide	34.00	-0-	-0-
Water	208.00** (210,000 gal.)	266.00 (112,000 gal.)	54.00** (60,000 gal.)
Labor	430.00*** (100 hrs.)	-0-*** (145 hrs.)	882.00 (126 hrs)
Machine costs	103.32 (21 hrs.)	39.36 (8 hrs)	24.60 (5 hrs)
Total expenses	1,540.32	642.86	1,124.10
Yield	3,860 melons	12,600 lb	126 bu.
Income	864.00	2,320.00	3,339.00
Net income (Loss)	(676.32)	1,677.14	2,214.90
Net income/acre	**(676.32)**	**3,354.28**	**6,644.70**
Dollar return/ Dollar input	0.6	3.6	3.0

* Costs amortized over 3 years.
** Includes the cost of fuel and 5-year amortization of irrigation system.
*** Does not include the cost of unpaid family labor.

The cooperators who grew for local farmers' markets achieved very high returns (Tables 1 and 2); however, their costs do not always include unpaid family labor. The Powell County cooperator's data reflect only his costs and returns for one-third of an acre of green beans, which was the only crop in his mix for which we were able to obtain complete data. He achieved an excellent net return of $2,215 from that one-third acre plot ($6,645/acre, Table 3).

Overall, weeds again seemed to be the biggest problem for most growers. Bacterial spot and speck were also problems that reduced marketable yields for most growers again this year. The later maturing of most crops due to the cool, wet conditions early in the growing season also hurt crop prices and grower returns.

Most of the grower/cooperators were growing vegetables commercially for the first time, and those with positive returns indicated they will likely continue to grow vegetables.

On-Farm Commercial Muskmelon (Cantaloupe) Demonstrations

Nathan Howell, Department of Horticulture

Introduction

Four on-farm commercial cantaloupe demonstrations were conducted in Central Kentucky in 2001. Grower/cooperators were located in Barren, Grayson, Hart, and Logan counties; all participants were members of the Green River Produce Marketing Cooperative located in Horse Cave, Kentucky. Each grower/cooperator came from a tobacco production background, and this was the first year for each to produce cantaloupes in an effort to diversify farm operations. All cooperators grew the Athena cantaloupe variety and marketed commercial melons through the Green River Produce Marketing Cooperative. Each demonstration plot consisted of approximately 1 acre.

Materials and Methods

Grower/cooperators were provided with 7,200 linear feet of black plastic mulch and drip irrigation lines (enough for 1 acre of harvested melons). Equipment for raised bed preparation and transplanting was provided by Green River Produce Marketing Cooperative for a nominal fee. Field preparation was followed by fertilizer application according to soil test results and recommendations provided by the University of Kentucky. Plastic mulch was laid in mid-April, nearly one month before transplanting. Weather conditions were very cold and windy at the time; however, there was little wind damage. The plastic was laid in rows that were no longer than 400 feet with 5 feet between centers; this allowed each producer to use the 7,200 linear feet of plastic on about an acre and a half plot of ground. The drip irrigation systems used in the demonstrations used city water, well water, or groundwater.

All cooperators provided their own transplants. Either the cooperator or local greenhouse managers in the region grew the transplants. Plants were transplanted during the first week of May, with three- to four-week-old plants spaced 24 inches apart in the rows. These spacings allowed each cooperator to attain a plant

Table 1. Muskmelon costs and returns for 1 acre demonstration plots, 2001.

Inputs	Barren Co.	Grayson Co.	Hart Co.	Logan Co.
Plants	378.00	350.00	378.00	180.00
Fertilizer/Lime	174.00	389.34	427.57	122.92
Black Plastic	135.00	135.00	135.00	135.00
Drip Line	132.00	132.00	132.00	132.00
Herbicides	39.00	26.50	39.00	--------
Insecticides	94.00	149.53	80.04	80.00
Fungicides	95.00	117.33	------	40.00
Pollination	------	50.00	------	------
Machine*	360.00*	397.00*	256.48*	170.00*
Irrigation/Water	60.00	175.00	217.00	60.00
Labor**	466.00**	175.00**	393.00**	450.00**
Co-op 15% Commission	282.07	66.10	56.81	292.56
Box/Pallet Fee	675.00	121.50	162.00	784.56
Co-op Membership	50.00	50.00	50.00	50.00
Bin Rental	60.00	40.00	40.00	60.00
Total Expenses	3000.07	2374.30	2366.90	2557.04
Yield	6715 melons	1530 melons	1315 melons	6773 melons
Income	4720.65	1044.40	955.21	4870.00
Net Income (Loss)	**1720.58**	**(1329.90)**	**(1411.69)**	**2312.96**
Dollar Return/ Dollar Input	*1.57*	*.44*	*.40*	*1.90*

* Includes machine rental, fuel and lube, repairs and depreciation.

** Includes hired labor and unpaid family labor

population of nearly 3,600 plants with projected yields of two marketable melons per plant. Almost every cooperator reported a 100 percent stand after the first week.

After plants were established, insecticides were applied to prevent cucumber beetle and other insect damage. Pounce, Asana, or Endosulfan were used on a weekly rotation for cucumber beetle control. Close to the period of fruit setting, Bravo Weather Stik was applied weekly for disease control. The University of Kentucky's recommendations (Publication ID-36) were used for both insecticides and fungicides. Plants were also irrigated bi-weekly or according to tensiometer readings. Forty pounds per acre of calcium nitrate was fertigated each week.

Harvests began in early July and ran until the end of the month for most cooperators. Harvests were every other day for the first week of harvest, every day during the second and third weeks, and every other day again during the final week. Melons were harvested at three-quarters to full slip.

Results and Discussion

The 2001 growing season was abnormal during the early stages of plant growth. Early settings in May went through 88 to 91 degree temperatures; after two weeks in the field, temperatures dropped to 65 to 70 degrees for a week during bloom set. Such conditions early in the growing season may have reduced fruit set.

Marketing issues also plagued cooperators in 2001. Brokers had requested that melons be harvested at three-quarters to full slip; however, half way through the harvest, these same buyers changed their harvest maturity criteria. The second request was for melons at an earlier maturity stage based more on color (more greenish) than slip. These melons were referred to as "breakers." These changes, together with a cooler failure and a line breakdown at the co-op, resulted in the loss of many cantaloupes that would have otherwise been marketable. Nevertheless, half of the cooperators were able to meet projected yields and were able to obtain a net return of 56 cents per melon ($1,700 to $2,300 net returns per acre, Table 1). These results are based on only those melons marketed through the cooperative. Many cooperators sold melons outside the co-op that did not meet commercial quality or maturity requirements. Actual returns may have been higher than the net returns shown in Table 1.

Overall, weeds and irrigation seemed to be the biggest concerns for most growers. Bacterial wilt and cucumber beetles were also problems that reduced marketable yields for most growers this season. An over-mature product that could not be shipped also hurt yields and returns. Of the four cooperators who grew cantaloupes commercially for Green River Produce Marketing Cooperative, two plan to increase their production in 2002, while the other two plan to look at other endeavors.

Rootstock and Interstem Effects on Pome and Stone Fruit Trees

Gerald R. Brown and Dwight Wolfe, Department of Horticulture

Introduction

Although apples are the principal tree fruit grown in Kentucky, the hot, humid summers and heavy clay soils in Kentucky make apple production here a more difficult task for growers in this state than for growers in the major apple-producing regions where soil and climate are more favorable. Also, peach production can be expected to be erratic because of extreme temperature fluctuations that occur in the winter and spring in Kentucky.

In spite of these challenges, productive orchards are one of the highest per acre income enterprises suitable for rolling, upland soil. Furthermore, in these upland sites, orchards have a low potential for soil erosion. Kentucky still imports more apples than it produces, and the strong market for peaches continues to encourage growers to plant peach trees.

Continued identification of improved rootstocks and cultivars is required for growth of the Kentucky fruit industry. For this reason, Kentucky continues to be a cooperator along with 39 other states and three Canadian provinces in the Cooperative Regional NC-140 Project: Rootstocks and Interstem Effects on Pome and Stone Fruit.

The NC-140 plantings are of utmost importance to Kentucky for gaining access to and testing new rootstocks from around the world. The detailed and objective evaluation of these rootstocks will provide growers with the information needed to select the most appropriate rootstocks for their needs when they become commercially available in the future.

The 1994 and 1999 apple rootstock plantings will provide us with needed information on adaptability of the slender spindle and the vertical axe systems to trees grown on our fertile soils. Also, the non-trellised, semi-dwarf group of rootstocks in the 1999 Apple Rootstock planting will provide us with information on the ability of these rootstocks to support themselves on their own root systems. The 1994 Peach Planting should provide us with needed information to determine if tree survival, winterhardiness, and cropping frequency can be improved by using any of the recently developed rootstocks.

The NC-140 orchard plantings are regularly used as demonstration plots for visiting fruit growers, Extension personnel, and research scientists. The research data collected in these trials will help to establish base-line production and economic records for the various orchard system/rootstock combinations that can be later utilized by orchardists in Kentucky.

Materials and Methods

Scions of known cultivars on various rootstocks were produced by commercial 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 at Princeton:

I. 1994 apple rootstock planting consisting of 'Red Gala' on six rootstocks and 10 replications per rootstock. Trees are spaced 13 feet apart within rows 18 feet apart.

II. 1999 dwarf and semi-dwarf apple rootstock planting consisting of two groups of apple rootstocks:
   - i) dwarfing group with 11 rootstocks and planted on a 10-foot x 16-foot spacing.
   - ii) a semi-dwarfing group with six rootstocks and planted on a 13-foot x 20-foot spacing.

III. 1994 peach rootstock planting consisting of 'Redhaven' peach on 12 different rootstocks and eight replications per rootstock. Trees are spaced 16 feet apart within rows 20 feet apart.

Trees of each rootstock were allocated to blocks (rows) in a randomized block design [i.e., each rootstock appears once and at random within each block (row)]. Soil management was a 6.5-foot herbicide strip with mowed sod alleyways. Trees were fertilized and sprayed according to local recommendations (1,2). Yield, trunk circumference, and maturity indices such as soluble solids were measured for each planting.

Results and Discussion

The winter of 2001 was mild, followed by several spring freezes and below normal rainfall from March through April in Central and Eastern Kentucky and below normal rainfall from March through June for Western Kentucky. Rainfall was moderate to above normal throughout the remainder of the growing season. Most fruit crops were harvested roughly 10 days earlier than normal. A late September hailstorm severely damaged the fruit in the 1999 NC-140 dwarf and semi-dwarf apple planting at Princeton, Kentucky.

I. 1994 Apple Semi-Dwarf Rootstock Planting

The 1994 semi-dwarf apple rootstock planting is the first trial at this station to be trained to the French vertical axe system. It also includes a number of new rootstocks, along with some that have performed well in previous plantings at UK Research and Education Center at Princeton.

This planting was established as planned, except for the substitution of B.9 for P.1. Trickle irrigation was installed, and a trellis system was constructed in 1995. The mortality of trees on M.26 (10 percent survival) differed significantly from trees on the other three rootstocks. Cumulative yield, yield in the year 2001, fruit size, trunk circumference, and number of root suckers varied significantly by rootstocks (Table 1). No significant differences were observed for either flesh firmness or percent soluble solids. Trees on CG.30 and V.2 have been the most productive ones in this planting.

II. 1999 Dwarf and Semi-Dwarf Apple Rootstock Plantings

This planting consists of two groups of apple rootstocks, a dwarfing group with 11 rootstocks, and a semi-dwarfing one with six rootstocks. Eight of the dwarfing rootstocks and three of the

Table 1. 2001 results of the NC-140 1994 apple semi-dwarf rootstock planting.[1]

Rootstock[2]	Cumulative yield per live tree (lb)	2001 yield (lb/tree)	Fruit size (oz/fruit)	Mean pressure (lb)	Percent soluble solids	Trunk circum-ference (in.)	Number of root suckers
CG.30	600	214	6.1	18.7	13.8	11.2	10
V.2	507	165	6.1	19.1	13.7	10.8	1
M.26 EMLA	386	99	5.4	19.7	15.0	9.1	0
B.9	240	71	5.4	18.9	14.1	6.6	2
Mean	439	146	5.9	19.0	14.0	9.5	4
LSD (0.05)	143	57	0.7	3.3	1.5	1.6	8

[1] University of Kentucky Research and Education Center, Princeton, Ky.
[2] Arranged by cumulative yield in descending order.

Table 2. 2001 results of the NC-140 1999 apple dwarf and semi-dwarf rootstock planting.[1]

Rootstock	Yield (lb/tree)	Number of fruits	Average fruit weight (oz/fruit)	Number of flower clusters	Number of root suckers	Trunk circum-ference (in.)	Percent soluble solids
Dwarfing[2]							
Supporter 3	27.2	88	4.9	176	1.2	4.6	12.2
G.16N	26.6	79	5.5	156	1.5	5.9	12.1
CG.4013	25.7	71	5.6	77	8.3	6.8	13.1
G.16T	24.0	70	5.9	124	2.6	5.9	13.4
Supporter 1	24.0	82	4.8	157	2.8	4.7	12.2
Supporter 2	20.5	58	5.9	119	0.3	5.1	12.7
CG.3041	18.3	52	5.7	60	0.5	4.9	12.8
M.9 NAKBT 337	8.9	21	7.1	28	2.2	4.7	13.7
CG.5179	6.7	18	6.3	29	4.5	5.2	13.1
M.26 EMLA	4.5	11	7.2	24	1.0	5.1	14.1
CG.5202	4.2	12	6.6	17	5.0	6.1	12.9
Mean	16.7	50	6.0	89	2.7	5.3	12.9
LSD (0.05)	10.9	32	1.3	50	4.1	0.7	1.3
Semi-Dwarfing[2]							
CG.30N	17.2	44	6.4	83	5.0	6.6	13.1
M.26 EMLA	10.6	29	5.8	43	0.5	5.0	13.6
Supporter 4	9.2	26	6.3	54	3.5	4.9	12.3
M.7 EMLA	7.9	25	5.2	49	18.3	6.1	13.2
CG.7707	2.3	6	7.7	21	3.7	6.6	13.2
CG.4814	1.2	4	5.3	11	7.2	5.8	13.6
Mean	7.1	20	6.1	39	6.5	5.7	13.1
LSD (0.05)	6.5	20	1.8	29	16.3	1.3	2.0

[1] University of Kentucky Research and Education Center, Princeton, Ky.
[2] Within group, arranged by yield in descending order.

Table 3. 2001 results of the 1994 NC-140 peach rootstock planting.[1]

Rootstock[2]	Cumulative yield per live tree (lb)	2001 yield (lb/fruit)	Truck circum-ference (in.)	Average fruit wt. (oz/fruit)	Flesh firmness (lb)	Soluble solids (%)
GF 305	507	148	18.4	8.8	3.1	9.7
Lovell	507	115	18.7	7.6	2.6	10.2
BY 520-9	503	146	18.3	9.2	1.3	10.0
Rubira	460	108	17.9	8.8	2.0	10.5
Montclar	459	99	18.5	9.4	2.9	10.6
Stark's Redleaf	443	95	18.7	9.0	2.2	10.0
Ta Tao 5	437	119	15.9	7.4	6.8	10.8
BY 520-8	437	75	18.0	6.4	1.3	10.5
Tenn Natural	428	112	16.0	7.9	3.3	10.9
Bailey	408	95	15.4	8.4	3.3	11.2
Ishtara	397	104	14.3	7.7	4.2	9.6
Higama	375	82	16.4	8.4	2.6	9.8
Mean	448	108	17.3	8.4	3.1	10.3
LSD (0.05)	90	42	1.6	7.7	2.0	1.1

[1] University of Kentucky Research and Education Center, Princeton, Ky.
[2] Arranged by cumulative yield (kg/tree) in descending order.

semi-dwarfing ones had not been previously tested at the Princeton station.

Ninety trees of a possible 108 are in our planting because 12 were not available for our site (one CG.16N, two CG.4013, three CG.3041, one CG.4814, and four CG.30N). Further, three trees never leafed out after planting (one CG.16T, one CG.16N, and one CG.3041). However, all the other trees are alive.

For both groups, significant differences among rootstocks were observed for trunk circumference, yield, number of fruit harvested, average fruit weight, and the number of flower clusters per tree (Table 2). The number of root suckers and the percent soluble solids varied significantly only among the dwarf rootstocks. Flesh firmness did not vary significantly by rootstocks for either the dwarf or semi-dwarf group. Twenty-two of the 31 trees planted have been supported by tree stakes due to their lean exceeding 30 degrees from vertical.

III. 1994 Peach Rootstock Planting

Peaches are one of the most popular fruits in Kentucky. The strong market for this crop continues to entice growers to plant trees in spite of the fact that one can expect erratic production due to the extreme temperature fluctuations that occur in the winter and spring in this state.

A rootstock that is more suitable to Kentucky's climate than ones traditionally used would be of great value to the fruit industry in the state. A rootstock that could significantly delay bloom would change the future of the Kentucky peach industry. To date, 75 of the 94 trees planted are alive (80 percent survival).

Statistical differences were observed for trunk circumference, yield in 2001, fruit size, flesh firmness, and percent soluble solids (Table 3) but not for cumulative yield, date of bloom, and number of root suckers. The Julian date for 90 percent bloom was 98 (April 8, 2001). The Julian date for 10 percent fruit maturity was 184 (July 3, 2001).

Literature Cited

1. G.R. Brown, R.T. Jones, J.G. Strang, L.A. Lester, J.R. Hartman, D.E. Hershman, R.T. Bessin. *1998 Commercial Tree Fruit Spray Guide.* University of Kentucky College of Agriculture Cooperative Extension Service, Publication ID-98.
2. *Midwest Tree Fruit Handbook.* University of Kentucky College of Agriculture Cooperative Extension Service, Publication ID-93.

Optimal Training of Apple Trees for High Density Plantings

Gerald R. Brown and Dwight Wolfe, Department of Horticulture

Introduction

Kentucky apple growers often have a problem with excessive vegetative growth or vigor, which greatly reduces the production that can be achieved from high density apple plantings. Early production and optimal fruit size on vigorous sites are obtained when photosynthates are balanced properly between flower bud initiation and vegetative growth. Pruning and training are possibly the most important operations performed by growers to maintain the proper balance between flower bud initiation and vegetative growth. Identification of effective pruning and training techniques for vigorous sites is required for continued expansion of apple production in Kentucky. The University of Kentucky College of Agriculture and the Kentucky State Horticultural Society have made long-term commitments to help meet this need. For this reason, ongoing research has been conducted to determine the training and pruning practices needed to obtain early production and optimal fruit size from trees trained to either the slender spindle or the French axe system.

Materials and Methods

One hundred-eighty trees of Golden Delicious on M.9 rootstocks were set out in May 1997 in a randomized complete block design with eight treatment combinations (five rows, 32 trees/row). Trunk circumference averaged 2.4 inches at planting and did not vary significantly among rootstocks. A trellis was constructed, and trickle irrigation was installed. Trees were spaced 8 feet apart within rows 16.4 feet apart. Soil management was a 6.5-foot herbicide strip with mowed sod alleyways. Trees were fertilized and sprayed according to local recommendations (1,2). Yield (beginning with 1998 yield), trunk circumference, and maturity indices such as soluble solids and flesh pressure were measured.

The trees were trained according to prescribed treatment protocols (Table 1). Trees began to fill their allotted space in 1999, and leader management was modified to maintain leaders at specified heights (Table 1). Limbs of one tree that overlapped or touched those of adjacent trees were headed back into two-year-old wood.

Results and Discussion

No differences among the four pruning levels were observed for cumulative yield (1998-2001), yield in 2001, fruit size (average fruit weight), trunk circumference, number of root suckers, flesh firmness, and soluble solids (Table 2). No significant differences were observed between the French axe and slender spindle training systems for any of these variables.

The light crop in 2000, which yielded less than 10 percent of that in 2001, resulted in an increase in vegetative growth that consequently increased the amount of detailed pruning required in 2001—9.6 minutes—compared to the time of 3 minutes required in 2000 (Table 2).

Table 1. Pruning/training treatments of the UK-KSHS apple training study at Princeton, Ky.

System	Pruning Level	Pruning Interval in wks	Amount of one-year-old wood left after heading at planting	Angle[1]	Limbs[2]	Leader management 1999[3]	Leader management 2000[4]
French Axe	Light	1	Not headed	45	No	D	12
French Axe	Moderate	2	12-16 in.	45-60	Yes	C&D	11
French Axe	Moderate	1	12-16 in.	45-60	Yes	D	11
French Axe	Heavy	1	8-12 in.	60-90	Yes	D	10
Slender Spindle	Light	1	Not headed	45	No	A	9
Slender Spindle	Moderate	2	14-20 in.	45-60	Yes	B	9 Y
Slender Spindle	Moderate	1	14-20 in.	45-60	Yes	B	9 Y
Slender Spindle	Heavy	1	10-14 in.	60-80	Yes	C	9 Z

1 Angle limbs are to be positioned.

2 French Axe—completely remove overly vigorous branches with narrow angles when 3 to 6 inches long. Slender Spindle—completely remove branches that compete with leader. In 2000, for both training systems, limbs overlapping or touching those of adjacent trees were headed back into two-year-old wood.

3 A = weak leader renewal and new leader headed at 12 inches. B = bend leader at 60° angle, alternating direction with every 18 in. of new growth. C = leader bagged 1 month prior to bud break and bag removed at appropriate time. D = leader bent to horizontal, alternating direction after buds break on top side.

4 Leaders were maintained at specified heights (in feet) by cutting to an alternate leader when necessary. Y = Alternate leader was bent to horizontal for 6 weeks. Z = Alternate leader was "snaked" throughout growing season. Leader management was the same in 2001 as in 2000.

This planting has been regularly used as a demonstration for visiting apple growers, Extension personnel, and research scientists. The research data collected in these trials has helped to establish baseline economics and production methods for the various orchard system/rootstock combinations that can be utilized by orchardists in Kentucky.

Literature Cited

1. G.R. Brown, R.T. Jones, J.G. Strang, L.A. Lester, J.R. Hartman, D.E. Hershman, R.T. Bessin. *1998 Commercial Tree Fruit Spray Guide.* University of Kentucky College of Agriculture Cooperative Extension Service, Publication ID-98.
2. *Midwest Tree Fruit Handbook.* University of Kentucky College of Agriculture Cooperative Extension Service, Publication ID-93.

Table 2. Time requirements and effects of summer apple pruning/training treatments on apple yields in the UK-KSHS apple training study at Princeton, Ky., 2001.

Pruning level[1] - interval in wks	Trunk circumference (inches)	Yield[2] per tree (lb) Cumulative	Yield[2] per tree (lb) 2001	Average fruit wt. (oz)	Minutes per tree[3] 1997	1998	1999	2000	2001	Total minutes per tree	Minutes per lb of fruit
Light - 1	7.7	125	93	7.1	12.2	10.2	18.2	4.4	9.6	54.6	0.44
Moderate - 2	7.7	131	83	6.9	9.6	8.6	16.5	3.4	9.6	47.7	0.36
Moderate - 1	7.7	128	86	7.0	11.4	11.1	19.1	2.1	9.6	53.3	0.42
Heavy - 1	7.7	124	80	6.7	11.9	12.0	21.6	2.5	9.5	57.5	0.46
Mean	7.7	127	86	6.9	11.3	10.3	18.9	3.0	9.6	53.1	0.42
LSD (0.05)	0.6	24	21	0.4							

1 The protocol was changed in year 2000 from 1) pruning every week and 2) pruning every other week to pruning once early in the season on all treatments.

2 Yield is the sum of picked and dropped fruit. Dropped fruit averaged 9.1 lb/tree.

3 Total pruning and training periods were 14 weeks (1997); 12 weeks (1998); 18 weeks (1999), 4 weeks (2000), and 4 weeks (2001).

Evaluation of Eastern European Wine Grape Varieties for Kentucky

Gerald R. Brown, Dwight Wolfe, John Strang, and April Satanek, Department of Horticulture

Introduction

There is increasing interest in producing grapes for wine in Kentucky. Grapes have a high income per acre potential on upland sites. One of the critical needs for the Kentucky grape producer is the identification of varieties that are well adapted to Kentucky and are capable of producing a sufficient quantity of high quality grapes.

Traditionally, 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 (*Vitus labrusca* X *V. vinifera*). Generally, the Muscadine and European grapes are not adapted to Kentucky's environment. American grapes grow well, but fruit quality for wine is usually substandard. Many American French hybrids grow well, and fruit quality for wine is intermediate between the American and French parents. The majority of the wine from Europe and the West Coast of the United States is made from European grapes.

European grapes are not well adapted to northern Europe, and vines are buried to prevent winter injury, a very labor-intensive operation. Northern Europeans have crossed *V. vinifera* with different *Vitis sp.*, including some species from China. The resulting advanced selections have shown improved hardiness as well as outstanding fruit quality when grown in Eastern Europe. The late Dr. Bob Goodman of the University of Missouri evaluated these selections in Eastern Europe and selected candidates based on winterhardiness, disease resistance, and fruit quality. After importation, these grapes were grown in Missouri under post-entry quarantine, and in 1998 the first cultivars were distributed to selected land-grant institutions in the United States, Kentucky being one of them.

The objective of the program is to evaluate these selections in different regions of the United States. It should be noted that to participate in this program, 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 at Princeton. The vines were planted 8 feet apart in rows 12 feet apart. The planting stock was small potted cuttings. These were trained to two leaders and tied to 5-foot 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-foot-wide herbicide strip was maintained beneath the vines with mowed sod alleyways.

Beginning in 2000 and continuing in 2001, yield, cluster size (as weight in grams per cluster), berry size (as weight in grams per berry), pH, and Brix (as percent soluble solids) were recorded for each selection. The harvested grapes were distributed to cooperating wine makers, and the wine quality produced from some of these selections was evaluated.

Results and Discussion

Yield, fruit quality components, and the cooperators receiving fruit from particular grape varieties of grapes harvested in 2000 are listed in Table 1. Wine made from these grapes (listed in Table 1) was evaluated on June 23, 2001, and October 20,

Table 1. Yield and fruit quality results for the year 2000 from the 1998 eastern European wine grape variety trial at UK Education and Research Center, Princeton, Ky.

Cultivar	Harvest date	Number of vines	Yield T/A[1]	Cluster wt. (g)	Berry wt. (g)	Soluble solids %	pH	Wine makers[2]
Bianca (N[3])	8-14	15	3.0	367	1.8	21.0	3.6	Dave, Eddie, & Thomas Walker
Bianca (S)	8-14	15	2.1	233	1.7	21.6	3.6	Dave, Eddie, & Thomas Walker
I 31/67	8-14	12	2.0	500	1.3	18.0	3.6	Eddie O'Daniel
Iskorka	8-14	14	3.9	400	1.5	21.0	-	Dave Miller
Kozma 55 (N)	8-21	12	0.8	333	1.5	19.0	3.3	Chris Nelson
Kozma 55 (S)	8-21	13	0.4	233	1.8	19.6	3.6	Chris Nelson
Kozma 525	8-21	14	1.5	467	1.4	-	3.6	Chris Nelson
Laurot	8-21	15	1.8	367	1.0	18.2	3.3	Eric Durbin
Liza	8-21	14	1.2	333	1.1	19.0	3.1	Butch Meyer
M 39-9/74	8-21	14	2.4	600	2.3	19.2	3.5	Eric Durbin
Malverina	8-17	11	2.9	567	1.9	18.0	3.4	Dave and Butch
Petra	8-17	13	1.1	300	1.3	21.4	3.7	Gari Thompson
Rani Riesling	8-17	14	0.5	500	1.2	18.0	3.4	Butch Meyer
Rubin Tairovski	8-11	14	2.6	433	1.6	19.0	-	Eddie O'Daniel
Toldi	8-17	14	2.4	500	3.2	19.0	3.5	Butch Meyer
XIV-1-86	8-17	13	4.7	533	2.0	16.4	3.3	Dave, Butch, & Gari Thompson
XIV-11-57	8-19	10	2.4	210	1.0	18.8	3.6	Eddie O'Daniel
XX-15-51	8-11	15	1.5	300	1.1	21.0	-	Gari Thompson
34-4-49	8-21	15	1.2	467	1.2	19.0	3.2	Butch Meyer

[1] Tons per acre. Vines in this planting are on an 8 x 12-foot spacing, or 454 vines per acre.

[2] The authors wish to thank the participating wine makers for their contributions to this study.

[3] An "N" or "S" indicates from north or south part of row, respectively.

2001, by members of the Kentucky Vineyard Society. Results from these evaluations are shown in Table 2. Yield, fruit quality components, and the cooperators receiving fruit from particular grape varieties of grapes harvested in 2001 are listed in Table 3. A notable difference between years was that fruit sugar content and pH were slightly lower in 2001 than in 2000. One variety, 'Burmunk' has yet to be harvested. Less than 50 percent of the vines initially planted have survived; no fruit was produced in 2000; and in 2001 green June beetles destroyed the small amount of fruit. All data should be considered preliminary as it will take several years to fully evaluate these selections for wine quality and vine adaptation to Kentucky.

Table 2. Wine tasting results 2000 season grapes—June 23 and October 20, 2001.

Cultivar	Color	Wine maker	Average[1]	Range[2]	Comments
Bianca	white	T. Walker			Wine was very harsh and not evaluated.
Bianca	white	D. Miller	9.7	5–16	Weak aftertaste, light appearance, reddish on skins.
I31/67	red	E. O'Daniel	8.6	1–14	Good but would not buy, light appearance, young, chocolate aroma.
Iskorka	white	D. Miller	11.1	7–14	Good dessert wine, low tannin, smooth, reddish on skins.
Kozma 55	red	C. Nelson	8.8	3–17	Thick appearance, no flavor, good tannins, slight haze, perfumey.
Kozma 525	red	C. Nelson	11.2	8–17	Purple appearance, flat taste.
Laurot	red	E. Durbin	12.8	11–14	Needs aging, high tannin, would be very good with food, high acid, tastes very much like a good, rich Chancellor, light wine, fruit maybe shows some promise, lots of tannins, great deep color, this aroma tastes exactly that of Chancellor, barnyard aroma.
Liza	white	B. Meyer	15.0	14–17	Long aftertaste.
M39-9/74	red	E. Durbin	11.5	6–15	Tastes like Chambourcin, somewhat astringent, tough one, aroma part perfume.
Malverina	white	B. Meyer	12.7	9–17	Some alcohol noticeable, spice, slight chemical taste.
Malverina	white	D. Miller	11.2	6–17	High alcohol.
Petra	white	G. Thompson	12.8	9–16	Chemical taste, slight off color, weak bouquet.
Rani Riesling	white	B. Meyer			Wine did not turn out.
Rubin Tairovski	red	E. O'Daniel	11.2	8–14	New, no balance, dull, light red color, smoky, tobacco aroma.
Toldi	white	B. Meyer	10.8	5–14	Very earthy, young, light aroma.
XIV-1-86	white	B. Meyer	15.2	12–17	Sweet, spicy, cleansing sweet.
XIV-1-86	white	G. Thompson	9.4	6–14	Slight chemical taste, clean, clear, colorless, stuck fermentation.
XIV-1-86	white	D. Miller	14.2	9–19	Good legs, pear, slight off color.
XIV-11-57	red	E. O'Daniel	10.4	7–15	Long aftertaste, berry-like aroma.
XX-15-51	white	G. Thompson	13.0	9–15	High alcohol, good balance, good legs, very slight straw color, short, pucker aroma.
34-4-49	white	B. Meyer	11.6	9–14	This wine would really do well aged in oak, the flavor profile would match up very well with oak, light fruit, long, lingering aftertaste, off nose, stuck fermentation.
Cayuga White (std)[3]	white	B. Wilson	8.8	6–11	The best white from this trial, good acid, crisp, very pleasant, good for the long haul.
Chambourcin (std)	red	B. Wilson	14.3	8–19	Chambourcin, bit light, good structure and tannins, still light on fruit but true taste, clean aftertaste, good balance, well made, nice pencil shaving tones, good color, varietal nose.
Vidal Blanc (std)	white	C. Nelson	14.8	11–17	Well made, great balance, this wine is a "ringer" for a nice Vidal Blanc.

1 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 9-10 tasters-Jim Bravard, Danny Buechele, Dave Miller, Bud Mirus, Mickey Mirus, Butch Meyer, Dr. Chris Nelson, Eddie O' Daniel, Jay Pruce, Gina Pruce, Gari Thompson, George Wessel.

2 Range 1st number = lowest score received, 2nd number = highest score received.

3 (std) Cayuga White, Chambourcin and Vidal Blanc were included in the trial as high quality French American standards for comparison.

Table 3. Yield and fruit quality results for the year 2001 from the 1998 eastern European wine grape variety trial at the UK Research and Education Center, Princeton, Ky.

Cultivar	Wine makers[1]	Harvest date	Number of vines	T/A[2]	Cluster wt. (g)	Berry wt. (g)	Brix	pH
Bianca	Krasimir Georgiev	8-3	15	4.4	160	1.6	16.6	3.0
Bianca (½)	Chris Voytek	8-6	15	4.6	181	1.7	18.6	3.4
I 31/67	Chris Nelson	8-13	12	2.0	238	1.4	18.2	3.5
Iskorka	Mike Dudley	7-27	14	3.6	175	1.8	16.2	3.2
Kozma 55	Butch Meyer	8-22	26	2.5	188	0.8	19.2	3.4
Kozma 525	Eric Durbin	8-20	14	5.2	414	1.5	18.4	3.5
Laurot	Gari Thompson	8-22	14	3.5	203	1.0	17.8	3.2
Liza	Eric Durbin	8-14	14	3.7	134	0.9	20.8	3.2
M 39-9/74	Chris Nelson	9-12	14	3.1	289	2.4	17.9	3.3
Malverina	Gari Thompson	8-6	11	7.6	260	2.0	17.8	3.3
Petra	Eddie O'Daniel	8-3	11	1.9	157	1.1	15.0	3.2
Rani Riesling	Butch Meyer	8-7	14	3.0	250	1.4	19.0	3.2
Rubin Tairovski[3]	Eddie O'Daniel	8-3	14	6.5	422	1.2	17.6	3.2
Toldi	Chris Voytek	8-13	14	8.3	352	3.2	17.6	3.3
XIV-1-86	Butch Meyer	8-7	14	4.1	284	1.7	15.7	3.3
XIV-11-57	Eddie O'Daniel	8-3	10	6.4	224	1.0	13.1	3.1
XX-15-51	Mike Dudley	7-27	15	4.2	202	1.6	18.2	3.2
34-4-49	Gari Thompson	8-7	14	3.1	381	1.4	16.7	3.2

1 The authors wish to thank the participating wine makers for their cooperation in this study.
2 Tons per acre. Vines in this planting are on an 8 x 12-foot spacing, or 454 vines per acre.
3 20 pounds went to Krasimir and Vicky Georgiev.

Pierce's Disease, a New Disease of Grapes in Kentucky

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Introduction

Pierce's disease is a threat to grapes in California and in southern states from Florida to Texas. Disease symptoms vary with species and cultivar but are typified by marginal browning of leaves and death of vines. This disease is favored by the hot weather found in the southeastern United States.

Symptoms. Symptoms vary with the different species and cultivars. Symptoms in spring and early summer include delayed shoot growth, leaf mottling, and dwarfing of new shoots. Late summer and fall symptoms are more dramatic and include burning, scorching, or drying of leaves, wilting or premature coloring of fruit, and uneven cane maturity. Scorching begins near the margin of the leaf blade where tissues become completely desiccated and die. As summer progresses into fall, scorching progressively spreads inward in concentric zones until the entire leaf blade is affected. Leaf blades often fall from the vine at the point of attachment to the petiole, leaving the petiole still attached to the shoot.

The disease progresses along the grapevine with symptoms developing in adjacent leaves along the shoot both above and below the point of initial infection. Flower clusters on infected vines usually dry up. Late in the season, wood on affected canes fails to mature normally, leaving green "islands" of tissue that persist into the dormant season and can be seen on canes throughout the winter. Tips of shoots often die the first year the vine is infected. Initially, only one or a few canes on a vine show foliar and wood symptoms. Symptoms are more pronounced in vines that are stressed by high temperatures and drought conditions.

Grape susceptibility and disease spread. Some grape cultivars are very susceptible, usually dying within two years. Most French (*vinifera*) varieties die within two to five years, while American (*labrusca*) varieties often live longer than five years. French-American hybrids are intermediate in susceptibility. Pierce's disease is spread by several types of sharpshooter leafhoppers, by spittlebugs, and by grafting.

For many years, trees, especially oaks, in Kentucky landscapes have suffered from bacterial leaf scorch disease, also caused by *Xylella fastidiosa* (but a different strain from the one that causes Pierce's disease). Leaf scorching symptoms associated with this disease annually appear in late summer. Symptoms are quite striking on pin and red oaks with individual leaves turning one-third to two-thirds brown on the leaf ends and margins. The causal agent of bacterial leaf scorch is also vectored by leafhoppers or other xylem-feeding insects. As far as is known, the grape pathogen is similar, but not identical, to the tree leaf scorch pathogen. Thus, the disease would not be spread from trees to grapes.

Materials and Methods

Grape leaves showing symptoms of bacterial leaf scorch were collected from a vineyard in Hancock County and delivered to the UK Plant Disease Diagnostic Laboratory. Petioles from affected leaves were crushed using a mortar and pestle so that the extract could be tested for presence of the pathogen using a special laboratory test, an enzyme-linked immunosorbent assay

(ELISA) developed for *X. fastidiosa* ("Pathoscreen-Xf," Agdia, Inc., Elkhart, IN). Color reactions for the ELISA test were evaluated visually and by using an ELISA plate reader. To overcome doubts due the possibility that the ELISA test might give a false positive reaction, specimens were sent to a laboratory in California that specializes in testing for Pierce's disease using a rapid-cycling real-time polymerase chain reaction (PCR) assay for presence of bacterial DNA (California Seed & Plant Lab., Inc., Elverta, CA).

Results and Discussion

In our laboratory, some of the samples reacted strongly positive in ELISA tests for *X. fastidiosa,* the Pierce's disease pathogen. The PCR assay done by the laboratory in California corroborated our ELISA test so the specimens again were positive. Thus, Pierce's disease of grapes caused by *X. fastidiosa* was discovered for the first time in Western Kentucky (1). This disease can be devastating to grape production, and much more Kentucky research is needed.

In other regions, *X. fastidiosa* is distributed in a wide range of monocot and dicot native plants that may be infected but not show symptoms. We do not know if the bacterium has become established in the wild and, if so, on which plants. We have preliminary evidence that *X. fastidiosa* can live in some grasses, weeds, and woody plants here in Kentucky. These plants do not show scorch symptoms but could be reservoirs of the bacteria. We do not know if these plants harbor the Pierce's disease strain, however. Pierce's disease could be carried from infected vegetation to grapes or from diseased grapes to healthy grapes by insect vectors; however, we know little about which vectors are involved in Kentucky. Where the disease is isolated, removal of infected vines should keep further spread to a minimum.

With an emerging grape industry developing in Kentucky, it is important that growers and County Extension Agents be on the lookout for this disease. Personnel in the UK Plant Disease Diagnostic Laboratory can run specialized tests to determine the presence of the Pierce's disease bacterium.

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Eastern Kentucky Blueberry Cultivar Trial

R. Terry Jones, William Turner, Amanda Ferguson, and John C. Snyder, Department of Horticulture; David C. Ditsch, Department of Agronomy

Although blueberries are a native fruit crop, only limited commercial acreage has been established in Kentucky. Blueberries have an excellent potential for local sales and U-pick operations. Recent research into the health benefits of small fruits including blueberries may help further increase sales. *Vaccinium* is increasing in popularity in the world of pharmaceuticals. As consumers become more conscious of the foods they eat, they may find themselves eating more blueberries. Scientists attribute the blueberry's healing powers to the flavonoid anthocyanin that is responsible for the blue color found only in the berry's peel. Anthocyanins and other flavonoids could help fight the development of cancer, cardiovascular disease, as well as eye problems such as glaucoma and poor night vision.

The high initial startup costs for blueberries, approximately $4,000 per acre, is mainly due to land preparation, plant, and labor costs. However, after the plants reach maturity in approximately five years, the profits should steadily increase to as high as $6,000 per acre. Farmers must make the decision to grow blueberries based on their own land and facilities.

The longevity of a properly managed blueberry crop 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 of berries. Harvest usually begins in early June and lasts into July.

Materials and Methods

Two blueberry plantings were established in the fall (October) of 1996 at the University of Kentucky Robinson Station at Quicksand and the Laurel Fork Demonstration Site (Table 1). The Laurel Fork site is part of the UK Robinson Forest in the southeastern corner of Breathitt County. It is at a higher elevation (1,200 feet) than Quicksand (733 feet), and apple tree phenology at this site is seven to 10 days later than similar cultivars at Quicksand. Growth, yield, and survival of various blueberry cultivars were compared between a normal silt loam site at Quicksand and a disturbed mine site (Laurel Fork). The plantings consisted of eight to 12 rows of various cultivars[1] in a randomized complete block design. Plants were spaced 4 feet apart in raised beds 14 feet apart. Drip irrigation with point source emitters (2 gph/plant) was installed shortly after planting. Plants were fertilized beginning in the spring of 1997. In 2001, one application of 5 pounds of 5-20-20 per 100 feet followed by two sidedressings of 2 pounds of ammonium sulfate per 100 feet of row (at bloom and again two weeks later) were applied. Netting was used at both sites to prevent loss due to birds.

[1]Some cultivars were furnished by Hartman's Plant Company, P.O. Box 100, Lacota, MI 49063 or were purchased from Fall Creek Farm & Nursery Inc., 39318 Jasper-Lowell Rd., Lowell, OR 97452. James R. Ballington at North Carolina State University and John Clark at University of Arkansas supplied other cultivars used in the trial.

Results

Twenty-one cultivars at Quicksand and 18 cultivars at Laurel Fork were tested, and results are shown in Tables 2 and 3, respectively. Late spring freezes (April 17-19, 26) during bud swell and bloom hurt the blueberry yields in 2001. It is believed that early maturing cultivars like Duke may have suffered greater losses. The Laurel Fork reclamation site is about 500 feet higher in elevation than Quicksand and has much better air drainage. Moreover, based on time of apple tree bloom, Laurel Fork plant development is about seven to 10 days behind that seen at Quicksand. As a result, the plants had thicker foliage, grew better, and were higher yielding in 2001 on the disturbed soil site at Laurel Fork (Table 2). This is in contrast to past years where Quicksand was the more productive site.

Briggitta was the highest yielding cultivar at Quicksand followed by Bluegold and Bluejay (Table 2). Briggitta's yield was significantly higher than 18 of the 21 cultivars tested at Quicksand and 11 of those tested at Laurel Fork. Briggitta is an attractive large-fruited cultivar that matures relatively late in Kentucky's growing season with only 51 percent of the fruit picked during the first four harvests. Ozark Blue is another attractive late-maturing berry. Even though the Ozark Blue plants were a year younger than the cultivars that were planted first, they produced the sixth highest yield. Several of the North Carolina numbered cultivars also appear to be late maturing. One North Carolina entry (NC-2675) also gave a relatively high yield at both locations and had large, very attractive berries. Late-maturing blueberries in Kentucky will require protective sprays to prevent damage by Japanese beetles.

Table 1. 1996 Laurel Fork and Quicksand soil test results.

Location	pH	Buf-pH	P	K	Ca	Mg	Zn
Laurel Fork mine site[1]	5.9	7.2	46	206	1057	541	10.7
Quicksand	5.7	6.5	14	173	1497	126	5.1

1 Mine soil pH adjusted with granular sulfur at 2.5 lb/100 sq ft in late summer 1996, 2 months prior to planting. Both sites received 2.5 cubic ft of Canadian peat/50 sq ft of bed area prior to raised bed formation. Additional peat (0.13 cubic ft) was placed in each hole at planting. Granular elemental sulfur (0.75 lb./100 sq ft) was applied to the beds at Quicksand.

Briggitta was the highest yielding blueberry variety at Laurel Fork (Table 3) followed by Patriot, Reka, Bluecrop, Toro, Bluegold, and Nelson. The largest berry sizes were those of NC-2675 and Toro followed by Briggitta and Sierra. Based on appearance, the most attractive blueberries at Quicksand were Briggitta, Ozark Blue, NC-2675, and Toro. At Laurel Fork, Briggitta, Bluecrop, Toro, Bluegold, Nelson, Sierra, and NC-2675 were judged to be the most attractive. At both locations berries of the cultivar Reka failed to color up properly (reddish-white instead of blue) and would have been difficult to sell.

These data represent only the second harvest response from the various cultivars after three and a half to four and a half years of growth. Additional harvests and observations will be needed to determine which cultivars are the best performing over

Table 2. Yield and quality of blueberry cultivars at Quicksand, Ky., 2001.

Cultivar[1]	Fruit yield lb/bush[2]	Berry size oz/berry[2]	Visual size rating[3]	Taste[4]	Appearance[5]	% total fruit first two harvests[6]	% total fruit first four harvests[6]
Briggitta	7.1 A	0.05 ABC	VL	ST	A+	2	51
Bluegold	5.6 AB	0.04 ABCD	LM	T	A	27	61
Bluejay	5.0 ABC	0.03 BCD	M	SB	A	37	87
Blueray	4.0 BCD	0.06 A	VL	ST	A	26	82
Reka	3.9 BCD	0.03 CD	SM	T	A-	42	81
Ozarkblue*	3.7 BCD	0.06 AB	VL	ST	A+	0.8	33
NC-2675*	3.7 BCD	0.06 A	VL	ST	A+	25	76
NC-2852*	3.5 BCD	0.03 D	SM	S	A	10	46
Ornablue	3.3 BCD	0.02 D	S	BT	A	38	73
NC-1852*	3.2 BCD	0.05 ABC	M	ST	A	37	85
O'Neal	3.2 BCD	0.04 ABCD	M	SB	A	53	97
Bluecrop	3.1 BCD	0.04 ABCD	ML	ST	A	21	69
NC-1832*	3.0 BCD	0.04 BCD	M	SB	A	0	4
NC-1827*	3.0 BCD	0.03 CD	M	T	A	0	5
Sierra	2.9 BCD	0.04 ABCD	L	SB	A	33	94
Toro	2.9 BCD	0.05 ABC	L	SB	A+	36	93
Patriot	2.8 BDC	0.04 ABCD	LM	ST	A	45	91
Nelson	2.7 DC	0.05 ABCD	M	ST	A	8	52
Duke	2.7 DC	0.05 ABCD	LM	ST	A	84	100
Spartan	1.7 D	0.05 ABC	VL	S	A	46	87
Jersey	1.7 D	0.03 CD	M	SB	A	6	72
LSD[2]	1.98	0.02					

* Cultivars followed by an * are one year younger than the other cultivars in the trial.
1 In descending order of yield.
2 Numbers followed by the same letter within columns are not significantly different (P = 0.05).
3 Visual size ratings: S = small, M = medium, L = large, VL = very large.
4 Informal taste ratings: S = sweet, T = tart, B = bland.
5 Appearance ratings: A- = below average, A = average, A+ = above average.
6 Harvest dates: 6/08, 6/15, 6/20, 6/29, 7/09, 7/16 (38 day harvest season).

Table 3. Yield and quality of blueberry cultivars at Laurel Fork mine site, 2001.

Cultivar[1]	Fruit yield lb/bush[2]	Berry size oz/fruit[2]	Visual size rating[3]	Taste[4]	Appearance[5]	% total fruit first two harvests[6]	% total fruit first four harvests[6]
Briggitta	8.4 A	0.05 BC	VL	ST	A+	7	56
Patriot	7.1 AB	0.04 CDEFG	LM	ST	A	48	82
Reka	6.6 ABC	0.04 DEFG	M	ST	A-	43	62
Bluecrop	6.5 ABCD	0.05 CDE	L	SB	A+	28	61
Toro	6.3 ABCD	0.06 AB	VL	S	A+	24	75
Bluegold	6.2 ABCD	0.04 CDEFG	LM	T	A+	25	63
Nelson	6.0 ABCD	0.05 CDEF	L	ST	A+	24	67
Ornablue	5.2 BCD	0.02 H	S	SB	A	40	78
Sierra	5.0 BCD	0.05 BCD	VL	ST	A+	36	84
Blueray	4.2 CDE	0.04 FG	M	S	A	42	83
Bluejay	4.0 DE	0.03 G	M	S	A	60	93
Duke	4.0 DE	0.05 CDEF	L	S	A	84	99
NC-2675*	2.0 EF	0.07 A	VL	S	A+	80	95
O'Neal*	1.9 EF	0.04 CDEFG	M	SB	A	79	98
NC-1852*	0.9 F	0.05 CDE	M	S	A	95	100
NC-1832*	0.7 F	0.01 H	S	ST	A	0	39
NC-2852*	0.6 F	0.04 EFG	SM	ST	A	58	92
NC-1827	0.4 F	0.01 H	SM	ST	A	0	71
LSD[2]	2.3	0.01					

* Cultivars followed by an * are one year younger than the other cultivars in the trial.
1 In descending order of yield.
2 Numbers followed by the same letter within columns are not significantly different (P = 0.05).
3 Visual size ratings: S = small, M = medium, L = large, VL = very large.
4 Informal taste ratings: S = sweet, T = tart, B = bland.
5 Appearance ratings: A- = below average, A = average, A+ = above average.
6 Harvest dates: 6/08, 6/15, 6/20, 6/29, 7/09, 7/16 (38 day harvest season).

time in Kentucky. For additional information and trial results see also:

Jones, R. Terry, William Turner, and John C. Snyder. 2000. Eastern Kentucky Blueberry Trial. *2000 Fruit and Vegetable Crops Research Report*. PR-436:18-19.

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Western Kentucky Blueberry Cultivar Trial

Dwight Wolfe and Gerald R. Brown, Department of Horticulture

Introduction

The blueberry is a fruit crop native to North America. At present, Kentucky blueberries have a small established commercial market and an excellent potential for local sales, U-pick, and home use. Blueberries have recently been touted for their health benefits because of their high levels of antioxidants. Also, highbush blueberries have been a good supplemental crop for some Kentucky growers. For these reasons, the goal of this study was to evaluate highbush blueberry varieties for adaptability to Kentucky.

Materials and Methods

This blueberry cultivar trial was established in the spring of 1993 at the UK College of Agriculture Research and Education Center at Princeton. The planting consisted of eight cultivars spaced 4 feet apart within rows spaced 14 feet apart. Prior to planting, the pH was reduced from above 6 to 5.4 with elemental sulfur. The planting has been mulched yearly with sawdust and is trickle irrigated using 1 gph vortex emitters. Plants were netted during the last week of May, and fruit was harvested from the first week of June through the first week of July.

Results and Discussion

Cumulative yield from 1995 through 2001, the 2001 yields, and average percentage of fruit ripe by the end of the first and third weeks of June are shown in Table 1. Yields in 2001 averaged about one-third lower than those reported in 2000 (3). This was probably the result of several freezes occurring throughout the month of March 2001. Duke and Sierra have produced the most fruit (cumulative yield) to date, although Nelson produced the most fruit in 2001.

Table 1. Yields of blueberry cultivars in Western Kentucky.[1]

	Yield (lb/bush)		Average percent ripe fruit at end of week in June 2000	
Cultivar[2]	**Cumulative**	**2001**	**1st**	**3rd**
Sierra	50.7	8.7	0	85
Duke	50.1	6.3	44	100
Nelson	47.8	10.5	0	48
Toro	47.5	8.7	0	72
Bluecrop	45.0	9.1	0	79
Blue Gold	41.8	6.2	0	93
Sunrise	29.2	3.5	48	100
Patriot	26.6	4.1	0	100
LSD (0.05)	5.6	1.8	--	--

[1] The planting was established in April 1993. Plant spacing is 4 feet between bushes in rows 14 feet apart. There are three bushes/cultivar/rep combination.

[2] In descending order of cumulative yield (1995-2001).

Duke and Sunrise have been the earliest ripening cultivars in this planting, with 44 percent and 48 percent respectively of their fruit ripening during the first week of June this year. Nelson was the latest ripening cultivar again this year, with only half of its fruit being picked by the third week of July 2001.

These results should be useful to growers in choosing blueberry cultivars. The potential labor conflicts of blueberry harvest with the production and/or harvest of other crops may have to be evaluated, especially with regard to the highest yielding cultivar. Additional factors important for cultivar selection are discussed in other publications (1,2).

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Bell and Specialty Pepper Evaluations for Bacterial Spot Resistance, Yield, and Quality

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Introduction

After completing a three-year (1995-97) evaluation of bell pepper cultivars under induced bacterial spot (*Xanthomonas campestris* pv. *vesicatoria* or *Xcv*) and bacterial spot-free environments, we began a new series of trials in 2000 to compare new cultivars with previously recommended cultivars that were either highly resistant ('Boynton Bell') and/or that had very attractive fruits ('X3R Wizard'). While spot-resistant pepper cultivars with the *Bs2* gene (resistance to *Xcv* races 1, 2, and 3) gained widespread acceptance in the state, a number of new resistant cultivars has been released since 1997. In addition to bells, we also wanted to screen a large number of hot and specialty peppers, some of which also carry the *Bs2* gene. Out-of-state buyers have expressed a strong interest in sourcing hot and specialty peppers from Kentucky. Bell varieties were tested again in replicated trials at two locations in 2001, while hot and specialty peppers were observed for a second year in non-replicated 'RACE' trials at the same locations.

Materials and Methods

Near-duplicate trials were planted at the Horticultural Crops Research Station in Lexington (LEX) and at an isolated location in Eastern Kentucky at the Robinson Experiment Station in Quicksand (QSND). Sixteen bell and 46 hot and specialty pepper cultivars were seeded in the greenhouse at LEX on 26 March. Seedlings were grown in 72-cell plastic trays and transplanted to the field on 16 May (LEX). Fourteen of the same bell cultivars and all of the same hot/specialty cultivars were transplanted at QSND on 29-30 May. Each LEX trial received 62 lb N/acre prior to planting supplemented by an additional 38 lb N/acre divided into three weekly fertigations from 27 June to 12 July (100 lb N/acre season total). Trials at QSND received preplant applications of 50 lb N/acre supplemented by 60 lb N/acre divided into four fertigations applied from 13 June to 20 July (110 lb N/acre season total). Phosphorus and potassium were applied prior to planting at both locations according to soil test recommendations.

Plots at both locations consisted of 16 plants in double rows with four replications in a randomized complete block design for bells and in single plots for hot and specialty peppers. All were planted on raised beds with black plastic mulch and drip irrigation. Plants of all cultivars were spaced 12 inches apart in the row with 15 inches between the two rows on each bed. Beds were 6 feet apart from center to center. A tank mix of maneb+fixed copper was applied weekly for bacterial spot (BLS) protection at Lexington.

No preventive fungicide treatments were applied at QSND in order to encourage the development of a natural BLS epidemic. No insecticides were required in the field at LEX or QSND. A pheromone trap for adult male European corn borers was placed adjacent to the trial field at LEX.

Thirteen new bell cultivars with the *Bs2* gene were compared with resistant controls 'Boynton Bell' and 'X3R Wizard' and with a susceptible control, 'King Arthur' (*Bs1* only, Table 1). The 13 new cultivars included seven from the 2000 trial and six that were tested for the first time in 2001. Mature green fruits were harvested four times in LEX and twice at QSND.

Marketable fruits were graded and weighed according to size class (U.S. No. 1 extra large, large, medium). We also weighed misshapen fruits that could be marketed to foodservice as "choppers" (LEX only). Yields in each size class were multiplied by their respective wholesale market prices to determine gross returns ("income") for each cultivar. The income variable has been a good indicator of a cultivar's overall performance, taking into account yields of the different size classes and their price differentials. Prices from 2000 were also used for the 2001 trials.

Hot and specialty peppers included a group of 13 jalapeño cultivars of which two had the *Bs2* resistance gene ('X3R Ixtapa' and 'El Rey'= SAX 7603) and others claiming multiple virus resistance (Table 3). These were compared with 'Mitla'. Other pepper types included were three serrano cultivars, six anaheim cultivars, seven poblano/ancho cultivars (entry SVR 35-4845-7 has the *Bs2* gene), four Italian/cubanelle cultivars, four hot banana/wax cultivars (X3R Hot Spot and SVR 35-4846-7 with *Bs2* gene), six sweet banana/wax cultivars ('Pageant', 'Sweet Spot', and PX 35-4360-7 with *Bs2* gene), two fresno cultivars, and two pepperoncini cultivars (Tables 4 and 5).

Fruit appearance ratings. All bell pepper fruits harvested from all replications at the second harvest (July 19) at LEX were laid out in the field for careful examination and quality ratings. All fruits from single plots of hot and specialty pepper cultivars were evaluated in the same way at LEX on July 30. Bell pepper fruits from two replications were evaluated at QSND (August 9, first harvest). Overall appearance ratings took several things into account, including, in order of importance, overall attractiveness, shape, smoothness, degree of "flattening" (bell cultivars only), color, and uniformity of shape.

Plant support requirements. Some of the hot and specialty pepper cultivars required staking and tying in these trials that used close spacings, double rows, and plastic mulch with drip irrigation. All specialty cultivars at LEX were inspected at maximum fruit load to determine if staking and tying were needed; those requiring support are indicated in Tables 4 and 5. Tomato stakes (shorter stakes could also have been used) were driven into the ground at the four corners of individual plots; plants were "fenced in" by running a string (tomato twine) around these four stakes. A single stringing was adequate for some cultivars, while others required two or three successive stringings.

Table 1. Yields, gross returns, and appearance of bell pepper cultivars under bacterial spot-free conditions in Lexington, Ky.; 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	25.0	89	10,180	4	7	3	dk green	most fruits longer than wide
King Arthur	S	22.5	88	9,079	3	5	4	light-med green	deep blossom-end cavities
4 Star	RG	22.2	86	9,111	3.5	6	4	light-med green	
Boynton Bell	HM	21.7	92	9,003	3	5	3	med-dk green	~15% of fruits 2-lobed (pointed)
Corvette	S	20.6	88	8,407	3	6	3&4	med-dk green	~10% elongated (2-lobed)
X3R Red Knight	S	20.5	90	8,428	3	5	4	med-dk green	
SP 6112	SW	20.2	78	8,087	4	6	3	med green	
Conquest	HM	20.0	85	8,021	2	5	3&4	light-med green	deep stem-end cavities, many misshapes
Orion	EZ	20.0	93	8,219	4	6	4	med-dk green	
Lexington	S	19.8	87	8,022	3.5	6	3	dk green	
PR99Y-3	PR	19.5	87	7,947	3	5	3&4	med green	many misshapen fruits
Defiance	S	18.7	87	7,568	4	7	3&4	dk green	
X3R Ironsides	S	18.4	92	7,585	4	6	3	med green	~5% w/deep stem-end cavities
X3R Wizard	S	18.0	92	7,447	3	6	3&4	dk green	
RPP 9430	RG	17.3	89	7,029	3	6	4	med-dk green	~10% of fruits elongated
ACX 209	AC	17.2	89	7,035	3.5	6	3	med green	
Waller-Duncan LSD (P<0.05)		5.2	7	2,133					

[1] Total marketable yield included yields of U.S. Fancy and No. 1 fruits of medium (>2.5 in. diameter) size and larger plus misshapen but sound fruit which could be sold as "choppers" to foodservice buyers.

[2] Percentage of total yield that was extra-large (>3.5 in. diameter) and large (>3 in. diameter but ≤ 3.5 in. diam.).

[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.

Table 2. Yields, gross returns, and appearance of bell pepper cultivars at Quicksand, Ky.; yield and returns data are means of four replications. All cultivars except King Arthur have the Bs2 gene for resistance to bacterial spot races 1, 2, and 3.

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
4 Star	RG	18.4	86	7,496	--	--	--	--	--
X3R Red Knight	S	18.0	90	7,344	3	6	3	med green	earlier maturing; some red fruits
Defiance	S	17.8	87	7,256	3.5	7	3&4	med-dk green	nice blocky fruits
X3R Aristotle	S	17.4	90	7,164	3	5	3	med-dk green	some 2-lobed fruits
RPP 9430	RG	17.3	88	7,105	--	--	--	--	--
X3R Ironsides	S	16.7	83	6,794	2	5	3	light-med green	some 2-lobed
PR99Y-3	PR	16.0	86	6,508	3	5	3	light-med green	deep stem end; some 2-lobed
Conquest	HM	15.9	91	6,560	3	5	3	med green	slightly elongated; some red fruits
Orion	EZ	15.8	86	6,486	3	5	3	med green	
SP 6112	SW	15.5	81	6,290	3	5	3	med-dk green	many small fruits
Corvette	S	15.1	86	6,194	3.5	5	3	med green	some 2-lobed
Boynton Bell	HM	14.9	77	5,978	3	5	3	med green	
ACX 209	AC	14.7	82	5,994	3	5	2,3,4[6]	med green	many 2&3-lobed fruits; elongated
King Arthur	S	14.3	77	5,746	2	4	3&4	med green	
Lexington	S	13.6	82	5,520	3	5	3	dk green	many small and flattened fruits
X3R Wizard	S	12.8	90	5,289	4	6	3&4	dk green	nice; slightly elongated
Waller-Duncan LSD (P<0.05)		ns	12.2	ns					

[1] Total marketable yield included yields of U.S. Fancy and No. 1 fruits of medium (>2.5 in. diameter) size and larger.

[2] Percentage of total yield that was extra-large (>3.5 in. diameter) and large (>3 in. diameter but ≤ 3.5 in. diam.).

[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.

[4] Average visual uniformity of fruit shape where 1 = least uniform, 5 = completely uniform.

[5] Visual fruit appearance rating where 1 = worst, 9 = best, taking into account overall attractiveness, shape, smoothness, degree of flattening, color, and shape uniformity; all fruits from two replications observed at the first harvest (Aug 9).

[6] 3&4 = about half and half 3- and 4-lobed; 3 = mostly 3-lobed; 4 = mostly 4-lobed; 2,3,4 = about equal numbers of 2-, 3-, and 4-lobed.

Table 3. Yields from single plots of jalapeno pepper cultivars at Lexington and Quicksand with fruit characteristics from Lexington, Ky., 2001.

Cultivar (resistance gene)	Seed source	Mkt. yield LEX -- (tons/acre) --	Mkt. yield QSND -- (tons/acre) --	BLS[2]	Fruit characteristics: Cracking[3]	Average[4] Ln (in.)	Average[4] Diam (in.)	Average[4] Wt (g)	Appear. rating[5]	Color[6]	Comments
Coyame	S	27.4	--[1]	2	3	3.2	1.3	34	7	mg-dg	~10-20% slightly crescent-shaped
X3R Ixtapa (Bs2)	S	26.1	10.4	2	3	3.2	1.3	28	6	mg-dg	Some stubby, misshapen (~2%); ~10% purpling
RPP 7042-VP	RG	24.9	19.2	2	4	3.3	1.1	25	7	mg	
Summer Heat 6000	AC	23.6	19.8	2	3	3.4	1.3	34	7	mg-dg	Nice; ~50% very slightly curved
Mitla	S	23.4	20.1		3	2.9	1.1	24	7	mg-dg	Nice
El Rey (Bs2)	SK/SW	23.1	12.9	1	3	3.1	1.3	35	5	mg	Taper not always smooth
Torreon	S	22.9	20.7	2	3	3.3	1.2	27	6	mg-dg	
Ballpark	S	21.7	16.2	2	2	3.6	1.0	28	6	mg-dg	Some crescent-shaped (~10-15%)
Grande	S	21.4	18.0	4	3	3.2	1.2	30	6	mg	~5% with purple (anthocyanin) areas
HMX 3677	HM	21.3	16.1	2	4	3.0	1.3	26	7	dg	
Hybrid No. 7	RU	21.2	22.3	2	2	3.3	1.3	31	6	mg	~10% crescent-shaped
Jalandro	UG	20.8	12.2		1	3.3	1.6	40	4	mg	
HMX 3676	HM	13.9	16.1	2	3	2.7	1.2	31	7	mg-dg	Nice; some frts. very lightly curved.

1 Data not available from Quicksand for this cultivar.
2 Bacterial spot symptoms were observed in some plots at QSND and may have affected yields of those cultivars: '1' = plots with mild infection, '2' = plots with mild to moderate infections, '4' = plots that had severe infections. A blank in this column indicates that no symptoms were observed; blanks or numbers do *not* imply resistance or tolerance.
3 Extent of cracking in jalapeno fruits where 0 = none; 5 = very extensive, over entire fruit surface (Lexington trial); some cracking may be a desirable trait in Hispanic markets.
4 Average of a sample of 10 fruits (length and width); avg. fruit weight = marketable yields divided by number of fruits (entire season, Lexington).
5 Visual fruit appearance ratings where 1 = worst, 9 = best, taking into account overall attractiveness, shape, color, and uniformity (Lexington).
6 mg = medium green; dg = dark green (Lexington trial).

Inoculation and Disease Assessment

As in previous years, LEX plots were sprayed weekly with copper+maneb to help protect against bacterial spot, while QSND plots were left unsprayed in order to encourage the development of a natural epidemic. June weather conditions in QSND were very favorable for BLS epidemic development, and a natural epidemic did occur early in the season. Bell and specialty cultivars were assessed only once at QSND for BLS symptoms on June 28. Symptoms were extensive and severe on some cultivars in the hot and specialty trial by that date. BLS symptoms were scored as follows: 0 = no symptoms, 1 = very few (trace) symptoms visible, 2 = symptoms obvious but not extensive, and 4 = extensive symptoms (plants severely affected). These observations were made prior to the inoculation attempt described below.

In order to encourage a more uniform BLS epidemic within the trial, an attempt was made to inoculate all bell cultivars with inoculum collected from the hot pepper trial. About 300 leaves with typical symptoms were collected at random from various susceptible cultivars within the hot pepper trial plot on 27 June. These were placed in a plastic bucket with sufficient distilled water to cover the leaves. The mixture was stirred for about 10 minutes with a wooden stick to enhance extraction of the bacteria, making an effort to crush some leaves on the side of the bucket. The mixture was then poured through a cotton bag to remove leaf debris and squeezed by hand. Two gallons of this mixture were diluted further with water to make a total volume of 4 gallons. This mixture was applied uniformly to all plants in the bell pepper trial using a hand-operated sprayer. The inoculation attempt was made in late afternoon, within 15 minutes of the extraction. Heavy rains had preceded the inoculation attempt; the ground and foliage were wet during the inoculation and remained wet until mid-morning the following day. We considered this procedure to be a relatively simple means of ensuring more uniform epidemics using only races of the bacterium already found within the trial; we have successfully used this method in trials with other crops in the past.

About three hours after the inoculations, some of the mixture remaining in the sprayer was applied to pepper seedlings growing in a greenhouse on the Lexington campus. These seedlings developed extensive BLS symptoms within 10 days.

Results and Discussion

As in previous years, we wanted to encourage disease and evaluate resistance at QSND while keeping the LEX trial free of bacterial spot. No bacterial spot symptoms were observed in the bell or hot/specialty trials in LEX.

Bell cultivars. Total marketable yields, gross incomes, and fruit quality characteristics for bell cultivars grown without bacterial spot at LEX are shown in Table 1. Although yields were somewhat lower than in 2000, most of the cultivars were high yielding (20 to 25 tons/acre) at LEX with nine that were not significantly different from the top-yielding cultivar 'X3R Aristotle' (Table 1). 'Aristotle', 'King Arthur' (bacterial spot susceptible), '4 Star', 'Boynton Bell', and 'Lexington' were also in this category in the 2000 LEX trial.

Table 4. Yields from single plots of specialty pepper cultivars at Lexington and Quicksand with fruit characteristics from Lexington, Ky., 2001.

		Mkt. yield			Fruit characteristics						
		LEX	QSND		Average[3]						
type Cultivar	Seed source	-- (tons/acre) --		Bac. spot[2]	Ln (in.)	Diam (in.)	Wt (g)	Appear. rating[4]	Color[5]	Plant support[6]	Comments
serrano											
Tuxtlas	S	22.4	–[1]		2.9	0.8	12	7	mg	req'd.	~20% slightly crescent-shaped
Serrano del Sol	S	21.0	17.4		3.1	0.8	11	7	mg	req'd.	Nice, slightly crescent-shaped
Tampico Fiesta	HN/AS	15.3	13.7	2	2.9	0.6	7	6	lg-mg	req'd.	~50% slightly crescent-shaped
anaheim											
Novajoa	S	31.0	23.3	4	8	1.7	65	5	lg-mg	ben.	~30% 'C'-shaped
Garden Salsa	S	24.6	13.7	2	6.9	1.5	48	6	mg	req'd.	~30% 'C'-shaped, many culls from blossom-end decay
Sahuaro	S	18.7	12.4		6.7	2.1	73	5	lg	req'd.	10-20% 'C'-shaped, many culls from blossom-end decay
PX-35-4606-7	S	18.3	19.6		7.3	2.0	69	7	mg	ben.	Nice
Anaheim TMR 23	S	17.7	11.7	2	7.0	1.9	59	6	lg	req'd.	~20% 'C'-shaped, some blossom end decay
Joe E. Parker	R	14.8	21.3		6.3	1.7	59	4	lg	req'd.	~40% 'C'-shaped
poblano/ancho											
Ancho Villa	RG	21.0	12.3	2	5.4	3.0	133	6	lg-mg	req'd.	Lighter colored than most
SVR 35-4845-7 (Bs2)	S	17.2	10.7	4	4.9	2.8	94	7	dg	req'd.	Very nice
Ancho Ranchero	RG	14.6	11.6	2	5.1	2.9	99	4	lg-dg	req'd.	Highly variable
Ancho San Martin	SW	11.4	11.4		4.7	2.7	70	6	mg-dg	req'd.	Many culls from blossom-end decay
Mulato Costeno	S	10.3	10.6		3.9	2.4	67	6	dg	req'd.	Small fruit size
PS 13194	S	9.7	10.2	1	4.5	2.6	90	6	mg-dg	req'd.	variable sizes; many culls from blossom-end decay
Mulato Isleno	S	3.9	3.9		4.3	2.3	54	5	dg	req'd.	Small fruit size; very low yield
Italian/cubanelle											
Aruba	RG	28.3	15.6	1	7.5	3.0	137	5	lg-py	ben.	~20% apostrophe-shaped
ACX 500	AC	24.2	9.4	2	7.5	2.8	115	5	py	req'd.	~40% apostrophe-shaped; nice color
Corno Di Toro	RU	18.4	16.5	4	6.6	2.3	107	6	lg-mg	ben.	~10% apostrophe-shaped
Key West (Bs2)	S	16.7	22.0	1	7.1	2.9	116	4	lg	ben.	~40% apostrophe-shaped

1 Data not available from Quicksand for this cultivar.

2 Bacterial spot symptoms were observed in some plots at QSND and may have affected yields of those cultivars: '1' = plots with mild infection, '2' = plots with mild to moderate infections, '4' = plots that had severe infections. A blank in this column indicates that no symptoms were observed; blanks or numbers do *not* imply resistance or tolerance.

3 Average of a sample of 10 fruits (length and width); avg. fruit weight based on marketable yields divided by number of fruits (entire season, Lexington).

4 Visual fruit appearance ratings where 1 = worst, 9 = best, taking into account overall attractiveness, shape, color, and uniformity (Lexington).

5 Lg = light green; mg = medium green; dg = dark green; vdg = very dark green; gy = greenish yellow; py = pale yellow; ly = lemon yellow.

6 Staking with one or more strings may be required using double rows on plastic with drip as indicated by 'req'd.' = cultivars requiring staking/support; 'ben.' = cultivars that may benefit from staking.

Yields, income, and fruit quality characteristics for most of the same cultivars grown at QSND are shown in Table 2. While an early bacterial spot epidemic did occur in the trial at this location, it had ended abruptly and inexplicably by the second week in July. No new bacterial spot lesions developed in the field at QSND after the inoculation attempt. In fact, all bacterial spot activity suddenly stopped in both the inoculated trial and the adjacent hot pepper trial that had not been inoculated. The reasons for this failure are not understood but may be the result of environmental factors. Night temperatures below 61°F are known to suppress bacterial spot development regardless of daytime temperatures. Nights were unusually cool from 12-17 July (57°F was the average night temperature for that period). In addition, although the plots were still soaked from heavy rains prior to inoculation, rainfall did not occur again until eight days after the inoculation.

There were no statistically significant differences among cultivars for total marketable yields or gross incomes at QSND. Marketable yields ranged from 13 to18 tons per acre (Table 2). Some of the highest yielding cultivars at QSND were also in the highest yielding group of varieties tested at LEX: '4 Star', 'X3R Aristotle', 'X3R Red Knight'. Yields appeared to have been affected by the early bacterial spot epidemic. 'King Arthur' and 'X3R Wizard' were among the lowest-yielding cultivars at this location; these cultivars have been among the most susceptible in previous trials exposed to natural and induced BLS epidemics at QSND.

Scores for BLS symptom development from the 28 June assessment were extremely variable (c.v. = 116 percent), and no statistically significant differences were detected among cultivars (data not shown). This single assessment did not provide enough information to make valid comparisons for BLS resistance among cultivars. 'Conquest', a cultivar with the *Bs2* gene,

Table 5. Yields from single plots of specialty pepper cultivars at Lexington and Quicksand with fruit characteristics from Lexington, Ky., 2001.

type Cultivar	Seed source	Mkt. yield LEX	Mkt. yield QSND	BLS[1]	Fruit characteristics Average[2] Ln (in.)	Diam (in.)	Wt (g)	Appear. rating[3]	Color[4]	Plant support[5]	Comments
		-- (tons/acre) --									
hot banana/wax											
X3R Hot Spot (Bs2)	S	26.2	23.5		6.3	1.6	54	6	py	ben.	
Inferno	S	25.6	17.7	4	7.0	1.6	64	4	py	ben.	Over 50% short and apostrophe-shaped
Santa Fe Grande	S	16.8	14.5	4	2.9	1.1	19	7	py	poss.	Very nice; jalapeno size and shape
sweet banana/wax											
PX 35-4360-7 (Bs2)	S	32.5	26.8	2	6.5	1.6	58	7	py	req'd.	~50% 'C'/apostrophe-shaped; many w/ blossom end decay
Market Sweet	RU	28.7	15.9	4	6.8	1.8	65	4	py-lg	poss.	Over 50% short and 'C'/apostrophe-shaped
Sweet Spot	S	24.5	17.6	2	6.9	1.8	58	5	py	ben.	Many culls
Pageant (Bs2)	RG	23.6	18.3		6.2	1.7	70	4	py	poss.	Over 50% short and 'C'/apostrophe-shaped
Banana Supreme	RU	23.5	14.9	2	6.2	1.8	65	5	py	poss.	~50% short and 'C'/apostrophe-shaped
Bounty	S	21.3	20.1	2	7.1	1.6	76	5	py	ben.	~50% short and 'C'/apostrophe-shaped
fresno											
Grande (upright)	PG	7.2	15.0				22			poss.	
Supreme (pendant)	PG	4.7	3.9	2			19			req'd.	
pepperoncini											
Pepperoncini	RU	17.6	11.5	2	3.9	1.5	39	6	lg-mg	req'd.	~40% 'C'-shaped
PX 17494	S	12.5	14.8	1	3.3	1.3	18	7	lg	req'd.	Mostly straight, more uniform

1 Bacterial spot symptoms were observed in some plots at QSND and may have affected yields of those cultivars: '1' = plots with mild infection, '2' = plots with mild to moderate infections, '4' = plots that had severe infections. A blank in this column indicates that no symptoms were observed; blanks or numbers do *not* imply resistance or tolerance.

2 Average from a sample of 10 fruits (length and width); avg. fruit weight based on marketable yields divided by number of fruits (entire season, Lexington).

3 Visual fruit appearance ratings where 1 = worst, 9 = best, taking into account overall attractiveness, shape, color, and uniformity (Lexington).

4 Lg = light green; mg = medium green; dg = dark green; vdg = very dark green; gy = greenish yellow; py = pale yellow; ly = lemon yellow.

5 Staking with one or more strings may be required using double rows on plastic with drip as indicated by 'req'd.' = cultivars requiring staking/support; 'ben.' = cultivars that may benefit from staking; 'poss.' = cultivars that possibly need staking under windy conditions or with heavy fruit loads.

had the highest average score for BLS symptoms at this first and only assessment date.

While BLS symptoms had nearly disappeared by the third week in July, leaf spots caused by *Phyllosticta* sp. were evident on many of the bell and specialty cultivars by July 11.

Fruit quality characteristics for bell cultivars are also shown in Tables 1 and 2. 'Aristotle' and 'Defiance' received the highest fruit appearance ratings at LEX, which were better than ratings for 'X3R Wizard'. 'Aristotle', 'Lexington', 'Defiance', and 'X3R Wizard' had the darkest green fruits in the LEX trial. 'Defiance', 'X3R Wizard', and 'X3R Red Knight' received the best appearance scores at QSND. Many other cultivars received acceptable appearance ratings (6 or above at LEX or 5 and above at QSND) while 'King Arthur', 'Boynton Bell', 'X3R Red Knight', 'Conquest', and PR99Y-3 were rated lower than the others at LEX. 'X3R Aristotle' scored lower in overall appearance at QSND than at LEX. 'King Arthur' had the lowest score at QSND. 'King Arthur' has had consistently low fruit appearance scores in a number of trials; we consider it and similar cultivars better suited to foodservice markets.

Cultivars that were the highest yielding *and* that had acceptable or better fruit quality ratings at both locations included 'X3R Aristotle', '4 Star', and 'Orion'. A possible disadvantage of a cultivar like '4 Star' was its light to medium green-colored fruits (also light green in the 2000 trial); it may be difficult to market these lighter colored cultivars when buyers have become accustomed to receiving those with darker fruits like 'X3R Wizard'.

Jalapeños. Yields and fruit characteristics of the 13 jalapeño pepper cultivars grown in single plots at LEX and QSND are shown in Table 3. Two of these cultivars carried the *Bs2* gene for bacterial spot resistance. Most jalapeño cultivars had high marketable yields at LEX ranging from 14 to 27 tons per acre with three cultivars exceeding 'Mitla' (Table 3). Among these 'Coyame', 'Summer Heat 6000', and RPP 7042-VP had the most attractive fruits.

Cultivars were exposed to a natural bacterial spot epidemic early in the season at QSND; however, the epidemic had nearly disappeared by mid-July and only a single assessment for symptoms was obtained. Unlike results from the 2000 jalapeño trial, the two cultivars with the *Bs2* gene and 'Jalandro' appeared to be most affected by this short-lived epidemic (Table 3).

Serranos. Marketable yields for the three serrano cultivars at LEX ranged from 15 to 22 tons per acre with 'Tuxtlas' and 'Serrano del Sol' having the highest yields and most attractive fruits (Table 4). 'Tuxtlas' was also the highest yielding and most attractive serrano in 2000.

Table 6. Tentative ranking of pepper types and cultivars by their relative susceptibility to bacterial spot (based on results from trials at Quicksand, Ky., in 2000).

BLS risk	Group[1]	Resistance gene(s)	% BLS2[2]	Cultivars[3]
Lowest	resistant Jalapeños	Bs2	3-22	X3R Ixtapa, El Rey
	tolerant Serranos	--	3-10	Tampico Fiesta, Serrano Chili
	most resistant Bells[4]	Bs2	8-13	X3R Ironsides, Peninsula, X3R Chalice, X3R Aristotle, X3R Red Knight
	resistant Hot banana	Bs2	17	X3R Hot Spot
	tolerant Habanero	--	22	Habanero (Hollar Seed Co.)
	tolerant Cubanelle	--	40	Aruba
	tolerant Hot bananas/wax	--	40-52	Hungarian Yellow Wax, ACX 400, Romanian Hot Hybrid
	tolerant Cayenne (Misc.)	--	62	Mesilla
	tolerant Poblanos/anchos	--	62-67	Ancho San Martin, Ancho Villa
	less resistant Bells[4]	Bs2, --	63-71	X3R Wizard, Bennington
	tolerant Sweet bananas/wax	Bs2, --	62-75	Pageant, Market Sweet, Sweet Banana
	susceptible Cubanelles	--	67-77	Biscayne, ACX 500, Giant Aconcagua, Corno di Toro
	susceptible Hot bananas/wax	--	65-80	Hungarian Heat, Inferno
	susceptible Anaheims	--	72-80	Mexiheim, Garden Salsa, Anaheim TMR 23
	susceptible Bells	Bs1, Bs3[5]	80-82	King Arthur, Merlin, Consul, Vivaldi, Guardian, Sentinel
	susceptible Jalapeños	--	80-87	Mitla, Tam Jalapeño No.1, Delicias, Perfecto, Summer Heat 5000
Highest	susceptible Poblanos/anchos	--	72-85	Ancho Ranchero

1 Cultivars within types (Bells, Jalapeños, or hot/specialty types in Tables 4 and 5) grouped as: 1) "resistant" = having *Bs2* gene and high yielding with fewer symptoms and defoliation overall than 2) "tolerant" = having no major resistance gene but with considerably fewer symptoms and yielding more marketable fruits than 3) "susceptible" = little to no marketable yield with extensive foliar symptoms and defoliation.

2 % BLS = range of the avg. percentages of leaves with bacterial spot symptoms under severe epidemic conditions at QSND in 2000; data were from 2 assessment dates and one or more cultivars.

3 Not all cultivars tested are listed; others may be equally resistant, tolerant, or susceptible.

4 Bell cultivars that were the "most resistant" with highest yields and gross returns. "Less resistant Bells" are those cultivars (with or without *Bs2*) that had relatively high AUDPC values, % BLS, and defoliation in 2000.

5 Cultivars having *Bs1*, *Bs3*, or both were as susceptible as those with no major resistance genes in 1995 trials.

Anaheims. Yields of the six anaheim cultivars ranged from 15 to 31 tons per acre at LEX; 'Novajoa' was the highest yielding while PX-35-4606-7 and 'Anaheim TMR 23' had the most attractive fruits (Table 4). 'Novajoa' was also highest yielding at QSND in spite of severe BLS symptoms early in the season (Table 4).

Poblano/anchos. Yields among the seven poblano cultivars at LEX ranged from 4 to 21 tons per acre. 'Ancho Villa' was again (as in 2000) the highest yielding with the largest fruit size (Table 4); fruits of this cultivar, however, were lighter colored, which could possibly be a disadvantage in some markets. The only entry with the *Bs2* gene for resistance to bacterial spot (SVR 35-4845-7) was high yielding and had the highest appearance rating at LEX. Most poblano/ancho cultivars are quite susceptible to bacterial spot, and yields at QSND may have been affected by the early epidemic at this location (Table 4). 'Mulato Isleno' had very low yields at both locations.

Italian/cubanelles. Yields for the four Italian/cubanelle or frying peppers ranged from 17 to 28 tons per acre at LEX (Table 4). 'Aruba' had the highest yield and largest fruit size followed by 'ACX 500'. As in 2000, 'Corno di Toro' was considered to have the most attractive fruits, although they were light to medium green in color instead of the typical light green or pale yellow. 'Key West', a new cultivar with the resistance to bacterial spot, appeared to be unaffected by the early epidemic at QSND (Table 4).

Hot banana/wax. Two hot banana cultivars and 'Santa Fe Grande' were tested. 'X3R Hot Spot' (with the *Bs2* gene) had the highest marketable yield and good appearance ratings at LEX (26 tons/acre, Table 5). Both 'Inferno' and 'Santa Fe Grande' had severe symptoms of bacterial spot associated with the early epidemic at QSND.

Sweet banana/wax. The six sweet banana or sweet wax cultivars included two with the *Bs2* gene ('Pageant' and PX 35-4360-7); yields at LEX ranged from 21 to 32 tons per acre (Table 5). PX 35-4360-7 was the highest yielding entry at both locations and had the most attractive fruits. Most cultivars had many "C"—or apostrophe-shaped—fruits. 'Market Sweet' was high yielding at LEX but exhibited severe BLS symptoms during the brief epidemic at QSND.

Fresno and pepperoncini. Two fresno cultivars—one with upright fruits and one with pendant fruits—were included in the trials. Marketable yield was higher and fruit size larger for the upright type (Table 5). 'Pepperoncini' from Rupp Seed Company was the highest yielding of the two pepperoncini types tested at LEX. PX 17494 had more attractive fruits at LEX and had higher yields at QSND. The authors are not familiar with market requirements for pepperoncini types; these are usually brined and sold with pizza. Perhaps "C"-shaped pepperoncini fruits could be as desirable as straight fruits.

Pepper types, cultivars, and bacterial spot risk. Kentucky pepper growers experienced periodic devastating bacterial spot epidemics prior to the widespread planting of resistant cultivars after 1995. There is growing interest in Kentucky and other states in growing hot and specialty pepper cultivars, many of which do not carry any major resistance genes. While there is a significant risk of bacterial spot epidemics associated with the production of some of these cultivars, others can be grown with less likelihood of disaster, especially with a sound spray regimen. Relative bacterial spot risks for various pepper types and cultivars were estimated after the 2000 trials and are shown in Table 6. Our recommendation remains that growers use resistant cultivars whenever possible *in conjunction with* copper+maneb preventive spray programs.

Acknowledgment

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Plant Populations and Nitrogen Sources for Bell Pepper Production

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Introduction

Commercial pepper production is a fairly new venture for many farmers in the western part of the state where agronomic row crops and tobacco have been the traditional commodities grown. However, the signing of contracts for 100 acres of bell peppers in 2001 through the local co-op gave farmers a chance to grow small acreage pepper plots to determine if higher returns on land, capital, and management could be achieved.

The Kentucky Pepper Integrated Crop Management Grower Manual (IPM-13) was relied upon heavily as our guide for recommended production practices. While those who followed the recommendations in the manual produced high yield and high quality bell pepper crops, there was interest in knowing if growing conditions in this part of the state could support adjustments in pepper stand populations and fertility management practices with the goal of achieving higher economic returns.

Supporting data on optimum bell pepper population stands is not readily available. A 12-inch in-row plant spacing is standard commercial practice that is recommended in the previously mentioned grower manual. This recommendation seems to be supported in part by an experiment by Locascio and Stall (1994) who reported that yields per bell pepper plant were 30 percent greater with a 12-inch in-row spacing than a 6-inch in-row plant spacing; yields per acre were similar with both in-row spacings even though the latter had a 33 percent greater number of plants per acre.

Fertility was another area of interest for reasons that included fertilizer analyses, cost, and application frequency. Two weeks following preplant incorporation of 50 lb N/A, the University of Kentucky recommends that an additional total of 50 to 75 lb N/A from either ammonium nitrate (NH_4NO_3) or calcium nitrate ($CaNO_3$) be applied in weekly fertigations. Calcium nitrate's per unit cost on an N basis is just more than 4½ times that of ammonium nitrate; however, calcium nitrate's supply of 20 percent calcium was a major reason many producers in the area used this form in hopes of avoiding blossom-end rot since, in contrast to Central Kentucky, base levels of free carbonate are minimal. Furthermore, interest in poultry litter as a fertility source was also evaluated to determine if preplant application could achieve a similar response as that obtained with synthetic fertilizers.

Two separate studies were conducted to evaluate the effects of plant spacing on marketable yield and quality and to determine if differences in fertility management practices would affect pepper yield, quality, and their predisposition to blossom-end rot.

Materials and Methods

Plant Population. The population density study was planted on May 2 using 242-cell trays of bell pepper 'Brigadier' transplants. All plants were set on 4-inch high, 3-foot wide beds that were 6 feet between centers and covered with black plastic mulch with drip irrigation. Experimental units consisted of 25-foot-long double rows, 18 inches apart with four different in-row plant spacings. These four treatments included 9-inch, 12-inch, 15-inch, and 18-inch spacings. Preplant fertilizer and weekly fertigation using calcium nitrate was applied as recommended in IPM-13. Treatments were replicated four times in a randomized complete block design.

Plots were harvested four times (weekly from July 2 to July 19 and again on July 26). All peppers were graded into extra large, large, medium, and choppers. Total marketable weight for all harvested peppers was also determined. All data were subjected to an analysis of variance to test for main effects, and a regression analysis was used to determine rate response to pepper plant population treatments.

Poultry Litter and Nitrogen Sources. On May 7, a pepper fertilizer experiment was established with six treatments consisting of a factorial set of three preplant fertilizer combinations of ammonium nitrate (AN) and poultry litter (PL) together with two fertigated nitrogen fertilizers: ammonium nitrate (AN) or calcium nitrate (CN). The preplant fertilizer was applied at 50 lb N/A in combinations that included 100 percent AN, 50 percent AN+50 percent PL, and 100 percent PL. All treatments were applied in fields with transplants and mulch beds similar to those previously described for the population study. Soil pH was 6.2, indicating no additional lime was needed. Each experimental unit consisted of 25-foot-long beds with double rows that were18 inches apart with12 inches between plants in the rows. All treatments were replicated four times and in a randomized complete block design.

Plots were harvested July 7, July 14, and July 24 and graded into extra large, large, medium, and choppers. Total marketable weight for all harvested peppers was determined. The number of peppers with blossom-end rot were counted and pepper greenness was estimated using a qualitative rating scale of 1 to 5 (1 = light green, 5 = darkest green).

Mature leaf samples near the distal end of pepper plants were collected during the second harvest from randomly selected plants from each experimental unit. Collected leaves were analyzed for total nutrient content at Analytical Laboratories, Memphis, Tennessee.

All data were subjected to an analysis of variance to test for main effects, and the orthogonal polynomial trend comparisons procedure was used to evaluate the effect of preplant fertilizer combinations and fertigation N source.

Results and Discussion

Plant Population. Yield and weight measurements for all treatments showed a similar general response to differences in pepper population density and time of harvest. On a per plant basis, 15-inch and 18-inch spacings tended to have consistently higher weights (Figure 1) and more extra-large peppers (Figure 2) compared to 9-inch and 12-inch spacings, although higher per acre marketable yields and numbers of extra-large peppers were generally achieved with the 12-inch and 15-inch spacings. The one exception to this was after the fourth harvest: the 18-inch spacing was significantly higher in pepper weight and extra-large grade peppers.

Peppers graded large showed the highest yields for 9- through 15-inch spacings during the first and second pickings on a per acre basis. However, the third and fourth harvest had higher large-graded pepper yields for spacings between 12 and 18 inches. On a per plant basis, a 15-inch spacing produced a higher number of large-grade peppers for the first two pickings, while the 18-inch spacing produced a greater number of large-grade peppers for the final two pickings when compared to other treatments. The 9-inch spacing averaged 20 percent lower large-grade yields on a per plant basis regardless of the time of harvest. Overall, the number of chopper-grade peppers stayed around 30 percent of total harvest regardless of plant spacing.

Total yield (Table 1) did not differ on a per acre basis for any of the spacings. Spacing peppers at 9 inches, however, did produce less total weight (Table 1) when compared to the other treatments.

Information from these studies should not be considered recommendations for commercial bell pepper production. Rather, this information can be used to help make appropriate adjustments to individual operations. Data from the population density study indicate that spacing plants at 12 or 15 inches tended to result in higher pepper yields and weights through the first half of the harvest season. Eighteen-inch spacings resulted in higher yields during the second half of the harvest season.

Figure 1. Pepper harvest weights on a land unit basis.

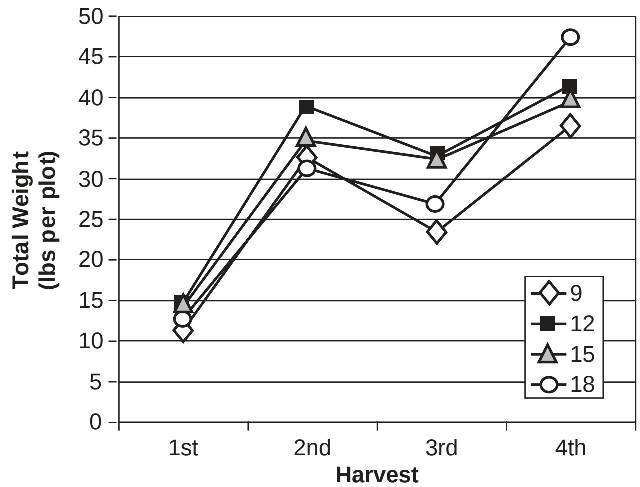
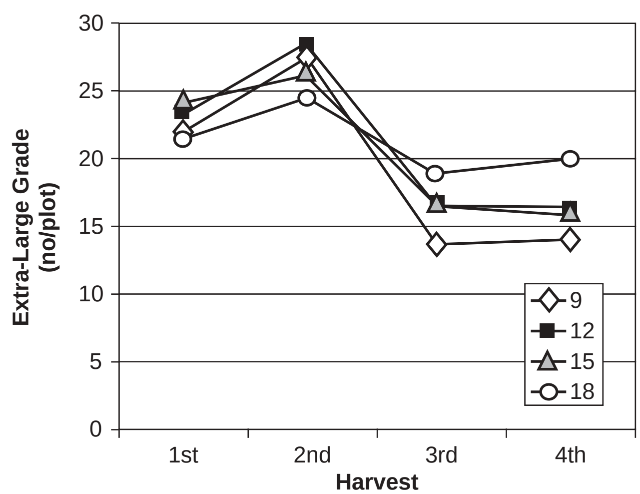


Figure 2. Extra-large grade peppers on a land unit basis.



While high yield potential is possible with 18-inch spacings during the latter part of the growing season, several disadvantages come to mind if using this spacing: target market date, inefficient water usage, and increased potential for sunburned fruit.

Premium prices for Kentucky-grown peppers generally occur during the first half of July. Peppers spaced 18 inches apart

Table 1. In-row spacings' influence on total harvested bell pepper weight and yield on a per plot basis, Henderson County, Ky., 2001.

In-row plant spacing	Total weight (lb/plot)	Total X-Large[1] (no./plot)	Total Large (no./plot)	Total Medium (no./plot)	Total Chopper (no./plot)	Total peppers (no./plot)
9 inch	103.5 b[2]	78.2	68.0	8.3	65.8	220.3
12 inch	127.7 a	84.2	72.5	7.2	76.5	240.4
15 inch	121.0 a	79.3	69.4	5.8	81.2	235.7
18 inch	118.3 a	84.8	73.2	3.0	64.2	225.2
		NS[3]	NS[3]	L[3]		NS[3]

[1] Pepper grades: Extra-large (>7 oz); Large (6-7 oz); Medium (<6 oz); Choppers (deformed fruit).

[2] Means followed by same letter do not significantly differ within columns (P = 0.05, Duncan's MRT).

[3] L = significant linear response. NS = non significant; * = significant at $P \leq 0.05$.

Table 2. Fertigated N type's affect on bell pepper weight, yield and fruit characteristics, Henderson County, Ky.

Fertigated N Source	Total X-Large[1] (no./plot)	Total Large (no./plot)	Total Medium (no./plot)	Total Chopper (no./plot)	Total peppers (no./plot)	Fruit color[2] (1 - 5)
Ammonium Nitrate	66.0 a[3]	42.1	11.6	46.1	165.8	3.8
Calcium Nitrate	55.8 b	38.5	9.4	43.4	147.1	3.3
		NS	NS	NS	NS	NS

[1] Pepper grades: Extra-large (>7 oz); Large (6-7 oz); Medium (<6 oz); Choppers (deformed fruit).

[2] Fruit color: 1 = lightest green, 5 = darkest green.

[3] Means followed by same letter do not significantly differ within columns (P = 0.05, Duncan's MRT).

may miss this window of maximum profit potential as seen with 12 and 15 inches and the premium prices they might receive.

Poultry Litter and N Sources. There were no significant differences for any of the growth and yield measurements among the different preplant treatments of poultry litter, ammonium nitrate, or the combination of the two, nor were there interactions with the two different N fertilizer types used for supplemental fertigation (data not shown). Using poultry litter as the sole source of preplant fertilizer, or in combination with ammonium nitrate, resulted in similar plant growth and yield.

Fertigation with ammonium nitrate resulted in a higher number of extra-large peppers than fertigation with calcium nitrate (8.3 from AN vs. 5.1 from CN) during the first picking and for the total number of extra-large peppers harvested (Table 2) prior to the experiment's termination. In addition, harvested peppers tended to be darker green (Table 2) than those grown solely under fertigation with calcium nitrate.

The number of large-, medium- and chopper-grade peppers were similar in number for each harvest interval (data not shown) and for their respective totals (Table 2) regardless of fertilizer N type. Using ammonium nitrate as the sole fertilizer source for fertigation did not produce a higher number of peppers with blossom-end rot. Neither treatment resulted in fruits affected by blossom-end rot in this trial.

Leaf analyses of pepper plants indicated that fertigation N type had a significant effect on leaf N content; however, N leaf content was also affected by a preplant N type x fertigation N type interaction (Table 3). Pepper N leaf content was higher in plants under ammonium nitrate fertigation. No differences in other essential elements, including leaf calcium content, were present for any of the treatments evaluated (data not shown).

Peppers responded well to poultry litter used as a preplant fertilizer source. Fertigation with ammonium nitrate produced more extra-large peppers, resulted in a higher foliar N content, and darker green pepper plants than did fertigation with calcium nitrate. One inference as to why ammonium nitrate produced more extra-large peppers, with a slightly darker green color, is the higher nitrogen content within the plant. No differences were found, however, for the number of large, medium, and chopper-grade peppers, as well as total yield and weight between ammonium nitrate or calcium nitrate fertigation.

Table 3. Preplant and fertigated N type's affect on pepper leaf total percent nitrogen content at second harvest, Henderson County, Ky., 2001.

	Preplant fertilizer treatment		
Fertigated N Source	100% AN	50% PL+ 50% AN	100% PL
		% N	
Ammonium Nitrate	5.1 a[1]	5.2 a	5.2 a
Calcium Nitrate	4.8 b	4.5 b	4.8 b

[1] Means followed by same letter within columns are not significantly different (*P* 0.05).

This study also suggests that if pH is corrected prior to planting, ammonium nitrate may be used as the sole fertigation N source without causing an increase in blossom-end rot. This is also supported by the fact the leaf Ca content was similar for both ammonium nitrate and calcium nitrate fertigation. The key to preventing blossom-end rot seems not to be the influx of available calcium but rather keeping moisture consistent within a plant's effective root zone during the growing season. This is best accomplished by using plastic mulch and drip irrigation with irrigation frequency determined by routine soil moisture monitoring with tensiometers.

One option not evaluated in this study that growers may want to consider if they are concerned about calcium availability is alternating between ammonium nitrate and calcium nitrate for weekly fertigations.

Literature Cited

Locascio, S.J., and W.M. Stall. 1994. Bell pepper yield as influenced by plant spacing and row arrangement. J. Amer. Soc. Hortic. Sci. 119:899-902.

Feasibility of Biological Control of European Corn Borer in Peppers

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Introduction

Integrated pest management practices have aided farmers in reducing the amount of pesticides used to control insects and in using them more effectively when needed. Biological control is a component of IPM that is growing in popularity, especially among organic growers. Biocontrol uses one living organism to control the population of an unwanted pest. Tiny parasitic wasps (less than 0.5 mm long) from the genus *Trichogramma* have been used as biocontrol agents in sweet corn against European corn borer (ECB), *Ostrinia nubilalis*. ECB is also the most serious insect pest in peppers in Kentucky. Pepper crops are often damaged by second and third generation ECB larvae in the middle to later part of the growing season. Once hatched, the larvae are difficult to control because they quickly tunnel into the caps of pepper fruits. Once inside the fruit, ECB larvae cannot be killed with insecticides. Subsequent injury may go undetected until fruits decay from bacterial soft rot that occurs as a result of ECB damage.

Trichogrammae ostriniae is an egg parasite that was introduced into the United States from China. This species has been tested and found effective in reducing the number of insecticide treatments for control of ECB in sweet corn in the Northeast. Little is known about the wasps' effectiveness in controlling ECB in peppers, and to our knowledge this species has not been previously evaluated for its effectiveness in peppers. In this preliminary trial, we released *T. ostriniae* in a small, unreplicated trial in order to get an idea of its potential for ECB control in bell peppers and to learn scouting and other procedures in order to better plan replicated trials for 2002.

Materials and Methods

Two bacterial spot-resistant bell pepper cultivars, 'Early Sunsation' and 'Defiance', were planted in each of two 50-foot by 50-foot plots that were prepared at separate sites at the University of Kentucky Horticultural Research Farm in Lexington. One of these identical plots was designated the release plot and the other the control plot (no *T. ostriniae* released). The plots were approximately 300 yards apart, with fields of other crops, a gravel parking lot, and a building between them. The release plot was located downwind from the control plot.

Peppers were seeded on April 19 and transferred to 72-cell trays on May 16. The plants were set on May 30 into raised beds with black plastic mulch and drip irrigation. Standard commercial practices were used: plants were grown in double rows with 12 inches between plants within the row and 15 inches between the double rows. Each plot consisted of six double-row beds (384 plants) bordered by guard rows on each side (128 plants). The plants were irrigated as needed based on tensiometer readings.

One hundred and fifty pounds per acre of ammonium nitrate (50 lb N/A) was incorporated into each plot prior to planting. Plots were fertilized with P and K according to soil test results. An additional 10 lb N/A as ammonium nitrate was applied in the release plot and 7 lb N/A in the control plot in three fertigations. Total season N applications including preplant were 60 lb N/A for the release plot and 57 lb/A for the control plot. Maneb and copper (TennCop) were applied weekly to both plots to protect against bacterial spot. The insecticide Spintor was mistakenly applied once in the control plot; no other insecticide treatments were applied in the control or release plot. A pheromone trap was placed adjacent to the release plot to monitor ECB activity.

Thirty thousand *T. ostriniae*-parasitized *Ephestia* eggs (glued inside two paper cups with 15,000 each) were obtained from Cornell University and placed in the release plot on July 11. This was the date predicted as the first flight of second generation ECB moths for Lexington by the University of Kentucky ECB degree-day model. That flight turned out to be very light, and we decided to obtain and release a second batch of 30,000 a week later on July 18 in the same field. Paper cups containing the egg parasites had been folded and stapled shut in order to protect against predators and exposure; numerous pinholes had been made in the cups to allow the parasites to emerge. Releases were simply a matter of hanging the two paper cups under the leaf canopy of a plant in the center of the plot.

Plots were scouted twice weekly and the number of parasitized and unparasitized ECB egg masses recorded. Once eggs were located and their status recorded, leaves with eggs were flagged with a plastic marking ribbon and given a number. These egg masses were visited twice weekly and their condition recorded until hatching or their disappearance.

All green mature fruits were harvested on August 1 and 18. Marketable fruits were graded and weighed according to size class (U.S. No. 1 extra large, large, medium). Each fruit was carefully examined for signs of ECB feeding or injury; all fruits with noticeable signs of ECB activity were dissected to determine the presence of larvae. Only fruits with one or more larvae inside were recorded as having ECB damage.

Results and Discussion

ECB egg masses were first discovered in the trial on July 13. The second generation ECB moth flight was not as concentrated as in past years, and only small numbers of moths were caught until the end of the season. Our plan had been to release *T. ostriniae* to coincide with the predicted flight of second generation ECB around July 10; however, a total of only seven ECB moths had been trapped by July 25. The detected initiation of the moth flight occurred about a week later than predicted. This may have been due to low ECB numbers. A total of 19 egg masses in the release plot were located and monitored until hatching or disappearance from July 13 until August 10.

Only three ECB egg masses were found in the control plot; however, more than double the number and weight of ECB-damaged fruits occurred in this plot than in the release plot (see table below). The release plot yields were slightly higher than control plot yields. It is not known why ECB masses in the control plot were not as easily detected as those in the release plot. Many *T.*

European corn borer damage and pepper yields in *T. ostriniae* release and control plots at Lexington, Ky., 2001. Data are season totals from two harvests.

	ECB-damaged fruits		Mkt. yields (lb/plot)				Culls
	no./plot	wt (lb/plot)	X-Large	Large	Med.	Total	(lb/plot)
T. ostriniae release	35	16	729	143	13	885	46
control	74	38	580	206	8	794	30

ostriniae-parasitized ECB egg masses were also found in an adjacent sweet corn trial after ECB egg numbers in the pepper plot had declined. Only a few very small clusters of one to three ECB eggs were found in the pepper plots toward the end of the growing season.

Many of the flagged egg masses, whether parasitized or not, seemed to disappear during the course of the trial. These disappearances might have been caused by the feeding of predatory insects such as lady beetles, by egg casings being eaten after ECB or wasp emergence, or simply by becoming detached and lost.

Notes on scouting. Scouting techniques included brushing pepper leaves up with one's arm to expose undersides of the leaves. ECB eggs were most often found half way up from the bottom of the plant on the undersides of leaves and fruit. ECB moths laid eggs indiscriminately on both hail-damaged and whole leaves alike. Viable ECB eggs are scale-like, circular, milky-white with an iridescent casing; they are deposited in clusters (masses). When *T. ostriniae* parasitizes a ECB egg, the inside of the egg turns solid black. This parasitized condition should not be confused with the "black head" stage of ECB eggs. The black head stage occurs in non-parasitized eggs when heads of the ECB larvae become visible about 24 hours prior to hatching. The black head stage is not as completely black as in parasitized eggs. *T. ostriniae* are not able to parasitize eggs in the black head stage. Adult female *T. ostriniae* lay their eggs in ECB eggs, sometimes depositing more than one egg in each ECB egg. The wasp larva hatches inside the ECB egg, feeds on the contents, and pupates. The adult wasp chews a circular escape hole in the ECB egg casing and vacates the egg. These escape holes were visible with a hand lens. It takes about 10 days from egg deposition to wasp emergence. Because of their extremely small size, there appears to be no other practical way of monitoring *T. ostriniae* activity other than locating and recording parasitized eggs.

Many environmental factors are known to affect the success of *T. ostriniae*. The wasps prefer temperatures between 62 and 89°F, and relative humidities between 45 percent and 95 percent. The adults probably feed on nectar of the pepper plant flowers. Strong winds, dust, and rain will affect the wasps' performance. Studies conducted by Cornell University in New York have shown that *T. ostriniae* can persist even when pesticides are used because the developing wasps are protected inside the ECB egg.

Further trials. It was not our intention to determine if *T. ostriniae* could successfully control ECB in peppers in this preliminary trial. We hoped that these observations might indicate whether the technique looked promising. The results do seem to suggest that one or two inoculative releases of *T. ostriniae* have potential to help control ECB in peppers. The test also provided insights on scouting procedures and data collection for use in future trials.

Acknowledgments

Our thanks to Larry Blandford, Spencer Helsabeck, John Holden, Dave Lowry, Bonnie McCaffrey, and Kirk Ranta for help with harvest and data collection. We would also like to gratefully acknowledge the assistance of Mike Hoffmann, Mark Wright, and Sylvie Chenus of the Department of Entomology at Cornell University for generously providing the parasites and for their helpful suggestions and advice.

Note: *see* <www.uky.edu/Ag/Entomology/entfacts/fldcrops/ef106.htm> for more information regarding the degree-day model for predicting flights of European corn borer in Kentucky.

Yields and Quality of New Muskmelon Cultivars in Central Kentucky

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Introduction

Muskmelons or cantaloupes are one of the most important commercial vegetables in the region and are a priority crop for the UK vegetable research and Extension team. Muskmelons are the primary crop being grown and marketed by the newly formed Green River Produce Marketing Cooperative based in Hart County. This co-op serves small farmers in one of the most tobacco-dependent areas in the state. A few new eastern-type muskmelon cultivars have been recently released, some of which claim to be similar to Athena, which is currently the market standard. In this trial we compared three new cultivars with Athena.

Materials and Methods

Two seeds were sown into each cell in plastic cell packs (72 cells/tray) on 26 April at the UK Horticulture Research Farm in Lexington; trays were placed on bottom heat in a heated greenhouse until germination. Once germinated, the plants were moved to a cooler greenhouse. Plants were set in the field on 30 May into raised beds covered with black plastic with drip irrigation. The two plants from each cell were transplanted 3 feet apart within the row (two plants/hill) with 6 feet between rows. Plots consisted of two adjacent rows with five hills (10 plants) each in a randomized complete block design with four replications.

The plots were fertilized prior to planting with 150 lb/A of ammonium nitrate (50 lb N/A) and with P and K according to soil test results. An additional 30 lb/A (10 lb N/A) of ammonium nitrate was fertigated twice during the growing season for a season-long total of 70 lb N/acre. Curbit was applied for weed control between rows of plastic prior to vine coverage. The systemic insecticide Admire 2F was applied to the base of each plant soon after transplanting, using a backpack sprayer with the nozzle removed. Other insecticides were used as needed later in the season. Either Bravo or Quadris was applied on a weekly basis for disease control. Plots were scouted twice weekly to monitor pests and diseases. Plots were harvested six times between 6 August and 24 August. Measurements and soluble solids were determined on a subsample of five fruits from each variety in each replication from the first three harvests (6, 9, and 13 August).

Results

Cucumber beetle populations were high early in the season; many beetles were observed on transplants as they were set out. The post-transplant drench treatment with Admire was very effective for early season beetle control; vine coverage was early and thick. Plants were harvested six times, when fruit were at full slip.

Due to cloudy, rainy weather early in the season, the first harvest yielded mostly bland, low sugar fruit. Although there were no statistically significant differences for season-long yields, Minerva was the highest yielding in terms of tons of fruit per acre (Table 1). This variety had large fruits with deep sutures and heavy netting; it also had the highest soluble solids (sugar content) and was rated best for taste among the varieties tested (Table 2). Average fruit size was similar for Minerva, Odyssey, and Vienna (around 7 to 8 lb); all were larger than Athena (5 to 6 lb). Athena had the largest number of marketable fruits among the four cultivars (more than 10,000 per acre). Although none of these average sugar contents met USDA requirements for the "U.S. Fancy" grade, Minerva and Odyssey met the U.S. No. 1 grade. Higher sugar contents would be expected in a drier season.

Fruits of Odyssey were oblong and lightly netted. Odyssey looked much like Athena, although Odyssey fruits had deeper sutures. Athena yielded the most melons per acre, although sugars were low compared to Minerva and Odyssey. Vienna was also considered acceptable, although without outstanding qualities compared to the other cultivars in this trial. It will be difficult for new cultivars to compete when wholesale buyers continue to request Athena. For the time being, Minerva will be recommended for farmers' field trials as an excellent melon for roadside and local sales.

Acknowledgment

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Table 1. Average yields and fruit size for muskmelon cultivars, Lexington, Ky., 2001; data are means of four replications from six harvests.

Cultivar	Seed source	Reported disease tolerance[1]	Days to harvest	Yield (cwt/A)	Yield (tons/A)	Mkt. fruit no./A	No. culls/A	Average fruit size (lb)
Minerva	RG	$F_{0,1,2}$; $PM_{1,2}$	77	673	33.7	8833	303	7.6
Odyssey	SS	$F_{1,2}$; PM	75	585	29.2	7925	786	7.4
Athena	RG	$F_{0,1,2}$; $PM_{1,2}$	80	556	27.8	10285	1089	5.4
Vienna	S		80	549	27.4	7381	726	7.4

[1] F = Fusarium; PM = Powdery mildew; subscripts indicate races of the pathogen to which the cultivar is resistant or tolerant.

Table 2. Fruit quality characteristics of muskmelon cultivars, Lexington, Ky., 2001; data are means from a subsample of five fruits in each replication from the first three harvests.

Cultivar	Seed source	Fruit size Ln (in.)	Fruit size Diam. (in.)	Cavity size Ln (in.)	Cavity size Diam. (in.)	Flesh thick. (in.)	Taste[1]	S. solids (%)	Shape[2]	Netting[3]	Sutures[4]	Comments
Minerva	RG	8.0	7.4	5.5	3.5	2.3	3.5	10.6	Rnd-Obl	Hv	Dp	Very deep sutures.
Odyssey	SS	8.6	6.9	6.0	3.3	2.0	2	10.0	Obl	Lt-Md	Md	Blossom-end scars
Athena	RG	7.9	6.7	5.0	2.8	1.9	2	8.3	Rnd-Obl	Md	Sh	Smaller fruits
Vienna	S	8.5	7.5	5.6	3.3	2.1	2	8.0	Obl	Md	Sh	Nice flesh color.

[1] Informal taste rating scale: 1 = unpleasant texture, bland; 5 = excellent, very sweet muskmelon taste.

[2] Shape: Rnd = round, Obl = oblong.

[3] Netting: Lt = light, Md = medium, Hv = heavy.

[4] Sutures: Sh = shallow, Md = medium depth, Dp = deep.

Yields and Quality of New Muskmelon Cultivars in Eastern Kentucky

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Eastern muskmelon (cantaloupe) production has been identified as one of several profitable crops that Kentucky farmers can produce. Potential yields of 8,000 to 10,000 fruit/acre with gross returns of $5,000/acre are possible. Variable costs are roughly $1,000 per acre, and net returns to the grower are in the $2,200 range.

One farm cooperative, several grower marketing associations, and numerous farmers' market producers are currently producing cantaloupes for fresh market sales. This cultivar trial compares Athena, which is currently produced on 75 percent of all Eastern cantaloupe acreage, with five other cultivars that produce similar fruit. The cultivars were compared as to yield, fruit quality, and consumer acceptance.

Methods

Six cantaloupe cultivars (Table 1) were compared to determine yield, quality, size, percent solids, and shipping quality for potential use by Kentucky cooperatives for wholesale trade. An evaluation of taste, smell, and appearance was also made.

Table 1. Muskmelon cultivars tested at Quicksand, Ky., 2001.

Cultivars	Days to Mat*	Seed Source	Comments
Eclipse	63	SW	large size, good quality
Odyssey	65	SS	heavy netted, shallow sutures, holds and ships well.
Vienna	63	SW (S)	medium shelf life,
RAL 8793-VP	63	SW (RG)	large, very attractive, similar to Minerva.
Athena	63	SW (RG)	firm flesh, good shipper.
Minerva	65	SW (RG)	large, very attractive fruit

* Days from transplanting to first fruit harvested.

Cantaloupe seeds were seeded in plug trays and grown in the greenhouse for three weeks before transplanting on June 12. Cultivars were replicated four times with five plants per plot (3 feet between plants) in a randomized complete block design. Each replication was 15 feet long with rows that were 7 feet from center to center. Soil test results are shown in Table 2.

Table 2. Soil test results for muskmelon trial field at Quicksand, Ky., 2001.

pH	P	K	Ca	Mg	Zn
6.3	132	335	5167	254	15.5

We applied 50 lb/acre actual N and 100 lb/acre K_2O fertilizer preplant. An additional 50 lb actual N in the form of ammonium nitrate fertilizer was applied through the drip irrigation system. Curbit 3E and Gramoxone Extra (2.5) at 4 pints and 2 pints respectively were used for weed control between the plastic mulch strips two weeks after transplanting. One application of Poast 1.5 E at 2 pints/acre was applied as a spot treatment later in the season for control of annual grasses. Insect and disease controls were applied as needed.

Results

There was a significant difference in average fruit number per acre and average fruit size (Table 3). There was no statistically significant difference among cultivars in pounds of fruit produced per acre. Athena produced significantly more fruit per acre than Vienna or Minerva but was not different from the other three melons. Athena also produced fruit that were significantly

Table 3. Yields and quality of muskmelon cultivars at Quicksand, Ky., 2001; data are means of 4 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.

smaller than the other five cultivars. In roadside sales at a local fruit stand, customers chose (based on appearance) Minerva first, followed by Eclipse and RAL- 8793VP. When not displayed at the same time, Athena also sold well. Vienna and Odyssey did not sell well. In a taste and appearance rating using cut melon cubes, Athena, Minerva, and Eclipse were all rated highly by the participants. No one liked Vienna; Odyssey was not tested. At roadside stands, Eclipse, Minerva, and RAL 8793 VP would receive premium prices. Yield and fruit quality still make Athena the melon to beat for wholesale markets. Additional tests are planned for next year.

Table 4. Informal muskmelon taste test results at Quicksand, Ky., 2001; data are averages from six tasters using a scale of 1-10 (1 = poor and 10 = excellent).

Cultivar	Smell	Taste	Texture	Comments
Eclipse	5.0	6.2	7.2	Pretty looking, very good taste.
Odyssey*	na	na	na	na
Vienna	3.8	1.0	4.8	Poor, no taste or smell
RAL 8793-VP	5.7	6.8	5.8	Sweet, good taste
Athena	6.3	6.0	6.8	Good taste
Minerva	6.0	5.3	6.3	Good smooth taste

* Odyssey was not available at the time of the evaluation.

Specialty Melon Variety Observation Trial

John Strang, April Satanek, R. Terry Jones, Ric Bessin, Dave Lowry, Bonnie McCaffrey, Spencer Helsabeck, and John Holden, Department of Horticulture

Introduction

In this trial, a number of specialty melon varieties were evaluated in single (non-replicated) plots: honeydew, honeydew/cantaloupe hybrid, casaba, Christmas, canary, charentais, ananas, and others. These melon varieties vary considerably in taste, color, and size. All are very susceptible to bacterial wilt, making them very difficult to grow in Kentucky. The primary objective of this study was to see if these varieties could be grown using the newly approved soil insecticide Admire 2F for cucumber beetle and bacterial wilt control. These melons have the potential to become a high quality specialty item for local markets. This preliminary trial was not replicated since it was meant to eliminate poor cultivars and to identify promising cultivars worthy of further investigation.

Materials and Methods

Seeds of 20 specialty melon cultivars were planted in cell packs (72 cells per tray) on April 24 and May 10 in a greenhouse at the Horticulture Research Farm in Lexington; cell packs were set on a mist bench with bottom heat for germination. After germination, seedlings were thinned to one plant per cell and moved to a drier, cooler location. Plants were set into black plastic mulched, raised beds using a waterwheel setter on May 17 and May 29. Each plot was 45 feet long with 15 plants set 3 feet apart within the row. Rows were 6 feet apart. Drip irrigation was used to provide water as needed based on tensiometer readings.

One hundred and fifty lb/A of ammonium nitrate (50 lb N/acre) was applied and incorporated prior to planting. The plot was fertigated with a total of 13 lb N/A as ammonium nitrate

Table 1. Specialty melon fruit characteristics from single plots at Lexington, Ky., 2001.

Variety	Seed source	Days to harvest	Yield (cwt/A)	Culls (No./A)	Avg. wt/fruit (lb)	Exterior Fruit length (in.)	Exterior Fruit width (in.)	Flesh thick. (in.)	Seed cavity length (in.)	Seed cavity width (in.)	Disease incidence (%)[1]	Sugar (%)	Flavor (1-5)[2]
Creme de Menthe	SS	82	556	2,097	6.5	9.0	7.6	1.7	6.0	4.2	15	11.8	3.5
Sundew	SS	85	554	1,613	5.9	8.1	7.3	1.9	5.1	3.7	5	12.6	3.9
Honey Brew	RU	90	453	3,387	8.3	9.2	7.5	1.9	6.0	3.9	20	14.2	4.5
Sonora	RU	90	425	1,613	4.7	7.7	6.5	1.8	4.5	3.1	35	11.8	4.3
Dorado	SW	85	414	323	5.6	8.6	6.8	1.9	5.2	3.0	15*	13.5	4.8
Honey Gold	HM	85	414	323	6.1	7.8	6.9	1.7	5.1	3.4	5	13.4	3.9
St. Nick	HR	84	344	323	8.5	10.5	7.4	1.9	7.4	3.6	10	13.0	4.5
Passport	HL/RU	75	327	2,742	4.3	7.0	6.7	2.0	3.8	2.7	50*	8.8	2.8
Mary Gold	RU	92	308	161	3.4	7.0	5.7	1.6	4.5	2.5	20	12.6	3.5
HSR 2528	HL	95	288	484	3.8	8.7	6.2	1.6	5.9	3.1	5	11.8	4.5
Sun Jewel	JS	68	269	2,097	1.6	7.4	3.7	1.0	5.8	1.9	10	12.5	2.0
Gallicum	HR	80	257	5,162	3.9	6.2	6.0	1.8	3.9	2.5	15*	13.4	3.5
HMX0580	HM	80	237	3,065	5.4	8.0	6.0	1.7	5.1	2.6	20*	11.7	3.0
HSR 2527	HL	75	231	3,549	4.1	6.6	6.4	1.6	4.0	3.1	40	10.4	3.3
HMX 9606	HM	85	169	2,581	2.4	5.3	5.1	1.5	3.6	2.3	5	12.9	3.0
Earli Brew	SW	93	160	2,097	4.0	7.5	7.0	1.8	4.9	3.4	70	9.8	3.1
French Orange	HR	75	132	10,162	2.2	5.0	4.6	1.4	3.0	1.9	30	13.0	3.8
Early Hybrid Crenshaw	BU/SW	90	120	2,258	4.7	8.2	7.2	1.9	5.0	3.5	75	11.3	3.9
Dove	HL	75	104	4,839	4.3	7.1	6.0	1.8	4.4	2.5	30	14.8	4.0
Alienor	RU	80	53	4,194	2.8	5.7	5.2	1.4	3.9	2.5	80	7.3	2.0

[1] Estimated percentage of plant affected by anthracnose.
* Bacterial wilt disease also found.
[2] 1 = poor, 5 = excellent sweet taste, pleasant texture.

Table 2. Specialty melon fruit and vine characteristics from single plots at Lexington, Ky., 2001

Variety	Melon Type[1]	Flesh Color[2]	Rind Color[3]	Fruit Shape[4]	Cracking (1-4)[5]	Net Type[6]	Comments
Creme de Menthe	HD	lg - mg	lt gr	Ov	2.0	na	Doesn't slip, fruit checks with maturity, variable palatability, vines look good.
Sundew	HD	lg - mg	lt gr	Ov	2.0	na	Doesn't slip, fruit looks good, surface checking, and yellowing, fuzzy exterior.
Honey Brew	HD	lg - dg	lt gr	Ov	2.0	na	Doesn't slip, skin checking when ripe, fuzzy fruit, vines held up
Sonora	CA	cr - lg	dk yl	Ob	2.0	lt	Doesn't slip, bright yellow exterior, surface checking, vines held up well.
Dorado	CA	cr - lg	dk yl	Ob	1.0	lt	Doesn't slip, bright yellow exterior, excellent quality fruit, highly rated by local chefs vines look good, chefs, vines did not hold up.
Honey Gold	HD	lo	lt gr	Ov	1.0	na	Doesn't slip, thick green rind, firm, crunchy flesh, excellent vines.
St. Nick	CR	cr - wh	dk gr w/ lt gr streaks	Ob	1.0	md	Doesn't slip crisp flesh, produces over a long period, vines held up well, pick immature for better storage.
Passport	GA	lg - mg	tn/yl	Ro	4.0	hv	Stem slips when ripe, many fruit split open, vines held up medium, severe anthracnose.
Mary Gold	CS	lg - cr	dk yl	Ro	1.0	lt	Doesn't slip, wrinkly exterior, vines look good.
HSR 2528	AN	cr - gr	cr/yl	Ob	1.5	hv	Stem slips when ripe, heavy, dense melon, excellent quality.
Sun Jewel	AS	wh - cr	md yl w/wh sutures	Ob	4.0	na	Stem slips when ripe, fruit taste more like cucumbers and crack severely, produces over long time, vines very disease resistant.
Gallicum	GA	lg	tn/yl	Ro	2.5	hv	Stem slips when ripe, vines look good.
HMX0580	CA	cr - or	dk yl	Ob	2.0	lt	Doesn't slip, some chlorosis in leaves.
HSR 2527	AN	cr	tn/yl	Ro	1.5	hv	Stem slips when ripe, a lot of variation is fruit size, severe anthracnose.
HMX 9606	CH	do	tn/yl w/gr sutures	Ro	2.5	md	Harvest at half slip, melon firm to cut, thin rind, difficult to tell when ripe.
Earli Brew	HD	lg/cr	lt gr	Ro	2.0	na	Doesn't slip, attractive interior, plants lost to anthracnose.
French Orange	CH	do	tn/yl w/gr sutures	Ro	4.0	hv	Pick at half slip, firm, high quality, deep orange flesh, highly rated by local chefs, fruit splits in wet weather.
Early Hyb. Crenshaw	CN	mo	lt gr	Ro	3.0	na	Doesn't slip, lost a lot to decay in wet weather, lost about ½ the vines.
Dove	AN	lo - lg	tn/yl	Ob	4.0	md	Stem slips when ripe, lost majority of fruit to disease.
Alienor	CH	mo	tn/yl w/gr sutures	Ro	4.0	lt	Stem slips when ripe, fruit cracks open and decays before ripening in wet weather, vines did not hold up.

1 Melon Type HD = honeydew, CA = canary, CR = Christmas, GA = galia, CS = casaba, AN = ananas, AS = Asian, CH = charentais, CN = crenshaw
2 lg = light green, dg = dark green, cr = cream, wh = white, or = orange, mo = medium orange, lo = light orange, gr = green
3 lt = light, md = medium, dk = dark, gr = green, yl = yellow, tn = tan, cr = cream, wh = white
4 Ov = oval, Ob = oblong, Ro = round
5 1 = little or no cracking, 4 = severe cracking and fruit splitting
6 lt = light netting, md = medium netting, hv = heavy, raised netting, na- none.

divided into two applications. The systemic insecticide Admire 2F was applied to the base of each plant immediately after setting, using the maximum rate of 24 fluid ounces per acre. Foliar insecticide and miticide applications during the season included Sevin, Pounce, Asana, and Kelthane. Fungicide applications included Bravo and Quadris. Plots were scouted twice a week to determine the need for pesticide applications. A preemergence herbicide application of Curbit was applied and incorporated between the rows, just as vines began to cover the plastic.

Results

The use of Admire at the high rate resulted in very little plant loss despite extremely high early season cucumber beetle populations. Admire made it possible to grow some types of highly susceptible specialty melons in Kentucky. The 2001 growing season was not abnormally wet, although significant amounts of rain occurred early in the season. As a result, the first melon harvest produced many decayed fruit and resulted in low melon sugar contents (Table 1). Later harvests, as the weather turned drier, had improved yields, appearance, and sugar contents. Some melons did not "slip" at maturity (honeydew/cantaloupe hybrids) and were difficult to harvest at the correct stage. Some varieties cracked, split, and decayed and were judged as not being acceptable for production in Kentucky. Although early vine coverage was full and lush, anthracnose became a problem later in the season.

Honeydew type. The best overall honeydew type melons were Honey Brew, Sundew, and Honey Gold. Honey Brew was judged to be the best honeydew melon in the trial due to its exceptional flavor and large fruit size (Table 1). Sundew was a high yielding variety, with a high sugar content and good disease tolerance/plant survival. Honey Gold had good plant survival in the field and had light orange flesh with a green rind (Table 2) and was judged worthy of further trial. All of the honeydew type melons showed surface checking (Table 2). Creme de Menthe was the highest yielding honeydew, but the distinctive, slight mint flavor was not universally acceptable to our tasters. Earli Brew, an early maturing honeydew type, cracked severely, and the plants succumbed to disease quite early.

Canary (San Juan Canary) type. Dorado was one of the best melons in this category and in the trial. It was an attractive gold color and had a high yield with an excellent taste and few culls. Sonora also yielded well, despite increased disease incidence; however, this variety showed skin checking and was not as attractive externally as Dorado. Mary Gold, a casaba type melon, is smaller and rounder than canary melons but is often sold as a canary melon. It did not have the quality of the other two.

Miscellaneous melon recommendations. St. Nick, a long storage melon, produces over a long period and had a high sugar content with crispy, tasty flesh. HSR 2528 is an ananas type melon that matures late. When ripe, it has an excellent aroma and sweet flavor and is a heavy, dense melon. None of the charentais type melons performed well, and they were judged unacceptable for field production in Kentucky. They showed severe cracking and disease problems and had a bland taste under wet weather conditions. However, local chefs raved about the quality of French Orange. Sun Jewel, an Asian melon, is not a melon in the American sense as its taste is more reminiscent of cucumbers.

Cucumber Beetle Control and Its Impact on Bacterial Wilt in Muskmelons

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Introduction

Striped and spotted cucumber beetles can cause serious losses in cucumbers and muskmelons (cantaloupes) in Kentucky. While the adults feed mainly on foliage, stems, pollen, and flowers, their feeding on melon rinds late in the season may reduce market quality. Cucumber beetles are a major concern to muskmelon and cucumber growers because the adults overwinter and vector the bacterium that causes bacterial wilt disease. This disease kills the vines and can severely limit cucumber and cantaloupe production if not managed effectively. While larvae of these insects feed on roots and stems and can cause some damage, this damage is minimal compared to the potential losses due to bacterial wilt.

Commercial melon producers must control cucumber beetles, particularly on young plants. Both species, the striped and the spotted cucumber beetles, are effective vectors of bacterial wilt. Until the early 1990s, growers were able to use Furadan 15G at planting to provide systemic beetle control and reduce the incidence of the disease. However, that insecticide was canceled on cucurbits due to environmental issues. Currently, producers rely on foliar insecticides applied at seven- to 10-day intervals to keep beetle numbers to a minimum. In 2000, a single-year study at UK indicated that a single application of the new systemic insecticide Admire, applied at 20 fluid ounces per acre as a post-transplant drench, provided cucumber beetle control comparable to five weekly foliar applications of Pounce. In 2001, we looked at the protection provided by different rates of Admire 2F applied as a post-transplant drench to Athena melons.

Materials and Methods

A study was conducted at the UK Horticultural Research Farm in Lexington during the summer of 2001 to evaluate the effectiveness of three different rates of Admire 2F for control of cucumber beetles on cantaloupes and the impact of that control on the incidence of bacterial wilt. Four-week-old Athena cantaloupe plants were transplanted into raised black plastic mulched beds with trickle irrigation on May 17 using a waterwheel setter. Plants were spaced 18 inches apart in single rows; beds were 6 feet from center to center. Each experimental plot consisted of four rows of 10 melon plants each. Between each plot, a 60-foot-wide band of corn was transplanted into the rows to reduce cucumber beetle movement between plots.

Admire 2F was applied at three rates (all as post-transplant drenches): 24 fl oz/A per acre (the maximum allowable labeled rate), 16 fl oz/A (minimum labeled rate), and 8 fl oz/A (half the minimum labeled rate), and there was an untreated control. All of the Admire treatments were applied directly to the soil at the base of the plants in 1/3 ounce of water on May 17 immediately after transplanting. The post-transplant drench was selected to minimize worker exposure to insecticide residues while trying to maximize rapid uptake of the insecticide for cucumber beetle control. The Admire was intentionally not mixed with the transplant water because this type of application is prohibited. The application methods used in this study are labeled for commercial use.

Prior to harvest, beetle numbers were monitored by periodically recording the number of striped and spotted cucumber beetles on five plants in each plot and by use of a yellow sticky card in the corner of each plot until plants had “vined” together. Plants within the plots were examined frequently for the occurrence of bacterial wilt (based on wilt symptoms and bacterial streaming) until harvest was complete. Data were subjected to analysis of variance, and means were compared using Fisher’s Protected LSD.

Results and Discussion

During the course of this study, the striped cucumber beetle was far more numerous than the spotted beetle and comprised more than 95 percent of the cucumber beetles observed. Generally, numbers of striped cucumber beetles were very high in early June and declined through late July. Yellow sticky card monitoring revealed differences in the number of striped cucumber beetles among treatments (Table 1). During all sampling periods, many more striped cucumber beetles were captured in untreated plots than in any of the Admire-treated plots. There was no significant difference in the number of cucumber beetles captured on yellow sticky cards among the different rates of Admire.

All of the Admire treatments significantly reduced the numbers of cucumber beetles on the plants through June 9 (Table 2). No significant differences were detected in the numbers of these beetles found on the plants among the different rates of Admire. The same results were observed with numbers of live cucumber beetles found on the plants.

This farm has a long history of serious bacterial wilt problems. A high level of bacterial wilt incidence was observed in this study, with more than 70 percent of untreated plants infected by the end of the study. The incidence of bacterial wilt was significantly higher in the untreated plots all season as compared to any Admire treatment. The incidence of bacterial wilt among Admire rates was not different until July 9 when the 8-ounce rate showed more disease (Table 3).

Yields were significantly higher in plots using the labeled rates (16 and 24 fl oz/A) of Admire (Table 4). The plots with the rate below the labeled minimum had significantly lower melon yields. This study indicates that a single application of the systemic insecticide Admire, when used at the full labeled rate of 16 to 24 fl oz/A as a post-transplant drench, provided effective cucumber beetle control for four to six weeks. These data are consistent with our standing recommendations that *cucumber beetle control is critical to bacterial wilt control*. It must be pointed out that there are alternative application methods listed for cucurbits on the Admire label, but these methods were not evaluated, and the levels of cucumber beetle control, bacterial wilt infection, and melon yields with those methods may not be similar to that obtained with the post-transplant drench method.

Cucumber beetle numbers and the potential threat from bacterial wilt can be highly variable from year to year and between farms in Kentucky. Although only one insecticide treatment was applied in this study, commercial producers should continue to monitor beetle numbers throughout the season and use foliar treatments as necessary if numbers begin to rise. As was reported last year, weekly foliar treatments of recommended insecticides for cucumber beetle control can be highly effective (see Extension publication ID-36, *Vegetable Production Guide for Commercial Growers*). In some instances, a combination of a systemic insecticide like Admire at planting followed by foliar sprays of a different insecticide may be necessary to maintain effective control. This may be the most economical strategy.

Table 1. Numbers of striped and spotted cucumber beetles per yellow sticky card at Lexington, 2001.

	Numbers of Striped and Spotted Cucumber Beetles[1]			
	24 fl oz Admire	**16 fl oz Admire**	**8 fl oz Admire**	**Untreated**
May 28	1.8 b	2.0 b	1.3 b	46.3 a
June 3	20.8 b	23.3 b	26.3 b	141.3 a
June 9	15.3 b	25.3 b	29.3 b	127.8 a
Jun 18	12.8 b	23.8 b	30.8 b	93.8 a
June 25	8.8 b	9.5 b	10.5 b	25.0 a

[1] Means within the same date (row) that are followed by the same letter are not significantly different (LSD>0.05).

Table 2. Numbers of striped and spotted cucumber beetles per 5 plants at Lexington, 2001.

	Number of Striped & Spotted Cucumber Beetles[1]			
Date	**24 fl oz Admire**	**16 fl oz Admire**	**8 fl oz Admire**	**Untreated**
May 22	0.0 b	0.0 b	0.0 b	6.5 a
May 28	0.0 b	0.3 b	0.0 b	9.5 a
June 3	0.3 b	0.0 b	0.3 b	29.3 a
June 9	1.3 b	1.8 b	3.8 b	25.0 a

[1] Means within the same date (row) that are followed by the same letter are not significantly different (LSD>0.05).

Table 3. Number of plants per plot (40 plants) that had collapsed due to bacterial wilt, Lexington, 2001.

Date	**24 fl oz Admire[1]**	**16 fl oz Admire**	**8 fl oz Admire**	**Untreated**
June 9	0.0 b	0.0 b	0.0 b	4.5 a
June 18	0.0 b	0.0 b	0.5 b	10.5 a
June 25	0.0 b	0.3 b	1.5 b	18.5 a
July 9	0.3 c	2.8 c	8.3 b	28.3 a
July 17	0.8 c	3.5 c	10.3 b	29.0 a

[1] Means within the same date (row) that are followed by the same letters are not significantly different (LSD >0.05).

Table 4. Numbers and weight of marketable fruit per plot (40 plants were initially transplanted into each plot).

Treatment	**24 fl oz Admire[1]**	**16 fl oz Admire**	**8 fl oz Admire**	**Untreated**
Number of Fruits	84.3 a	76.0 a	51.8 b	11.3 c
Weight of Fruits	447.1 a	398.9 a	256.9 b	56.0 c

[1] Means within rows followed by the same letter are not significantly different (LSD >0.05).

Seeded and Seedless Watermelon Variety Trial

John Strang, April Satanek, John Snyder, Darrell Slone, Dave Lowry, Larry Blandford, Spencer Helsabeck, John Holden, Bonnie McCaffrey, and Kirk Ranta, Department of Horticulture

Introduction

Watermelon varieties are introduced by seed companies every year. This trial evaluated seeded and seedless watermelons in order to determine what varieties grow best in Kentucky. Relatively new to the market are seedless, orange-fleshed watermelons that, along with yellow seedless watermelons, are slowly becoming more available and taste much like the traditional red-fleshed varieties.

Materials and Methods

Seeds of 18 seedless and six seeded watermelon varieties were planted in cell packs on April 27. The trays were then placed onto a bench with bottom heat in a warm greenhouse. Once germinated, germination rates were recorded, and the plants were thinned to one plant per cell using scissors. On May 31, the plants were set into raised, black plastic mulched beds with a waterwheel setter. Six plants were spaced 4 feet apart within the row, and rows were spaced 10 feet apart. Each plot was replicated three times, with 8 feet between cultivars. Drip irrigation was used to fertigate and irrigate as needed.

Nitrogen, phosphorus, and potassium were applied preplant to the fields as warranted by soil tests. Two fields out of the three used for watermelons received 150 lbs/A each of phosphate and potash, and 225 lbs/A of ammonium nitrate. The third field received 150 lbs/A of phosphate and 225 lbs/A of ammonium nitrate. A total of 60 lbs/A of ammonium nitrate was fertigated over four applications throughout the season. Irrigation was halted four weeks prior to the estimated harvest time to raise the sugar content of the melons. Admire 2F, a systemic insecticide, was applied to the planting hole immediately after setting the plants at the rate of 24 fl oz per acre. Other foliar insecticides and miticides applied during the growing season included Sevin, Pounce, Asana, and Kelthane. The fungicides Bravo and Quadris were used for disease control. Insect and disease scouting was used to help determine pesticide application timing. Curbit was applied and incorporated into the ground between beds prior to vine cover.

Results and Discussion

During planting and the week following, the weather was unseasonably cold and wet. About half of the plants showed transplant stress and grew slowly the first week. Although vine coverage was heavier than in past years, yield was slightly lower.

Seeded Watermelons

The best performing seeded watermelons in the trial were Stars N' Stripes, Sangria, Athens, and Mara (Table 1). Stars N' Stripes, a large, oblong melon with a distinct mottled rind, had the highest yield. Sangria has been an excellent variety in past years, and there is a tendency for the fruit to be slightly narrow at one end. Athens and Mara also performed very well, and Mara had very large fruit.

Seedless Watermelons

The best performing seedless red watermelons were Millionaire, Triple Prize, Revolution, RWT 8096, and Ultra Cool. Millionaire was the highest yielding and is an excellent round seedless melon with an average sugar content (Table 1). Triple Prize has performed very well in the past and has an exceptional taste (Table 2). It had some hollow heart. Revolution, an elongate, seedless melon, had an excellent taste and yield.

The best performing orange-fleshed seedless watermelon was Orange Sweet. Its flavor and yield were good, but Orange Sweet had more seeds than we would like to see.

Treasure Chest was the best yellow-fleshed seedless watermelon.

Table 1. Seeded and seedless watermelon variety trial yield and fruit characteristics, Lexington, Ky., 2001.

Cultivar	Germ. Rate (%)	Type[1]	Shape	Seed Source	Days to Harvest	Yield (cwt/A)[2]	Avg. No. Mkt Melons per A	Avg Mkt Wt (lb)	No. Melons/A <10 lb	Outside Measurements Length (in.)	Outside Measurements Width (in.)	Rind Thick. (in.)	Sugar (%)
Stars N' Stripes	98	S	elongate	S	85	1290 a	5700	23.1	71	17.7	9.1	0.7	10.8
Sangria	95	S	elongate	SW	87	1220 ab	5400	22.8	0	16.8	8.7	0.7	12.1
Millionaire	82	T	round	HM/SW	92	1200 abc	8900	13.4	0	11.7	10.0	1.0	10.4
Athens	99	S	elongate	SS/SI	82	1110 abcd	4800	17.7	0	14.9	9.4	0.7	11.0
Mara	98	S	elongate	SI	85	1070 abcd	4400	24.7	0	15.2	9.6	0.7	11.4
Triple Prize	37	T	round	SW	85	980 abcdef	6300	15.3	653	11.2	10.3	0.8	11.4
Revolution	76	T	elongate	SS	82	930 bcdefg	4600	16.0	218	13.8	9.0	0.8	11.8
RWT 8096	64	T	oval	ST/RG	85	910 bcdefg	5900	15.5	0	11.4	9.0	0.7	11.5
Orange Sweet	64	T	round	SI	84	900 bcdefg	5200	17.1	71	10.5	10.0	0.7	10.2
Ultra Cool	41	T	round	SI	75	900 bcdefg	6300	14.3	290	9.8	9.7	0.7	12.1
Millenium	91	T	round	SW/HM	78	700 bcdefg	7000	13.0	582	10.7	8.7	0.6	11.6
Sterling	67	T	elongate	SW	92	870 cdefg	5000	17.3	0	14.7	8.1	0.8	11.2
Triple Crown	22	T	round	SW	85	860 cdefg	5700	15.1	0	11.4	9.9	0.8	11.5
Treasure Chest	61	T	round	RU	80	850 defg	6500	13.0	507	9.2	9.5	0.7	10.8
Crimson Jewel	71	T	round	RU	83	820 defg	6100	13.6	146	10.1	9.4	0.6	11.3
Crimson Delight	96	S	round	SW	75	820 defg	3500	24.0	0	11.5	11.1	0.6	10.9
Constitution	74	T	round	SS	80	800 defg	5400	14.1	290	10.0	9.2	0.7	11.6
Samuri	65	T	round	SI	85	790 defg	5000	15.6	436	12.1	9.7	0.7	11.6
Freedom	80	T	elongate	SS/SI	85-90	780 defg	5000	15.9	146	14.1	9.1	0.7	11.1
Buttercup	59	T	round	JS	85	750 efg	6300	11.7	1160	9.2	9.5	0.6	9.7
Imagination	40	T	round	SI/RG	85	720 fg	5900	12.3	0	9.8	9.1	0.6	11.1
Orange Sunshine	58	T	round	SI	85	670 fg	5200	12.8	290	10.2	9.9	0.8	10.9
Black Majic	99	S	elongate	SI	85	620 g	4400	14.2	71	9.6	9.3	0.5	9.4
4052 Seedless	58	T	round	SW	85	600 g	3300	18.3	2243	11.1	10.3	0.7	11.0

1 Melon Type S = Seeded, T = Triploid (seedless)

2 Numbers followed by the same letter are not significantly different (Duncan Waller LSD P = 0.05). Marketable yields are based on all melons larger than 10 pounds.

Table 2. Seeded and seedless watermelon variety trial fruit characteristics, Lexington, Ky., 2001.

Variety	Uniform. of Size (1-5)[1]	Uniform. of Shape (1-5)[2]	Hollow Heart (1-2)[3]	Flavor (1-5)[4]	Avg. Seed No./fruit	Interior Color[5]	Rind Type[6]	Comments
Stars N' Stripes	4	4.3	2.0	4.3	na	red	CS	Attractive interior, juicy, not many seeds, rind has distinctive mottling,"stripes."
Sangria	3.5	3.6	1.8	4.6	na	red	AS.	Attractive interior, some strings in flesh, flavorful.
Millionaire	3.2	3.4	2.0	4.0	3.3	red	CS	Tiny seeds (3/16 in.) if present, nice flesh texture, flesh a little tough, some sunscald.
Athens	4.3	4.0	2.0	4.1	na	dk pink	CS	Attractive interior, crispy tender textured flesh.
Mara	3	3.7	2.0	4.2	na	red	RS	Attractive, crisp, tender flesh, most fruit are jellybean-shaped.
Triple Prize	2.8	3.5	1.5	4.5	2.0	red	dk CS	Slightly tough flesh, attractive exterior.
Revolution	2.5	3.5	1.8	4.5	5.0	red	RS	Attractive interior.
RWT 8096	3.5	3.3	2.0	4.4	0.8	red	CS	Very tender flesh.
Orange Sweet	2.7	3.4	1.8	3.8	14.3	orange	JU	Flesh is a bit chewy, firm flesh, attractive interior, orange color varies in intensity throughout. Some BRN[7].
Ultra Cool	2.7	3.5	2.0	4.1	1.3	red	RS	Variability in rind thickness, attractive interior, somewhat chewy.
Millenium	2.8	2.5	2.0	4.2	1.3	pk red	BK	Very slight ribbing, tough rind.
Sterling	2.5	3.0	1.3	3.9	1.8	dk pink	AS	Slightly tough flesh, uncharacteristic low yield this season.
Triple Crown	2.7	3.5	1.7	4.2	2.3	lt red	RS	Firm, chewy flesh.
Treasure Chest	3.3	2.5	2.0	3.9	2.8	br yl	JU	Attractive interior and exterior, firm flesh, dark seed traces.
Crimson Jewel	2.8	3.4	2.0	4.4	2.3	pk red	dk CS	Tender, sweet, attractive red flesh.
Crimson Delight	2.3	3.5	2.0	4.1	na	dk pink	CS	Tender flesh, very juicy, delicate texture and taste.
Constitution	2.9	3.3	2.0	4.3	0.5	pk red	AS	Fibrous material in flesh, tough seed traces, thin rind, tender flesh.
Samuri	2.5	3.0	1.5	4.3	0.8	red	RS	Tender flesh, juicy, little chewy, nice red color. Some BRN[7].
Freedom	3.0	4.0	2.0	4.2	0.8	red	dk JU	Very attractive exterior and beautiful interior, nice texture.
Buttercup	3.0	3.0	2.0	3.4	1.5	br yl	JU	Very attractive interior, dark seed traces, firm flesh. Some BRN[t.]
Imagination	3.0	4.0	2.0	4.1	6.0	dk red	BK	Attractive interior and exterior, skin has slight white bloom, tender, attractive red flesh, wide difference in taste preferences. Some BRN[7].
Orange Sunshine	3.0	3.5	1.8	3.9	9.8	orange	RS	Very slight hollow heart, seeds gray and numerous.
Black Majic	3.0	4.3	2.0	3.4	na	dk pink	BK	Very thin rind, attractive interior, some fibrous strands in flesh.
4052 Seedless	3.0	4.0	1.8	4.1	4.8	red	CS	Many off types, some fibrous areas in flesh, crispy flesh. Some BRN[7]

1 Fruit Size Uniformity 1 = great variation in size, 5 = all the same size.
2 Fruit Shape Uniformity 1 = great variation in shape, 5 = all the same shape.
3 Hollow Heart Rating 1 = hollow heart, 2 = no hollow heart.
4 Informal taste test ratings: 1 = poor, 5 = excellent.
5 Flesh Color lt = light,dk = dark, pk = pink, br = bright, yl = yellow.
6 Rind Type AS = Allsweet, medium green rind w/dark green, broad mottles stripes; JU = Jubilee, light green rind w/distant, narrow, dark green. stripes; BK = Black, solid dark green rind; CS = Crimson Sweet, light green rind w/mottled, dark green stripes; RS = Royal Sweet, light green. rind w/wide, mottled, dark green stripes.
7 BRN = Bacterial rind necrosis.

Watermelon Variety Observation Trial

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Introduction

This observation trial with seeded and seedless (triploid) watermelon varieties was conducted on the Kentucky State University Research Farm in Franklin County. In this trial, the productivity of two seeded and eight seedless varieties were evaluated according to size and marketable yields.

Materials and Methods

Seeds were planted on April 24, 2001, and on June 7 the seedlings were transplanted by hand into raised, plastic mulched beds. Field preparation consisted of moldboard plowing and two subsequent rototilling operations. Each row (raised bed) was 12 feet apart, and the single plots within each row were 30 feet long and consisted of 10 plants spaced 3 feet apart. Prior to the laying of plastic mulch, nitrogen fertilizer in the form of ammonium nitrate was banded within each row at a rate of 50 lbs N/A. A midseason application of N was also applied by fertigation at a rate of 20 lbs N/A.

Weed control between beds was accomplished by cultivation and a banded application of Curbit at three weeks after transplanting. Foliar applications of the insecticide Pounce and fungicide Bravo were applied as needed to control insects and diseases.

Results

Rains in late May and early June coupled with mild temperatures delayed planting until the first week of June. Three harvests were conducted from August 16 through September 6. These late summer harvests may have caused the apparent high number of small melons (culls) at the end of the season. However, the summer was generally dry with mild temperatures, and plant vigor was high for all varieties up through the last harvest in early September.

Triploid Watermelons. The highest yielding seedless varieties in terms of marketable melons (> 10 lbs) were Triple Prize, Millionaire, and Millennium (Table 1). Triple Prize was also a top performer in variety trials conducted at the University of Kentucky's Horticulture Research Farm at Lexington in 1999 and 2000. Millionaire appeared to have slightly larger melons, so its overall yield (total weight per acre) was slightly higher than Triple Prize. The worst performing variety was Sterling. In the case of Sterling there appeared to be no pollination and fruit development.

Seeded Watermelons. The highest yielding seeded variety in terms of number of melons per acre (> 10 lbs), average melon weight, and total yield per acre was 'Stars and Stripes'.

Table 1. Yields of seeded and seedless watermelon varieties from single plots in Franklin County, Ky., 2001.

Variety	Melon Type[1]	Germ. %	Seed Source	Days to Harvest	Mkt. Melon Wt/A (>10lb)	No. mkt. Melons/A	Avg. Mkt. Melon Wt. (lb)	No. culls/A (<10lb)	Outside Measurements Length (in.)	Outside Measurements Width (in.)	Rind Thickness (in.)
Stars and Stripes	S	98	AS	85	107230	5082	21.1	605	14.3	8.2	0.6
Anthem	S	99	SS/SI	82	74415	3630	20.5	726	13.3	8.2	0.6
Millionaire	T	82	HM/SW	92	79279	4356	18.2	302	11.0	90.3	0.5
Millennium	T	91	HM/SW	78	50906	4168	12.2	402	9.3	8.0	0.4
Revolution	T	76	SS	82	52514	2420	21.7	242	14.0	10.1	0.6
Triple Prize	T	37	SW	85	68458	4437	15.4	121	10.1	8.9	0.5
Orange Sweet	T	64	SI	84	63621	2662	23.9	0	13.8	9.6	0.5
Freedom	T	80	SS/SI	85-90	59145	3146	18.8	847	13.0	8.0	0.6
Buttercup	T	59	JS	85	43451	2541	17.5	484	9.9	9.7	0.4
Sterling	T	67	SW	92	0	0	0	0	0	0	0

[1] Melon Type S = Seeded, T = Triploid (seedless).

Acorn and Specialty Winter Squash Variety Evaluation

John Strang, April Satanek, John Snyder, Darrell Slone, Dave Lowry, Larry Blandford, Spencer Helsabeck, and John Holden, Department of Horticulture

Introduction

Acorn squash are perennial fall favorites found at any fresh produce stand. They can also be found in markets year around. Acorn squash are situated at the top of winter squash sales. The typical acorn squash is dark, black-green, acorn-shaped, and firm. Recent cultivars have included orange and cream-colored acorn squash. This trial was conducted at the University of Kentucky Horticultural Research Farm in Lexington to determine the best acorn squash varieties for Kentucky growers. Due to wet conditions and high insect populations early in the season, this trial also showcased some of the various cultivars' disease tolerance and plant survival under less than optimal growing conditions.

Methods and Materials

On May 16, 11 acorn squash and seven assorted squash varieties were double-seeded into 72-cell trays in a greenhouse at the Horticulture Research Farm at Lexington. Once germinated, the plants were thinned to one plant per cell. On June 12, squash plants were set into raised, black plastic mulched beds with a waterwheel setter. Six plants were set 4 feet apart within the row, in rows 10 feet apart, with 8 feet between plots. Each plot was replicated four times. Drip irrigation was used to provide water and fertilizer during the season.

Plots received a preplant application of 150 lbs/A of ammonium nitrate; two replications also received an additional 150 lbs/A of potash as warranted by soil tests. During the growing season, a total of 12 lbs N/A was fertigated using ammonium nitrate in three applications. Insecticide and miticide applications included Sevin, Pounce, Asana, and Kelthane. Quadris was applied for disease control. Curbit was applied and incorporated between the beds just prior to vine coverage for weed control. One replication was treated with Basagran prior to planting to control a yellow nutsedge infestation. Plots were scouted weekly, and plants were harvested on August 17 and September 18. Single fruits from each replication at the first harvest were measured and evaluated for quality.

Results

Bacterial wilt was evident four weeks after setting the plants. Cucumber beetles were present at planting, and squash bugs followed shortly thereafter. A number of the plants died prematurely, and the fruit failed to mature. Despite difficult growing conditions, some varieties survived these diseases and insect pests and yielded well.

Acorn squash. Heart of Gold and Carnival were the top producing acorn squash types in the trial (Tables 1 and 3). These cultivars are decorative as well as edible. The exteriors of these squash are cream colored with dark green, mottled stripes. Carnival also has occasional orange patches. Heart of Gold had an excellent flavor. Table Ace and Tay Belle PM were the two best "traditional" dark green acorn squash. Plants of Table Ace held up well and Tay Belle PM, despite high cull numbers and some dead plants, still produced a good yield. Cream of the Crop is a beautiful, cream-colored squash. Table Gold is a very attractive, dark orange acorn squash.

Spaghetti squash. Small Wonder, a small, oval squash, produced very well; the plants held up throughout the season and the fruit consistently looked good (Tables 2 and 4). Hasta-La-Pasta, a larger, bright orange, oblong-fruited plant, succumbed to disease before most fruit matured, creating a lot of decayed fruits, though it did produce some quality fruit.

Kabocha squash. Both cultivars of kabocha squash yielded well, and the vines held up for the entire season. Both Sweet Mama and Delica had dry, extraordinarily sweet flesh. These varieties were considered an excellent substitute for sweet potatoes. The kabocha squash in this trial were harvested later than the other types and sustained some melonworm damage, increasing the number of culls.

Miscellaneous squash. Delicata is an excellent tasting, small, elongated squash. Sugar Loaf is oblong in shape, smaller, and tan, with green mottled stripes. Although both had excellent taste, quality fruit, and convenient serving sizes, they were not heavy producers. Sweet Dumpling had an excellent quality and sweet flesh, but it also had a low yield.

Table 1. Acorn squash yield and fruit characteristics, Lexington, Ky., 2001.

Variety	Seed Source	Days to Harvest	Yield (cwt/A)[1]		No. Mkt Fruit/A	Avg. Fruit Wt (lb)	Fruit Length (in.)	Fruit Width (in.)	Flesh Thick. (in.)	Culls (%)
Heart of Gold	SW	90	209	b	14100	1.5	4.1	4.9	0.8	3
Carnival	HR	85	193	bc	13800	1.4	4.1	4.9	0.8	4
Table Ace	HR	85	148	bcdef	9200	1.6	4.8	4.5	0.7	7
Tay Belle PM	S	70	140	bcdef	10700	1.3	5.5	4.9	0.9	11
Cream of the Crop	SW, HR	85	121	cdefg	7500	1.6	5.1	4.4	0.9	27
Mesa Queen	HL, SW	70	120	cdefg	7900	1.2	4.9	4.6	0.8	12
HMX 9736 PM	HM	75	95	efg	7900	1.2	4.4	4.3	0.7	4
Table Gold	SW	95	93	efg	8000	1.3	4.6	4.0	0.7	14
Table Queen	SW	90	80	efg	5900	1.3	5.0	4.4	0.7	16
Tuffy	JS	90	78	fg	6800	1.2	4.9	4.3	0.8	34
Table King	RU	80	55	g	5400	1.0	4.7	3.6	0.7	64

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

Table 2. Specialty winter squash yield and fruit characteristics, Lexington, Ky., 2001.

Type Variety	Seed Source	Days to Harvest	Yield (cwt/A)[1]		No. Mkt Fruit/A	Avg. Fruit Wt (lb)	Fruit Length (in.)	Fruit Width (in.)	Flesh Thick. (in.)	Culls (%)
Spaghetti										
Small Wonder	SW	90	374	a	21300	1.8	5.2	4.9	1.0	7
Hasta-La-Pasta	SW	80	184	bcd	8800	2.1	7.7	4.2	0.8	11
Kabocha										
Sweet Mama	SW	75	189	bc	5100	3.7	4.3	7.1	1.4	10
Delica	RU, HR	75	160	bcde	4800	3.4	3.9	7.0	1.2	8
specialty										
Delicata	HR/JS	100	125	cdefg	13400	0.9	7.2	2.7	0.6	21
Sugar Loaf	SW	100	108	defg	12000	0.9	5.1	3.2	0.7	24
Sweet Dumpling	HR, SW	100	80	efg	7900	1.0	3.9	4.0	0.7	10

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

Table 3. Acorn squash fruit and vine characteristics, Lexington, Ky., 2001.

Variety	Outside Color[1]	Inside Color[2]	Taste (1-5)[3]	Fruit Uniformity (1-5)[4]	Vine Size[5]	Comments
Heart of Gold	cr w/dg stripes	lor	4.2	2.8	Lv	Attractive fruit, orange ground spot, vines held up well.
Carnival	variable	lor	3.5	2.8	Sv	Attractive exterior (decorative), majority are cream colored with dark green mottled stripes and orange patches.
Table Ace	dg	y- or	3.2	3.8	Sv	Attractive exterior, heavy fruit, plants held up well.
Tay Belle PM	dg	mor	4.1	4.0	B	Attractive exterior, large fruit, light flesh color, thick, smooth flesh.
Cream of the Crop	cr	cr	2.7	4.3	B	Majority of plants succumbed to disease, many culls from sunburn/rot.
Mesa Queen	dg	mor	4.2	3.0	Sv	Sweet, fibrous, dark orange flesh, vines died in one rep.
HMX 9736 PM	dg	mor	3.7	3.1	B	Numerous culls due to sunburn/rot, vines didn't hold up.
Table Gold	dk or	dor	3.3	3.2	B	Very bright orange exterior, some with yellow stems.
Table Queen	dg	mor	3.9	3.1	Sv	Rind not colored well, sweet, fine texture, many vines died.
Tuffy	dg	y-or	4.4	3.0	Sv	Deeply grooved, slightly long and narrow for an acorn squash, dry, fine grained flesh, nice squash flavor.
Table King	dg	y-or	3.8	2.5	B	Unattractive, color variable, sunburned, small, poor quality fruit.

1 Outside color cr = cream, dg = dark green, or = orange, variable = see comments
2 Inside color l = light, m = medium, d = dark, or = orange, y = yellow, cr = cream, abl = yellow
3 Informal taste test scores: 1 = bland, unpleasant taste, 5 = sweet, pleasant consistency
4 Fruit uniformity 1 = extremely variable, 5 = very uniform
5 Vine size Lv = large vine, Sv = small vine, B = bush

Table 4. Miscellaneous squash fruit and vine characteristics, Lexington, Ky., 2001.

Type Variety	Outside Color[1]	Inside Color[2]	Taste (1-5)[3]	Fruit Uniformity (1-5)[4]	Vine Size[5]	Comments
Spaghetti						
Small Wonder	md or	y-or	3.3	4.3	Sv	Nice looking fruit, vines and fruit held up well.
Hasta-La-Pasta	dk or	mor	3.6	3.3	Sv	Very good orange color outside and inside, many fruit did rot.
Kabocha						
Sweet Mama	dg w/ lg stripes	dor	4.5	3.6	Lv	Nice fruit, very large seeds.
Delica	dg w/ lg stripes	dor	4.6	3.9	Lv	Attractive, very sweet flavor with a nice texture, vines held up well.
specialty						
Delicata	cr w/dg stripes	lor	4.1	3.1	Sv	Attractive fruit, vines held up well.
Sugar Loaf	tn w/ dg stripes	lyl	4.2	1.6	Sv	Attractive fruit, sweet dry flesh, vines held up very well.
Sweet Dumpling	cr w/dg stripes	dyl	4.5	2.8	Sv	Attractive exterior, excellent taste, all plants died in one rep.

1 Outside color dg = dark green, lg = light green, md = medium, cr = cream, dk = dark, or = orange, tn = tan.
2 Inside color l = light, m = medium, d = dark, or = orange, y = yellow, cr = cream.
3 Informal taste test scores: 1 = bland, unpleasant taste, 5 = sweet, pleasant consistency.
4 Fruit uniformity 1 = extremely variable, 5 = very uniform.
5 Vine size Lv = large vine, Sv = small vine, B = bush.

Sweet Corn Cultivar Evaluation for Northwestern Kentucky

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Introduction

The objective of this study was to compare 22 sugary-enhanced (*se*) sweet corn cultivars and the standard (*su*) cultivar Silver Queen for direct market use by evaluating plant, ear, yield, and flavor characteristics.

Materials and Methods

The selected plot area was established on a Loring silty clay soil. In late April, the plot was disked, and 250 lb/A of 15-15-15 and 220 lb/A of 34-0-0 (NH_4NO_3) were applied. The pH was 6.2, and no lime was added. The plot was separated into three sections so that sweet corn of different colors could be segregated, reducing or preventing cross-pollination. The plot was planted on May 10, consisting of rows 20 feet long and 3 feet apart with 50 seeds planted per row for a desired final stand of 30 plants per row. Germination, while delayed by weather conditions, was good for all varieties, and plants were manually thinned to 30 plants per row. The experimental design was a randomized complete block with four replications. Following planting, atrazine + metolachlor (Bicep 6L) at 1.2 + 1.5 lb ai/A, respectively, was surface applied. Ammonium nitrate was sidedressed at 100 lb /A when plants reached 8 inches in height. Permethrin (Pounce 3.2EC) was used at 0.2 lb ai/A for insect control starting at the tassel stage followed by another application during ear development. Observations included plant height, ear height above ground, ear length and diameter, shuck cover, tip fill, yield, and average ear weight. An informal taste test was performed, sampling at least 20 ears of each variety.

Results and Discussion

White Corn Varieties. The performance of white sweet corn varieties is summarized in Table 1. The white variety 94H263 again proved to be an excellent early-maturing selection for ear length, marketable yield, and flavor. Likewise, Avalanche and Silver King were the top producers and best tasting late-maturing varieties.

Yellow Corn Varieties. The performance of yellow sweet corn varieties is presented in Table 2. Welcome, a new early-maturing yellow sweet corn variety, had good flavor but did very poorly in all other characteristics evaluated. The newer variety Gold Nuggets also had good flavor but did not yield as well as last year. Weather conditions at time of planting were very warm and dry. This was followed by unusually cool weather that caused a 1½-week delay in harvest of many early-maturing varieties tested. These weather conditions may have played a part in the extremely low yields of Welcome and Gold Nuggets. The varieties Honey Select and Bodacious proved again that they are all-around high yield and high quality yellow sweet corn varieties.

Table 1. White sugary-enhanced (se) and Silver Queen sweet corn plant, ear, yield and flavor characteristics in Henderson County, Kentucky, 2001.

Cultivar (Seed Source)	Maturity[1] (Days)	Plant Height[2] (in.)	Ear Height[3] (in.)	Ear Length (in.)	Ear Diameter (in.)	Shuck Cover[4] (in.)	Tip Fill[5] (in.)	Marketable Ears (no./plot)	Ave Wt. 5 Ears Husked (lb)	Flavor[6] (1-4)
94H263 (SW)	70	66 D-F[7]	17 D	7.1 C	6.2 A	2.5 C-D	0.0 A	24 A-C	2.1 C	3.4 A
Silver Princess(RG)	74	65 E-F	19 B-D	8.0 A-B	6.0 A-B	1.3 E	0.0 A	18 B-C	2.6 A	2.9 C-D
Faith (SW)	77	65 B	21 B-C	8.1 A-B	5.8 A-B	0.8 E	0.0 A	18 C	2.1 C	2.6 D
Imaculata (RU)	78	71 D-E	21 B-C	7.4 B-C	5.9 A-B	3.6 A	0.0 A	23 A-C	2.1 C	3.0 B-C
Fantasia (S)	78	79 B-C	22 B	7.1 C	5.6 B	3.3 A-B	0.2 A-B	24 A-B	2.1 C	2.7 C-D
Avalanche (RU)	78	74 C-D	20 B-C	7.8 A-C	5.7 B	1.3 E	0.0 A	28 A	2.3 B-C	3.5 A
Frosty (RU)	80	61 F	15 D	7.7 A-C	6.0 A-B	2.2 D	0.0 A	26 A	2.2 B-C	3.1 B-C
Silver King (SW)	82	86 B	22 B	8.3 A	5.8 A-B	2.9 B-C	0.0 A	26 A	2.5 A-B	3.6 A
Silver Queen (WI)	92	95 A	28 A	8.1 A-B	5.6 B	1.2 E	0.1 A-B	19 B-C	2.7 A	3.0 B-C
LSD P = 0.05	≠	8	4	0.9	0.4	0.6	0.2	7	0.3	0.3

1 Relative days to maturity.
2 Distance from ground to top leaf at R6 stage of growth for 5 random samples of each replicate.
3 Distance from ground to bottom of ear for 5 random samples of each replicate.
4 Distance shuck extends beyond ear tip for 3 random samples of each replicate.
5 Distance of unfilled kernels at ear tip for 3 random samples of each replicate.
6 Flavor: 1 = Poor; 2 = Good; 3 = Very Good; 4 = Excellent.
7 Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 2. Yellow sugary-enhanced (se) sweet corn plant, ear, yield and flavor characteristics in Henderson County, Kentucky, 2001.

Cultivar (Seed Source)	Maturity[1] (Days)	Plant Height[2] (in.)	Ear Height[3] (in.)	Ear Length (in.)	Ear Diameter (in.)	Shuck Cover[4] (in.)	Tip Fill[5] (in.)	Marketable Ears (no/plot)	Ave Wt. 5 Ears Husked (lb)	Flavor[6] (1-4)
Welcome (RU)	70	46 C-D[7]	11 B	6.7 B	5.6 B-D	1.9 B	0.0 A	9 E	1.6 E	3.7 A-B
Gold Nuggets (RU)	75	65 A-B	22 A	6.9 A-B	5.9 B-C	2.6 A	1.1 C-D	13 D-E	2.2 C	3.8 A
Bodacious (SW)	75	56 B-C	20 A	7.5 A-B	5.5 C-D	2.2 A-B	0.4 A-B	28 A-B	2.0 C-D	3.6 A-B
Kandy Plus (RG)	75	75 A	24 A	8.0 A	6.6 A	1.6 B	0.9 B-D	17 C-D	3.4 A	3.5 A-B
Amaize (RU)	75	43 D	12 B	7.2 A-B	5.4 D	1.9 B	0.0 A	20 C-D	1.9 D	2.4 D
Honey Select (RG)	79	73 A	23 A	7.8.A-B	6.0 B	2.1 A-B	0.5 B-C	35 A	2.8 B	3.4 B
Incredible (SW)	85	74 A	22 A	7.2 A-B	6.0 B	2.1 A-B	1.2 D	25 B-C	2.7 B	3.0 C
LSD P = 0.05	≠	12	7	1.2	0.5	0.8	0.6	7	0.4	0.4

1 Relative days to maturity.
2 Distance from ground to top leaf at R6 stage of growth for 5 random samples of each replicate.
3 Distance from ground to bottom of ear for 5 random samples of each replicate.
4 Distance shuck extends beyond ear tip for 3 random samples of each replicate.
5 Distance of unfilled kernels at ear tip for 3 random samples of each replicate.
6 Flavor: 1 = Poor; 2 = Good; 3 = Very Good; 4 = Excellent.
7 Means followed by same letter do not significantly differ (P = 0.05, LSD).

Bicolor Corn. The performance of bicolor sweet corn varieties is summarized in Table 3. All bicolor varieties tested were very similar in ear length, shuck cover, and marketable yield. However, like the early-maturing yellow varieties, the early-maturing varieties Peaches and Cream and Temptation also had low yields, probably a reflection of the poor weather conditions early in the growing season. The variety Parfait, the current and past best flavored bicolor sweet corn variety, also was the top yielding variety in this year's trial. Over the past few years, this variety was an average performer for marketable yield. Other varieties that had good flavor and yield included Mystique, a newer variety that also performed well last year and a new variety, Buckeye.

Table 3. Bicolor sugary-enhanced (se) sweet corn plant, ear, yield and flavor characteristics in Henderson County, Kentucky, 2001.

Cultivar (Seed Source)	Maturity[1] (Days)	Plant Height[2] (in.)	Ear Height[3] (in.)	Ear Length (in.)	Ear Diameter (in.)	Shuck Cover[4] (in.)	Tip Fill[5] (in.)	Marketable Ears (no./plot)	Ave Wt. 5 Ears Husked (lb)	Flavor[6] (1-4)
Peaches and Cream (SW)	70	73 A-B[7]	19 B-C	7.6 A-B	6.0 A-C	2.2 A	0.7 C-D	15 B	2.4 B-C	2.8 B-C
Temptation (RU)	71	64 B	18 C	7.4 A-B	6.3 A	2.0 A	0.1 A-B	16 B	2.4 B-C	2.6 C
Bon Appetit (RU)	74	65 B	20 B-C	7.7 A-B	6.1 A-B	1.8 A	0.0 A	20 B	2.8 A	2.0 D
Buckeye (RU)	74	69 A-B	24 A-B	7.8 A-B	5.5 B	2.9 A	0.0 A	19 B	2.3 C	3.6 A
Mystique (RU)	75	70 A-B	22 A-C	7.8 A-B	5.9 B-C	2.0 A	0.2 A-B	20 B	2.8 A-B	3.7 A
Parfait (SW)	76	81 A	26 A	8.1 A	5.8 C-D	0.1 B	1.1 D	27 A	2.1 C	3.8 A
Serendipity (RG)	82	74 A-B	22 A-C	7.0 B	6.0 B-C	2.9 A	1.2 D	19 B	2.4 B-C	3.1 B
LSD P = 0.05	≠	12	5	0.9	0.4	1.1	0.7	7	0.4	0.4

1 Relative days to maturity.
2 Distance from ground to top leaf at R6 stage of growth for 5 random samples of each replicate.
3 Distance from ground to bottom of ear for 5 random samples of each replicate.
4 Distance shuck extends beyond ear tip for 3 random samples of each replicate.
5 Distance of unfilled kernels at ear tip for 3 random samples of each replicate.
6 Flavor: 1 = Poor; 2 = Good; 3 = Very Good; 4 = Excellent.
7 Means followed by same letter do not significantly differ (P = 0.05, LSD).

Broiler Litter Effective as Sweet Corn Fertilizer and Soil Conditioner

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Introduction

Over the past decade, Kentucky has seen major increases in broiler production, marketing 188.8 million birds in 1999. During the course of a year, these broilers can produce close to a half million tons of litter. Proper disposal of broiler litter is a concern since its repeated application to agricultural land can cause phosphorus accumulation in surface soil that is susceptible to losses through runoff and erosion.

One option is disposal of broiler litter on land used for horticultural production. Benefits of using broiler litter for production of value-added crops such as vegetables have not been extensively investigated. Applying broiler litter to vegetable crops like sweet corn would give broiler producers another disposal option.

The objectives of this study were to determine if poultry litter can be used as the only source of nitrogen (N) for sweet corn production and to determine the effect of broiler litter on soil bulk density.

Materials and Methods

This two-year study was conducted on two separate plots of Loring silt loam soil. Plots were planted with Silver King sweet corn on 1 June 2000 and 10 March 2001, respectively. In each year, the experiment included 12 treatments. One treatment received no nitrogen and another treatment received 50 lb of N applied as a sidedress of ammonium nitrate when plants were 12 inches tall. Five treatments were preplant incorporated using a total of 150 lb of N from poultry litter (PL) and/or ammonium nitrate (AN) as follows: 0 percent PL/100 percent AN; 25 percent PL/75 percent AN; 50 percent PL/50 percent AN; 75 percent PL/25 percent AN; and 100 percent PL/0 percent AN. The other five treatments received preplant incorporation of only 100 lb of N from PL and/or AN in the same five combinations as previously mentioned. These treatments also received a sidedress application of AN (50 lb of N) when plants were 12 inches tall.

All plots consisted of three rows, each 40 feet long and 3 feet apart with 100 seeds planted per row for a desired final stand of approximately 23,000 plants per acre. The middle row of each plot represented an experimental unit. All 12 treatments were replicated four times and arranged in a randomized complete block design.

Prior to planting, applications of PL and AN were incorporated 6 inches deep with a standard disk. Atrazine plus metolachor

(Dual II) at 1.2 + 1.5 lb ai/A, respectively, was applied two days after planting.

Plant height was measured at the reproductive silking (R1) stage of growth on five random plants in each plot. Marketable number of ears and marketable yield were measured following harvest. Soil bulk density after harvest was measured using a standard core method (3 inches deep). All data were subjected to analyses of variance to test for main effects, and regression analyses were used to determine rate responses to application ratios of PL and AN and to sidedress treatments.

Results and Discussion

Total N from PL produced a similar or superior sweet corn response for all measurements taken when compared to the AN treatment; however, while not always statistically significant, applying 75 percent PL /25 percent AN nitrogen ratios tended to produce the greatest response.

With regard to treatments that received 150 lb of N, sidedressing just more than 30 percent of plant N requirements with AN after plants reached 12 inches tall had no effect on any of the final measurements recorded. This was true when either PL or AN was used as the preplant N treatment (data not shown).

Plant height (Figure 1) of sweet corn increased linearly with higher ratios of poultry litter incorporated. Plant height was less for the control when compared to all other treatments.

Treatment effects for marketable ears (Figure 2) and yield (Figure 3) increased linearly with higher ratios of poultry litter applied, but a curvilinear relationship was also established for both sweet corn yield and weight—presumably related to the 75 percent PL treatment effect.

Regardless of fertilizer treatment, marketable yield of sweet corn was greater than that of the unfertilized control. Sweet corn grown in plots with 100 percent AN had a 31 percent higher yield than the control plots but was at least 11 percent lower in yield when compared to plots with 50 percent PL or more. Sweet corn grown in 75 percent PL plots had a higher marketable yield than sweet corn in 100 percent AN plots and similar yields when compared to the other PL plots.

Soil bulk density following harvest decreased linearly by adding larger ratios of poultry litter to the soil (Figure 4). Applications of litter at the 50 percent ratio and above resulted in bulk densities significantly lower than the control. While not significant, the addition of 100 percent AN showed a substantial decrease in soil bulk density when compared to the control. This may be explained by the potentially larger root system produced by sweet corn in response to AN applications. Increased root mass tends to break up soil density and, in turn, produce bulky, unstable pedons within the effective root zone.

Conclusions

Plant growth and yield results indicated that broiler litter can be used as an alternative, and possibly superior, source of fertilizer N on sweet corn. With regard to sweet corn receiving the recommended rate of N, all fertilizer can be applied at or just prior to planting since sidedressing did not prove to be any more beneficial to plant growth or yield. Based on results of this study, the ideal ratio of poultry litter and ammonium nitrate N fertilizer appears to be 75 percent PL and 25 percent AN. This may be explained by the presumption of quick N availability from ammonium nitrate to initiate plant growth followed by slower N release from poultry litter through the rest of the growing season.

A ton of broiler litter generally contains about 60 pounds of N, of which about 60 percent (36 pounds) will be available the year it is applied. Therefore, a sweet corn crop requiring 150 pounds of fertilizer N per acre, using a 75 percent PL/25 percent AN ratio, would need 3.1 tons of PL (113 pounds total N) and

Figure 1. Effect of ammonium nitrate and poultry litter treatments on final sweet corn height.

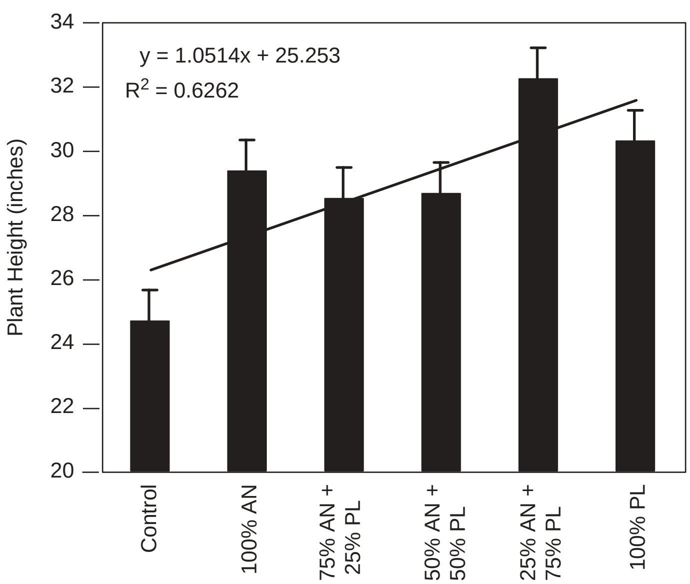


Figure 2. Effect of ammonium nitrate and poultry litter treatments on sweet corn marketable yield.

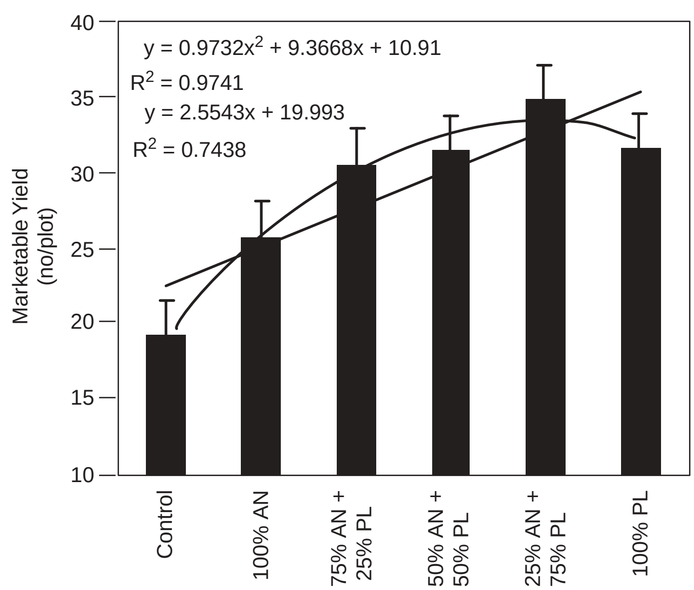


Figure 3. Effect of ammonium nitrate and poultry litter treatments on sweet corn marketable weight.

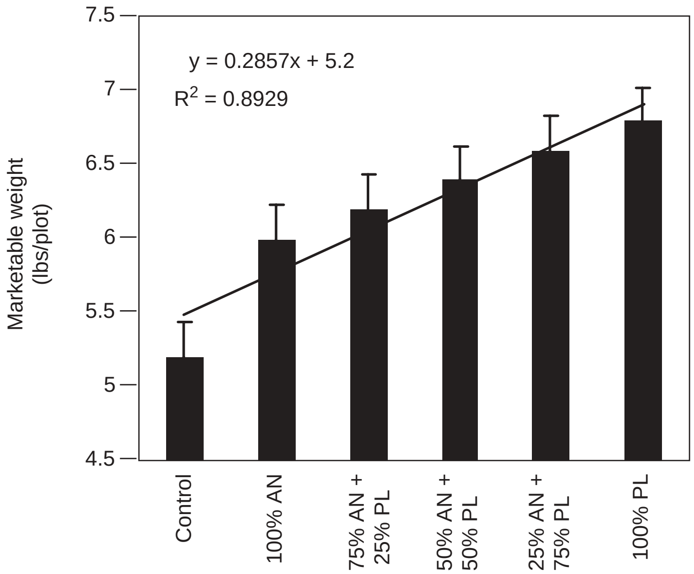
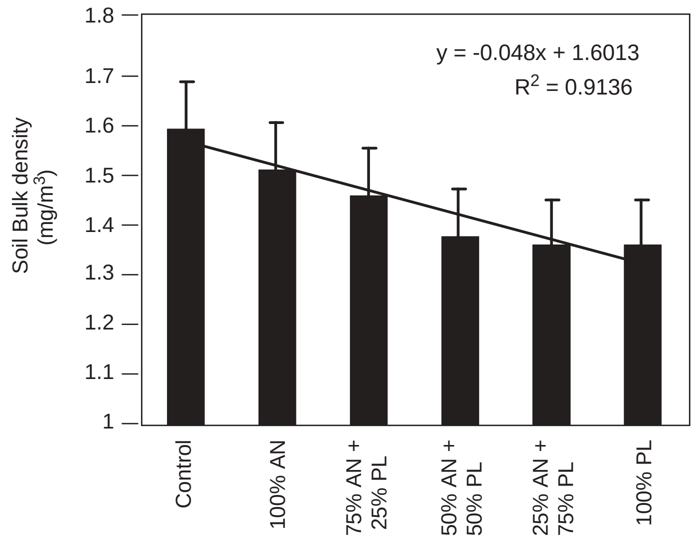


Figure 4. Effect of ammonium nitrate and poultry litter treatments on soil bulk density following harvest.



110 pounds of AN (37 pounds total N), respectively, per acre. Another benefit of using this ratio is reducing potential long-term phosphorus build-up in the soil that may occur when PL is the sole source of N.

Acknowledgments

The author would like to thank Charles Mulligan and Michael Reeder, both of Henderson County, for hosting the trials and Sandefur Farms, McLean County, for supplying chicken litter. The author also expresses appreciation to Greg Hefton of Hanson Spreader Service, Hopkins County, for supplying chicken litter and his custom spreading services. The experiment was funded in part by a SARE grant through Greg Henson, County Extension Agent for Agriculture, McLean County.

All America Selections Vegetable Display Gardens

Richard Durham and Shari Dutton, Department of Horticulture

Introduction

Recent All America Selections (AAS) winners are promoted through a nationwide display garden program. Many display gardens are associated with AAS trial gardens; however, the host institution need not be involved in the AAS trial program to sponsor a garden. The display garden can be planted with AAS vegetable selections, flower selections, or both. In 2001, an AAS vegetable display garden was planted at the University of Kentucky to demonstrate performance of recent selections to home gardeners and commercial producers.

Materials and Methods

The main display garden was located at the University of Kentucky Lexington-Fayette County Arboretum (UK Arboretum). Secondary plantings were made for display during field days and other events at the University of Kentucky Horticultural Research Farm in Lexington and at the University of Kentucky Research and Education Center at Quicksand. Selections planted are listed in Table 1. All plants were initially seeded in plug trays in the greenhouse and later transplanted to the field. Most transplanting was accomplished by late May. Evaluations were based primarily on the planting at the UK Arboretum unless otherwise noted. At the UK Arboretum, plants were sidedressed with ammonium nitrate at transplanting and again four to eight weeks after transplanting, depending on planting date. No insecticides were applied at the arboretum with the exception of two applications of organically approved Bt for control of worms on cabbage.

Results and Discussion

Cabbage F1 'Dynamo'

This cabbage produced a small, dense head weighing 2 to 2.5 pounds. There was no evidence of head splitting, and harvests were made over an extended period from early June to late July with little decrease in quality. The compact size of plants made this cabbage very suitable for home gardens, and the prolonged harvest window made possible by the resistance to head splitting may make it attractive to commercial growers.

Cabbage F1 'Savoy Express'

Savoy Express is promoted as being a relatively early savoy type cabbage that is compact and produces a small head (1 to 1.5 pounds). The plants grew very well after transplanting, but some wet weather around the time the heads were maturing caused a lot of internal and basal rot of the heads. This was much less of a problem with Dynamo, which was growing nearby.

Okra F1 'Cajun Delight'

Cajun Delight was slow to establish from transplanting and may have established better by direct seeding. Nevertheless, once established, the plants produced consistent yields of one to two pods per plant per week. A highlight of this variety was its earliness, with the first edible-sized pods produced 60 days after transplanting.

Thai Basil 'Siam Queen'

This basil produced a densely branched plant without the need for pinching, resulting in high yields of licorice-scented leaves. The plants reached a height of 28 to 30 inches, had equal spread, and exhibited little lodging. A drawback to this variety was that there was little regrowth of plants after being cut back.

Lemon Basil 'Sweet Dani'

Sweet Dani is an attractive plant that can be grown for both culinary and ornamental purposes. The plants were more compact than Siam Queen and reached a height of around 20 inches. The inflorescence also remained compact, with deep maroon to dark purple flowers. Sweet Dani also responded better to cutting back than Siam Queen by producing additional growth. Even without cutting back, Sweet Dani produced a second flush of growth; however, this made the plants less attractive due to the remaining presence and decline of the initial inflorescence.

Swiss Chard 'Bright Lights'

This plant received a lot of attention due to its bright rainbow of stem colors and robust size, which was up to 30 inches tall with equal spread. It has been used for both culinary and ornamental purposes. The foliage stays mild-flavored throughout the growing season, and new foliage was continually produced as the older leaves were removed. Interestingly, at the UK Arboretum plants were fed upon regularly by goldfinches. The feeding occurred at the tips of the leaves and was not excessively damaging. Most who saw them agreed that the attraction of the goldfinches to the Swiss chard was a benefit and not a liability, and this might add to the attractiveness of Bright Lights in the home garden.

Pumpkin 'Wee-B-Little'

Wee-B-Little was a miniature, ornamental type pumpkin with mature fruit weighing only about 1 pound. The plants were fairly compact and spread only 6 to 8 feet. This pumpkin was slow to establish at the UK Arboretum, with only 25 percent of plants surviving four weeks after transplanting. The remaining plants declined due to squash vine borer before the pumpkin fruit matured. Better growth was achieved at the Horticulture Research Farm, where plants were grown on black plastic mulch with drip irrigation and received insecticide treatments. There the fruit did mature. The fruit were attractive, and an added benefit was that the peduncle, or fruit stalk, is essentially spineless, making it easier to handle. For home production, one would be advised to apply early preventive insecticide sprays for squash vine borer.

Table 1. All America vegetable selections included in the display garden.

Selection	AAS selection year
Cabbage F1 'Dynamo'	1997
Okra F1 'Cajun Delight'	1997
Thai Basil 'Siam Queen'	1997
Lemon Basil ' Sweet Dani'	1998
Swiss Chard 'Bright Lights'	1998
Pumpkin 'Wee-B-Little'	1999
Squash F1 'Eight Ball'	1999
Tomato F1 'Juliet'	1999
Watermelon F1 'New Queen'	1999
Sweet Corn F1 'Indian Summer'	2000
Cabbage F1 'Savoy Express'	2000
Pea 'Mr. Big'	2000
Pepper F1 'Blushing Beauty'	2000
Onion F1 'Super Star'	2001
Pepper F1 'Giant Marconi'	2001
Tomato F1 'Jolly'	2001
Sweet Corn F1 'Honey Select'	2001

Squash 'F1 Eight Ball'

Eight Ball is a zucchini-type squash but one that is perfectly round. The plants bore fruit very early, 25 to 30 days after transplanting (about 35 to 40 days after seeding), and yields were high. Although Eight Ball is described as having a compact growth habit, it still reached 2.5 to 3 feet tall and spread 3 to 4 feet. The plants fell victim to squash vine borer by early August but had already produced a good crop of squash. The fruit were most tender if picked when 2 to 3 inches in diameter but were still very usable when more mature—even up to 5 inches in diameter.

Tomato F1 'Juliet'

This variety produced small, cherry-type tomatoes with elongated, red fruit that reached about 1 ounce in size. The plants were grown in cages, and the yields were very high. The fruit was very resistant to cracking, but quality was marginal since the fruit did not achieve good sugar content until late in the season—possibly due to cloudy, rainy weather and high plant vigor early in the season that changed to increased moisture stress and decreased plant vigor later in the season. The indeterminate growth habit made these plants difficult to contain in the cages, and it was necessary to prune vines occasionally to contain growth.

Tomato F1 'Jolly'

Jolly is a larger (1.5 ounce) cherry-type tomato that produces pink, peach-shaped fruit with a distinguishable point on the blossom end. Fruit tended to crack later in the season, and overall quality was not exceptional. The plants were prolific, with high yields and vigorous growth that required frequent pruning.

Watermelon F1 'New Queen'

New Queen was difficult to establish at the UK Arboretum. Plants generally lacked vigor, and only 50 percent of the plants survived longer than four weeks. The remaining plants set very few fruit, and the fruit did not mature. Plants at the Horticulture Research Farm did much better, likely due to the increased soil temperatures and more even soil moisture provided by the black plastic mulch and drip irrigation. New Queen produced an orange-fleshed, icebox-sized, seeded melon.

Sweet Corn F1 'Indian Summer'

Indian Summer is marketed as the first sweet corn with multicolored kernels. It also contains the *sh2* genotype resulting in supersweet kernels. Ears ripened about 79 days after planting. The small plot at the UK Arboretum (4 feet by 6 feet) produced some nicely filled ears. However, if this variety is being grown solely for brightly colored kernels, the gardener may be somewhat disappointed. The kernels do color, mostly in various shades of purple or yellow, but do not achieve their best color until the ears are very mature or even over-mature. The color darkens with cooking but also washes out to some extent, causing the water in the pot to turn dark. With these drawbacks in mind, Indian Summer with its colored kernels is still a fairly nice novelty corn suitable for the home gardener. Be aware that because of the *sh2* genetics, the kernels will shrivel as they dry, and the ears will not be suitable for use in fall decorations.

Sweet Corn F1 'Honey Select'

This is a yellow sweet corn that combines supersweet (*sh2*) and sugar enhanced *(se*) genetics into one variety. Ears were at the edible stage at around 80 days. In the small (4 feet by 6 feet) plot at the UK Arboretum, pollination and ear fill were surprisingly good. Kernels were very tender, and overall quality was good, certainly better than Indian Summer.

Pea 'Mr. Big'

Mr. Big is an English-type pea grown mostly for shelling, although some immature pods were also very edible. Plants were direct seeded in early April, and even with a late start date, the plants produced a good crop. Mature pods were larger than in most varieties, making it easy to spot the pods on the plant and easy to shell the peas. Plants continued to produce until late June.

Pepper F1 'Blushing Beauty'

This sweet pepper produces colored fruit on compact plants, making it a good addition to home gardens or even suitable in edible landscape-type situations. The fruit began pale yellow to ivory, became more yellow as it matured, then ripened to a bright orange red. The fruit flavor was good but not exceptional. There are certainly many green bell varieties with superior fruit quality, but the color progression of the fruit makes Blushing Beauty noteworthy. Good yields were achieved all summer until frost.

Pepper F1 'Giant Marconi'

Giant Marconi is marketed as an Italian grilling pepper, but it can also be used fresh as one would use bell peppers. The fruit are large, up to 8 inches long and 2 to 3 inches in diameter. They are dark green when immature, maturing to a deep red. The core and seeds are restricted to the stem end, making them easy to remove while maintaining the shape of the pepper. Mature fruit were extremely sweet when roasted. Yields were very high on bushy, 30-inch tall plants. Production continued until frost. This is another entry that may have potential for roadside or farmers' markets.

Onion F1 'Super Star'

Super Star was undoubtedly the most talked about entry in the AAS vegetable display garden. Exceptionally large bulbs (generally 1 pound or more) were produced about half submerged in the soil, making these onions real eye-catchers. Even though bulbs were exposed to sun, no sun scorch was noticed. When harvested immature, the bulbs had a very mild, sweet flavor and were suitable for eating fresh. As the bulbs matured, they became more pungent but were still suitable for some fresh uses but especially for use in cooking. Mature bulbs were successfully stored for four to six weeks. Bulbs for storage were harvested 100 days after transplanting. Further evaluation is necessary, but Super Star may well have potential for commercial production, especially for roadside or farmers' markets.

Acknowledgments

Thanks to Terry Jones for transplanting and caring for the vegetable display garden at Quicksand and to April Satanek for helping with transplanting the vegetable display garden at the Horticulture Research Farm.

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All America Selections, 1311 Butterfield Road, Suite 310, Downers Grove, IL 60515.
Web site: www.all-americaselections.org.

Yield and Disease Ratings for Heirloom Tomato Varieties

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Introduction

Heirloom or heritage vegetables are gaining in popularity, with home gardeners and commercial producers marketing through roadside stands and farmers' markets. Reasons for this increase in popularity include ethnic or regional preferences for certain cultivars and the belief that heirloom cultivars have superior fruit quality as opposed to those bred for specific marketing characteristics such as shelf life, firmness, and uniform ripening. This study was undertaken to evaluate a limited number of heirloom tomato cultivars for yield and disease incidence under Kentucky growing conditions. The recommendations from this study are mainly for home gardeners, although commercial producers might also find useful information.

Materials and Methods

A group of seven heirloom tomato varieties, all indeterminate types, were selected for evaluation along with three indeterminate control varieties (Beef Master, Better Boy, and Early Girl) commonly grown in home gardens (Table 1). Most varieties were seeded in the Horticulture Greenhouse (UK campus) on 2 April except for Mr. Stripey and Buck's Co. Hybrid, which were seeded on 9 April. Seeds were sown directly into 126-cell plastic trays. Transplanting to the field occurred on 30 May at the UK Horticultural Research Farm in Lexington. A plot consisted of five plants of a single variety, spaced 18 inches apart in a single row, on 6-inch-high raised beds spaced 6 feet apart, with black plastic mulch and trickle irrigation. Plots were not replicated. Drip irrigation was applied as needed. Plants were staked (to 5 feet), tied using the Florida weave system, and pruned to two main stems. Fifty pounds of nitrogen was applied as ammonium nitrate prior to bed formation, and a total of 10 additional pounds of nitrogen (divided into three applications) was applied with irrigation water. Plots were not treated with fungicides so that disease susceptibility could be evaluated. Insecticides were applied only as needed.

A total of five harvests were made from 20 July to 4 Sept. Yield was calculated as the total fruit picked from five-plant plots over the five harvest dates. On two harvest dates, 14 August and 24 August, fruit were graded into the following size classes: jumbo (> 3.5 inches in diameter), extra large (> 2.75 inches but < 3.5 inches), large (> 2.5 inches but < 2.75 inches), medium, and small (< 2.5 inches). Fruit were also sorted according to U.S. No. 1 or U.S. No. 2 grades. A quality score for each variety was calculated by combining the weight of all fruit considered marketable (size class large and above, U.S. No. 1 grade) divided by the total amount of fruit picked for that variety on the two dates when size classes were evaluated. Disease observations were made for early blight, powdery mildew, and tomato mosaic virus with the final disease evaluation made on 21 August.

Table 1. Yield, fruit quality, and disease rating of heirloom tomato varieties.

Variety (seed source)	Yield (lb)[1]	Fruit Quality (%)[2]	Disease rating[3]		
Heirlooms			**EB**	**PM**	**V**
Big Rainbow (BU)	19.8	42	25	35	(-)
Buck's Co. Hybrid (BU)	35.7	65	15	20	(++)
Delicious (BU)	31.0	51	30	0	(+)
German Johnson (TGS)	49.8	50	25	20	(-)
Giant Belgium (TT)	21.0	46	55	60	(+)
Mr. Stripey (J)	21.9	40	20	20	(+)
Pink Odoriko (TGS)	44.4	50	25	50	(-)
Controls					
Beef Master (FM)	49.8	34	25	40	(++)
Better Boy (FM)	37.0	59	40	20	(+)
Early Girl (FM)	36.9	61	40	60	(-)

1 Total yield of 5 plants over 5 picking dates.

2 Quality score is percentage of fruit, by weight, scoring U.S. No.1, size large or above, averaged over two picking dates.

3 EB = early blight with number indicating percent defoliation, PM = powdery mildew with number indicating the percentage of leaves infected, V = tomato mosaic virus, - = none evident, + = on newest growth only, ++ = established infection.

Results and Discussion

In general, the heirloom varieties grew very well under the production conditions described. However, these indeterminate types would have benefited from taller and sturdier stakes and increased in-row spacing. The disease incidence noted in Table 1, especially with regard to powdery mildew, may have been less severe with increased in-row spacing. It was noticed that fungal diseases were more severe on the west side of each plot than on the east side, presumably due to earlier drying by the morning sun on the east side. Wider spacing may have also allowed for faster drying of foliage by allowing better air circulation within and between plants.

When compared to controls, three heirloom varieties, Buck's Co. Hybrid, Pink Odoriko, and German Johnson, performed particularly well in this trial (Table 1). Buck's Co. Hybrid had the highest fruit quality of any variety in the study and yields that were comparable to two of the three control varieties. This variety produced deep red, round fruit that were very firm and smooth when ripe. Pink Odoriko produced higher yields than the control varieties, but this was offset by lower fruit quality, primarily due to cracking and small fruit. This variety produced round pink fruit that were also very firm and smooth at maturity. German Johnson had highest yields of any of the heirloom varieties, but this was offset by a fruit quality rating of only 50. The fruit quality was most affected by cracking and roughness of the fruit, which caused many fruit to be classified as U.S. #2, or culls. One other variety, Delicious, appeared promising. Yields for this variety were lower than the three previously mentioned, but the fruit were dark red, smooth, and generally fell in the large to extra-large size category. Some cracking resulted in lower fruit quality.

Two of the poorer performing varieties, Big Rainbow and Mr. Stripey, were low in yield and fruit quality because many of the fruit developed bacterial soft rot prior to picking. Fruit with this condition were removed from plants but not included in yield totals. Under home garden or commercial production where preventative fungicidal sprays are applied to control early blight, the soft rot may be less severe. Giant Belgium exhibited low yield more because of lower fruit set than from any fruit disease problem. The lower fruit quality score was due to excessive cracking and roughness of the fruit.

This initial trial of heirloom tomatoes was meant to evaluate a few varieties for their suitability for home garden production and gather preliminary data regarding whether any might be promising for commercial production. From this initial study, Buck's Co. Hybrid, Pink Odoriko, German Johnson, and possibly Delicious can be recommended to home gardeners. Buck's Co. Hybrid, with its high fruit quality and relatively high yields, may also be suitable for commercial production.

Acknowledgments

Thanks to April Satanek and Shari Dutton for assistance with transplanting and to Brent Rowell for assistance in fruit quality grading.

Yield of *Brassica* 'Mei Qing' and 'Tatsoi' in Hydroponic Greenhouse Production

Robert G. Anderson, Department of Horticulture

Introduction

Kentucky has more than 30 acres of greenhouses with modified pond or tank hydroponic beds for "float" tobacco transplant production. These facilities could be used to grow other crops during the fall, winter, and spring. Previous work has demonstrated that lettuces can be easily grown in such production systems (Anderson and Schmidt, 2001; Thompson et al., 1998). This study evaluated production of two types of pac choi, 'Mei Qing Choi' and 'Tatsoi', that could be grown in the same system and sold in Asian vegetable markets.

Materials and Methods

In this study, six 12-square-foot wooden hydroponic ponds or tanks were built in two rows of three on one side of a 30-foot x 60-foot naturally ventilated sidewall plastic greenhouse. Tanks were lined with black polyethylene and filled with water to a depth of 6 inches to make a tank volume of approximately 38 gallons. Electric water pumps were placed in each tank to oxygenate the water in the aeration treatments; previous work demonstrated that oxygen levels would be maintained at 4 to 6 ppm with this procedure. Holes (35) were cut in six 36-inch x 22-inch x 1-inch polystyrene sheets. The holes were 1.5 inches in diameter and spaced 5 x 6 inches. Plants were grown in 1-ounce plastic soufflé cups (Solo Cup Company, Urbana, Illinois) that had holes drilled in the bottom. A commercial inorganic fertilizer (Peter's 20N-4P-16.6K, Scotts, Marysville, Ohio) was added to the water in each tank and maintained at an EC of 1.2 dSm^{-1} (approximately 160 ppm NO_3-N).

Seed of Chinese cabbage varieties 'Mei Qing Choi' pac choi (*Brassica rapa* Chinensis group) and 'Tatsoi' (*Brassica rapa* Narinosa group) were purchased from Johnny's Selected Seeds, Albion, Maine. A single crop was grown in February 2001. Cups were filled with a peat-based germination medium (Scott's Redi-Earth, Marysville, Ohio) and placed in trays. Seeds were sown (January 15) in the cups and germinated at an average daily temperature of 76°F. Seedlings were fertigated twice per week with 150 ppm 20-10-20 inorganic fertilizer before placement in the hydroponic tanks. The plants were placed in the hydroponic ponds on February 5 and grew under natural light conditions. The greenhouse had a heat set-point of 60°F and a ventilation set-point of 75°F.

Plants were harvested from the tanks on March 7, and dry weights were measured for nine plants in each replicate. Plants were grown with and without aeration with three replicates in a randomized complete block.

Results and Discussion

Thirty days was sufficient to grow high quality heads of 'Tatsoi' and 'Mei Qing Choi' pac choi (Chinese cabbage). 'Mei Qing' has a relatively typical pac choi head with large, nearly white, thick petioles. On the other hand, 'Tatsoi' forms a loose head of long, thickened petioles with dark green leaf blades. It seems both would be fine for stir fry cooking and salads, but petioles of 'Tatsoi' are more like celery in form rather than a pac choi.

Aeration of the hydroponic solution is clearly necessary for the production of these plants. Dry weights were nearly double for those plants in aerated treatments compared to those in non-aerated treatments typical of a tobacco "float" bed (Figure 1). Aeration is just as important for lettuce in tank or "float" bed production (Anderson and Schmidt, 2001; Thompson et al., 1998). Although aeration is somewhat difficult to arrange for "float" beds, it is critical to the success of vegetable plant production in this type of hydroponic system.

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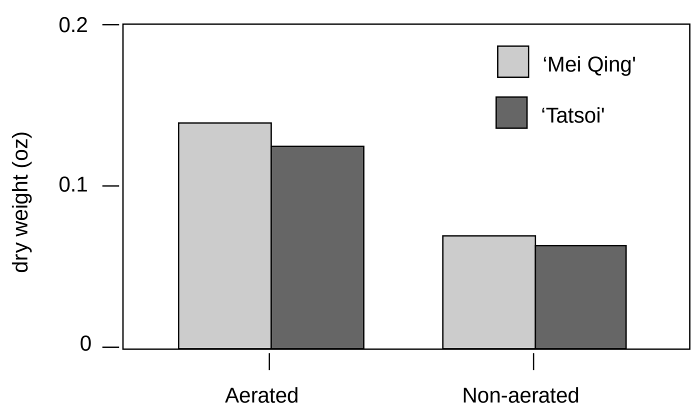
Figure 1. Mean shoot dry weight (oz.) of 'Mei Qing Choi' and 'Tatsoi' Chinese cabbage grown in aerated and non-aerated hydroponic ponds with inorganic fertilizer.



Nutrient Analysis of Selected Commercial Organic Fertilizers for Greenhouse Lettuce Production

Robert G. Anderson and L. Stephanie Schmidt, Department of Horticulture

Introduction

The market for organic produce continues to expand (Thompson, 2000). Kentucky has more than 30 acres of greenhouses with modified pond or tank hydroponic beds for "float" tobacco transplant production. The development of a certified organic greenhouse production system for lettuces and greens could allow Kentucky tobacco farmers access to a new market for their facilities as the tobacco market changes. In this study, commercial organic fertilizers were used to grow 'Ostinata' Bibb and 'Red Sails' leaf lettuce in a pond, tank, or "float" production system. Plant growth was evaluated, and the fertilizer solutions were analyzed for nutrient amounts and compared to recommended standards for inorganic fertilizers (Muckle, 1993, Thompson et al., 1998).

Materials and Methods

In this study, nine 12-square-foot wooden hydroponic ponds or tanks were built in three rows of three on one side of a 30-foot x 60-foot naturally ventilated sidewall plastic greenhouse. Tanks were lined with black polyethylene and filled with water to a depth of 6 inches to make a tank volume of approximately 38 gallons. Electric water pumps were placed in each tank to oxygenate the water; previous work demonstrated that oxygen levels would be maintained at 4 to 6 ppm with this procedure. Holes (35) were cut in eighteen 36-inch x 22-inch x 1-inch polystyrene sheets. The holes were 1.5 inches in diameter and spaced 5 inches x 6 inches. Lettuce plants were grown in 1-ounce plastic soufflé cups (Solo Cup Company, Urbana, IL) that had holes drilled in the bottom.

Inorganic fertilizer (Peter's 20-10-20, Scotts, Marysville, Ohio) or one of three commercially available, water-soluble organic fertilizers (Peaceful Valley Farm Supply, Grass Valley, California) was added to the water in each tank. Algamin, 0.2N-0P-3.3K, (18 percent cold processed kelp, *Ascophyllum nodulosum* from Norway) was applied at the label rate and three times the label rate, approximately 1 Tbs/gal. and 3 Tbs/gal., respectively. EcoNutrients, 0.2N-0.4P-0.8K (21 percent digested bull kelp, *Nereocystis luetkeana*, from Northern California) was applied at the label rate, 2 Tbs/gal. Omega 6N-2.6P-5K (microbe-digested organic fertilizer derived from blood meal, bone meal, and sulfate of potash) was applied at the label rate and one-half the label rate, approximately 2 Tbs/gal. and 1 Tbs/gal., respectively.

Three crops of lettuce were grown sequentially, one in September, another in October, and another in November of 2000. Cups were filled with a peat-based germination media (Scott's Redi-Earth, Marysville, Ohio) and placed in trays. Bibb lettuce 'Ostinata' and Grand Rapids lettuce 'Red Sails' seeds were sown in the cups and germinated at an average daily temperature of 76°F. Seedlings were grown for 14 days and fertigated with 150 ppm 20-10-20 inorganic fertilizer before placement in the hydroponic tanks. The plants grew under natural light conditions, and the greenhouse had a heat set-point of 60°F and a ventilation set-point of 75°F.

Plants were harvested from the tanks after 30 days, and the fresh and dry weights were measured. Five water samples were taken during each crop and analyzed as standard greenhouse water samples (available nutrients) and as organic samples (total nutrients). The September crop evaluated the label rate of Algamin, EcoNutrients, and inorganic fertilizer; the October crop evaluated the 3X label rate of Algamin, the label rate of Omega, and inorganic fertilizer; and the November crop evaluated inorganic fertilizer, the one-half label rate, and the label rate of Omega in randomized complete block experiments.

Results and Discussion

Water soluble materials derived from algae (Algamin and EcoNutrients) had little value as an organic fertilizer for lettuce. Dry weight of lettuce grown with these materials was only 10 to 18 percent of those grown in inorganic fertilizer, depending on the cultivar (Table 1). Nitrate nitrogen and phosphorus levels were less than 1 percent, and potassium was 5 to 20 percent of the recommended levels when used at the label rate or the 3X label rate for these fertilizers (Table 2). These results are comparable to our previous unpublished trials with fish waste (fish emulsion and fish

Table 1. Mean shoot dry weight (oz) of 'Ostinata' (O) and 'Red Sails' (RS) lettuce grown with inorganic and selected commercial organic fertilizers in 2000.

Fertilizer	Percent of Label Rate	September Crop		October Crop		November Crop	
		O	RS	O	RS	O	RS
Inorganic		0.134 a[1]	0.141 a	0.067 a	0.049 a	0.067 a	0.061 a
Omega	50					0.062 b	0.058 a
Omega	100			0.067 a	0.039 b	0.063 b	0.057 a
Algamin	100	0.027 b	0.049 b				
Algamin	300			0.005 b	0.015 b		
EcoNutrients	100	0.034 b	0.048 b				

[1] Means followed by the same letter in a column are not significantly different at $p = 0.05$ according to the Least Squares Means procedure.

powder). However, the poor plant growth with fish waste was attributed to the high biological oxygen demand from the fertilizers that prevented root penetration into the nutrient solution for three or more weeks, despite moderate nutrient levels.

Dry weight of lettuce grown with a formulated organic fertilizer (Omega) was similar or significantly lower than lettuce grown in inorganic fertilizer, depending on the cultivar (Table 1). Although dry weights were similar, head size was visually smaller with the organic fertilizer. Nitrate levels were 50 percent, P levels were 300 percent, and K levels were 100 to 120 percent of recommended levels (Table 2).

Production of lettuce in this study was simplified when compared to the sophisticated practices evaluated by Thompson et al. (1998). A commercial fertilizer was used as a control, rather than a formulated fertilizer. Plus, the inorganic fertilizer was supplemented only with additional fertilizer as the conductivity decreased and pH was not manipulated. The pH dropped dramatically throughout this study (Table 2), yet no apparent effects on lettuce growth were noted. Additionally, the commercial fertilizer did not match recommended nutrient amounts precisely. Fresh weights in this study did not reach the commercial goal of 5 ounces per head (Thompson et al., 1998). The heads of lettuce grown in the inorganic and Omega treatments averaged approximately 3.9 ounces. The dry weights, however, were generally similar to dry weights reported by Thompson et al. (1998), but difficult to compare because of different temperatures and light levels used in these studies.

In conclusion, this study indicates that it may be possible to formulate an organic fertilizer for the hydroponic production of lettuce in the greenhouse. It is unknown if state and federal agencies would certify such production practices as organic production.

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Thompson, G. 2000. International consumer demand for organic foods. HortTechnology 10(4):663-674.

For More Information:

UK New Crop Opportunities Center <http://www.uky.edu/Ag/NewCrops/>

A Handbook for the Production of CEA-Grown Hydroponic Lettuce—Cornell University <http://www.cals.cornell.edu/dept/flori/lettuce/index.html>

Hydroponic Food Production. A Definitive Guide to Soilless Culture. 1994. Howard M. Resh. 5th ed. Woodbridge Press, Santa Barbara, Calif.

Table 2. Recommended amounts (Muckle, 1993; Thompson, 1998) and measured amounts of macronutrients and pH in inorganic and selected commercial organic fertilizers used during September, October and/or November crops of lettuce in a pond culture system.

	N-P-K	Percent of Label Used	Weeks Used	NO_3 ppm	NH_3 ppm	P ppm	K ppm	Ca ppm	Mg ppm	pH	EC dSm^{-1}
Recommended amounts				125-156	0	28-31	215-252	84-93	24-26	5.6-6.0	1.2
Inorganic	20-4-16.6		12	90	6	34	140	10 ^{x}	10 ^{x}	4.8	1.2
Omega	6-2.6-5	100	8	80	22	95	240	0	0	5.8	2.0
Omega	6-2.6-5	50	4	42	11	45	145	0	0	6.5	1.4
Algamin	.2-0-3.3	300	4	2	0	2	48	16	70	7.1	0.9
Algamin	.2-0-3.3	100	4	0	0	0.3	8	8	21	7.4	0.3
EcoNutrients	.2-.4-.8	100	4	0	0	0	10	6	4	7.5	0.1

x - Municipal water used for the nutrient solutions added a mean of 52 ppm Ca and 27 ppm Mg and negligible amounts of N, P, and K.

Fruit and Vegetable Disease Observations from the Plant Disease Diagnostic Laboratory

Julie Beale, Paul Bachi, William Nesmith, and John Hartman, Department of Plant Pathology

Introduction

Diagnosis of plant diseases and providing recommendations for their control are the result of UK College of Agriculture research (Agricultural Experiment Station) and Cooperative Extension Service activities through the Department of Plant Pathology. We maintain two branches of the Plant Disease Diagnostic Laboratory, one on the UK campus in Lexington and one at the UK Research and Education Center in Princeton. Of the more than 4,000 plant specimens examined annually, approximately 5 percent are commercial fruit and vegetable plant specimens (1). Although there is no charge to the growers for plant disease diagnosis at UK, the estimated direct annual expenditure to support diagnosis of fruit and vegetable specimens by the laboratory is $15,000, excluding UK physical plant overhead costs.

Materials and Methods

Diagnosing fruit and vegetable diseases involves a great deal of research into the possible causes of the problem. 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 immunosorbent assays (ELISA), electron microscopy, nematode extraction, or soil pH and soluble salts tests. Diagnoses that require consultation with UK faculty plant pathologists and horticulturists, and which need culturing and ELISA, are common for commercial fruits and vegetables. 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 for Kentucky. Computer-based laboratory records are maintained to provide information used for conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs.

Following a mild fall, temperatures in December 2000 were 10 degrees below normal, and tree fruits not hardened off showed winter injury symptoms during the 2001 growing season. Kentucky early spring temperatures, while lower than normal in March, were well above normal in February and April, leading to early and sustained bloom on many fruit crops. Hard freezes occurred during bloom on April 18 and 19 causing fruit injury and affecting some diseases. March and April were drier than normal (April received only 1.4 inches of rain).

Results and Discussion

The following are *new and emerging fruit and vegetable diseases* in Kentucky:

- Pierce's disease of grapes caused by *Xylella fastidiosa*.
- Cucurbit yellow vine disease caused by *Serratia marsescens*.
- Phytophthora blight of peppers caused by *Phytophthora capsici*.
- Bacterial canker of peppers caused by *Clavibacter michiganensis* subsp. *michiganensis.*
- Copper-resistant bacterial speck of tomatoes caused by *Pseudomonas syringae* pv. *tomato*.

Tree Fruit Diseases

Dry weather in March and April reduced the occurrence of primary infections of apple scab (*Venturia inaequalis*). Nevertheless, there was just enough moisture to favor significant cedar rust (*Gymnosporangium juniperi-virginianae, G. clavipes,* and *G. globosum*) infections. Unusually warm April weather and occasional showers during apple and pear bloom resulted in devastating fire blight (*Erwinia amylovora*) outbreaks statewide. Spring frosts occurred and may have exacerbated fire blight and also caused apple fruits to show russeted equatorial bands later in the season. Seasonal summer rains (actually excess rain in July, with 7.3 inches) and long leaf wetness periods increased the incidence and severity of peach scab (*Cladosporium carpophilum*), secondary apple scab, apple frogeye leaf spot (*Sphaeropsis malorum*), apple sooty blotch (*Peltaster fructicola, Geastrumia polystigmatis, Leptodontium elatius,* and other fungi), and flyspeck (*Zygophiala jamaicensis*), all of which are enhanced by long leaf wetness periods. By season's end, susceptible unsprayed apples had less scab than usual, but fruits were covered with sooty blotch and flyspeck. Bitter rot (*Colletotrichum gloeosporioides*) was found in some apple orchards.

Small Fruit Diseases

Blackberries in some regions of Kentucky suffered winter injury. Systemic orange rust (*Gymnoconia nitens*) was devastating to blackberries in some locations. Blackberry rosette (*Cercosporella rubi*) was also observed. Tobacco ring spot virus (TRSV), causing mosaic symptoms and crumbly, unproductive berries, was found infecting blackberries in eastern and western Kentucky. A possible outbreak of impatiens necrotic spot (INSV) or another related virus is under investigation. Wet July weather and poorly drained soils stimulated root rot (*Phytophthora* spp.) of raspberries. Grape crown gall (*Agrobacterium tumefaciens*) incidence was up, and black rot (*Guignardia bidwellii*) and anthracnose (*Elsinoe ampelina*) were also prevalent. Pierce's disease (*X. fastidiosa*) was discovered for the first time in Western Kentucky (see separate report on this disease). This disease can be devastating to grape production—much more Kentucky research is needed. Strawberry anthracnose (*Colletotrichum acutatum*) and strawberry leaf spot (*Mycosphaerella fragariae*) occurred early in the season.

Vegetable Diseases

Due to a hot, wet summer in many areas of the state, infectious diseases significantly affected the success of production of commercial vegetable crops.

Vegetable Transplants. Several diseases were diagnosed from vegetable transplant production within the state. These included Tomato Mosaic Virus (ToMV), Tobacco Mosaic Virus (TMV) in tomatoes, Tomato Spotted Wilt Virus (TSWV), and Impatiens Necrotic Spot Virus (INSV) of tomato and pepper transplants. The first two viruses were probably from seed-borne sources, while the latter two likely came from other plants being grown in the same greenhouse. INSV may have developed as a result of vegetable transplants being produced in the same greenhouse with virus-susceptible ornamental plants such as petunia and impatiens.

Cole Crops. Diseases diagnosed included wirestem (*Rhizoctonia solani*) on transplants and newly set cole crops including cabbage, broccoli, and cauliflower. The fungus also caused stem and head rots later in the season. Blackleg of broccoli (*Phoma lingam)*, leaf spot of cabbage and broccoli (*Alternaria* spp.), and cabbage yellows (*Fusarium oxysporum*) were found several times. Pythium root rot was diagnosed from several transplant operations involving the float system, as was a very serious spiral root disorder on cabbage seedlings. Bacterial diseases included soft rot of the heads (*Erwinia* and *Pseudomonas*) and black rot (*Xanthomonas campestris*). Turnip diseases included Cercosporella leaf spot and anthracnose. Boron deficiency was also common in several crops. One or more aphid-borne viruses were observed in several cases, especially in fall plantings.

Tomatoes. Commercial tomato plantings were infected by several bacterial diseases including bacterial canker (*Clavibacter michiganensis*), bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), bacterial speck (*Pseudomonas syringae* pv. *tomato* including some strains that are copper resistant), bacterial wilt (*Ralstonia solanacearum*), and pith necrosis (*Pseudomonas corrugata*). The copper-resistant speck is of particular concern.

With the protracted hot and wet season, a much higher disease potential was present from the two major fungal leaf spots, early blight (*Alternaria solani*) and Septoria leaf spot (*Septoria lycopersici*). These were controlled well with the strobilurin fungicides where good application methods were followed. Powdery mildew was present again in greenhouses, but much less was noted in the field this year. Fungal stem diseases that took their toll included Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*), Phytophthora stem canker (*Phytophthora* spp.), Botrytis stem canker (*Botrytis cinerea*), timber rot (*Sclerotinia sclerotiorum*), and southern stem blight (*Sclerotium rolfsii*). The latter was especially serious in some situations where post-plant herbicides were applied late.

A number of viral diseases were present and caused some major losses associated with TSWV and ToMV and/or TMV. More common viruses resulting in minor losses were Tobacco Etch Virus (TEV), Potato Virus Y (PVY), Alfalfa Mosaic Virus (AMV), and Cucumber Mosaic Virus (CMV). Root knot nematodes, both *Meloidogyne incognita* and *M. hapla*, caused losses in several plantings. Root and stem infections (*Pythium* spp. and *Rhizoctonia* spp.) were also present. Fruit diseases included all the fungal and bacterial leaf diseases above plus anthracnose and buckeye rot. Tomato fruit also experienced a number of the physiological disorders such as catfacing, blossom-end rot, growth cracks, blotchy ripening, yellow shoulders, and sunscald.

Peppers. Phytophthora blight (caused by *Phytophthora capsici*) is emerging as a major pepper disease in Kentucky, especially in wet sites following pumpkins or tobacco. Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*) is another emerging major disease threat to peppers. This disease is probably coming in with the seed. Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*) remains an important problem but is declining with increased use of resistant varieties. Viruses are also increasing in importance, including several serious cases of TSWV, AMV, the potyvirus complex (mainly TEV), CMV, and TMV. Fruit anthracnose (*Colletotrichum* spp.) is increasing in importance, especially with the hot peppers. Occasionally southern stem blight (*Sclerotium rolfsii*) and stem rot (*Rhizoctonia solani*) were problems. Fusarium stem rot (starting in the greenhouse and continuing in the field), Rhizoctonia damping off, and Pythium root rot were often found. Pyllosticta leaf spot was found several times.

Cucurbits. Cucurbit crops are becoming more popular in Kentucky and their diseases are increasing in economic importance. Phytophthora root rot, stem rot, leaf blight, and fruit rot (*Phytophthora capsici*) are widespread in the state and cause great losses in many fields of pumpkins, squash, and cucumbers. Microdochium blight (*Microdochium* sp. recently renamed *Plectosporium*) was widespread and caused considerable damage in most fields that were not being sprayed well. This disease also developed strongly in some fields that had been sprayed regularly but where poor timing, poor coverage, or the wrong fungicides were involved. Like many other diseases, pumpkin fruit rot incidence is associated with a failure to use crop rotation away from other vegetables or tobacco. Fusarium (*Fusarium* spp.) fruit rots were a common problem again this year on pumpkin and winter squash along with Phytophthora blight. Nutritional disorders were also common, including several cases of manganese toxicity and blossom-end rot.

Anthracnose (*Colletotrichum* spp.), gummy stem blight/black rot (*Mycosphaerella melonis*), downy mildew (*Pseudoperonospora cubensis*), and powdery mildew (*Sphaerotheca fuliginea* or *Erysiphe cichoracearum*) were found at serious levels in some fields on many of the cucurbits. Alternaria leaf blight of melons was much more active this year than normal, occurring earlier and causing more damage. The potyvirus complex, dominated by Watermelon Mosaic Virus (WMV), was widespread in pumpkin and winter squash, while several cases of CMV were also found in melon crops. Bacterial diseases of cucurbits were frequent and included angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*), a bacterial fruit rot (*Xanthomonas cucurbitae*), and bacterial wilt (*Erwinia tracheiphila*). The latter has always been a major problem in cantaloupe and cucumber, but is now becoming more common in squash and pumpkin.

Symptoms of a newly emerging bacterial disease, Cucurbit Yellow Vine Decline (*Serratia marsescens*), were found in watermelon, muskmelon, summer squash, and winter squash. We have not yet proven that this pathogen was the causal agent; the disease was not identified until late summer (thanks to some excellent work by plant pathologists in Oklahoma). Based on symptoms present, it appears that this disease is now active in Kentucky as well as in other states to our west and southwest.

Other Vegetable Crops. Sweet corn rusts (*Puccinia graminis* and *P. sorghi*) were widespread again this year, with significant levels of Stewart's wilt (*Pantoea [Erwinia] stewartii* subsp. *stewartii*), and maize dwarf mosaic virus (MDMV) being observed. There were also isolated cases of anthracnose (*Colletotrichum graminicola*). Asparagus crown rot (*Fusarium* sp.), bean root and stem rot (*Pythium* spp., *Rhizoctonia solani* and *Fusarium solani* f.sp. *phaseoli*), bean anthracnose (*Colletotrichum lindemuthianum*), bean rust (*Uromyces appendiculatus*), bean common bacterial blight *(Xanthomonas campestris* pv. *phaseoli*), bean virus complex (mainly bean yellow mosaic virus), potato scab (*Streptomyces scabies*), and sweet potato scurf (*Monilochaetes infuscans*) were frequently observed this year. A severe case of soil pox of sweet potatoes (*Streptomyces ipomoea)* was associated with a high soil pH situation, a reminder that cultural practices markedly affect disease development. Okra diseases included Rhizoctonia root and stem rot, black root rot, powdery mildew, and root knot nematodes.

The laboratory has been conducting a survey of viruses infecting commercial vegetables in Kentucky for the past several years. Using ELISA tests, a broad range of virus diseases was found; no new viruses were detected in 2001. Growers are urged to bring to the attention of their County Extension Agent any observations 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 Quadris and Abound. These latter products present greater risks 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 now want to know if this is related to how we raise our crops or manage other diseases or to sources of seeds and transplants.

Because fruits and vegetables are high value crops, the Plant Disease Diagnostic Laboratory should be of great value to commercial growers. Many growers, however, are not using the laboratory often enough or they are waiting until their disease problem has become well established. By then, it may be too late to do anything about it or, in some cases, to correctly diagnose the sequence of diseases that may have led to the final outcome. Growers need to consult on a regular basis with their County Extension Agents so that appropriate plant specimens are sent to the laboratory in a timely manner. We are urging County Extension Agents to stress the need for accurate diagnosis of diseases of high value crops. Growers can work with their agents to ensure that they have the best possible information on fruit and vegetable diseases.

Literature Cited

1. Bachi, P.R., J.W. Beale, J.R. Hartman, D.E. Hershman, W.C. Nesmith, and P.C. Vincelli. 2002. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2001. UK Department of Plant Pathology. *In press.*

Appendix A: Sources of Vegetable Seeds

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

Code	Company Name and Address
AAS	All America Selection Trials, 1311 Butterfield Road, Suite 310, Downers Grove, IL 60515
AS/ASG	Asgrow Seed Co., 7000 Portage Rd., Kalamazoo, MI 49001
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
BBS	Baer's Best Seed, 154 Green St., Reading, MA 01867
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
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

Code	Company Name and Address
DR	DeRuiter Seeds Inc., P.O. Box 20228, Columbus, OH 43320
EB	Ernest Benery, P.O. Box 1127, Muenden, Germany
EX	Express Seed, 300 Artino Drive, Oberlin, OH 44074
EZ	ENZA Zaden, P.O. Box 7, 1600 AA, Enkhuisen, 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
HL/HOL	Hollar & Co. Inc., P.O. Box 106, Rocky Ford, CO 81067
H/HM	Harris Moran Seed Co., 3670 Buffalo Rd., Rochester, NY 14624, Ph: (716) 442-0424
HN	HungNong Seed America Inc., 3065 Pacheco Pass Hwy., Gilroy, CA 95020
HO	Holmes Seed Co., 2125-46th St., N.W., Canton, OH 44709
HZ	Hazera Seed, Ltd., P.O.B. 1565, Haifa, Israel
J	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
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

Code	Company Name and Address
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, 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
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
PS	Petoseed Co. Inc., P.O. Box 4206, Saticoy, CA 93004
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

Code	Company Name and Address
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, California 93030-7967
SI	Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503
SK	Sakata Seed America Inc., P.O. Box 880, Morgan Hill, CA 95038
ST	Stokes Seeds Inc., 737 Main St., Box 548, Buffalo, NY 14240

Code	Company Name and Address
SU/SS	Sunseeds, 18640 Sutter Blvd., P.O. Box 2078, Morgan Hill, CA 95038
SW	Seedway Inc., 1225 Zeager Rd., Elizabethtown, PA 17022
T/TR	Territorial Seed Company, P.O. Box 158, Cottage Grove, OR 97424
TGS	Tomato Growers Supply Co., P.O. Box 2237, Ft. Myers, FL 33902
TS	Tokita Seed Company, Ltd., Nakagawa, Omiya-shi, Saitama-ken 300, Japan
TT	Totally Tomatoes, PO Box 1626, Augusta, GA 30903
TW	Twilley Seeds Co. Inc., P.O. Box 65, Trevose, PA 19047
UG	United Genetics, 8000 Fairview Road, Hollister CA 95023

Code	Company Name and Address
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
ZR	Zeraim Seed Growers Company, Ltd., P.O. Box 103, Gedera 70 700, Israel

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