2012 Fruit and Vegetable Crops Research Report

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Important note to readers:

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

Cover: Sweet corn tasseling.

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Contents

The 2012 Fruit and Vegetable Crops Research Program

Timothy Coolong, Department of Horticulture

Fruit and vegetable production in Kentucky continues to grow. The 2012 Fruit and Vegetable crops research report includes results for more than 18 field research plots and several demonstration trials. This year fruit and vegetable research and demonstration trials were conducted in more than 15 counties in Kentucky (see map, right). Research was conducted by faculty and staff from several departments within the University of Kentucky College of Agriculture including: Horticulture, Plant Pathology, Entomology, and Agricultural Economics This report also includes collaborative research projects conducted with faculty and staff at Kentucky State University.

Variety trials included in this year's publication include: turnips, garlic, sweet corn, bell peppers, blueberries, blackberries, apples, peaches, and grapes. Additional research trials include organic management of cucumber beetles, the impact of mulches on tomato production, and heavy metal accumulation in plants exposed to several soil amendments. Variety trials provide us with much of the information necessary to update our recommendations in our Vegetable Production Guide for Commercial Growers (ID-36). However, when making decisions about what varieties to include in ID-36, we factor in performance of varieties at multiple locations in Kentucky over multiple years. We may also collaborate with researchers in surrounding states to discuss results of variety trials they have conducted. Only then after much research and analysis will we make variety recommendations for Kentucky. The results presented in this publication often reflect a single year of data at a limited number of locations. Although some varieties perform well across Kentucky year after year, others may not. Here are some helpful guidelines for interpreting the results of fruit and vegetable variety trials:

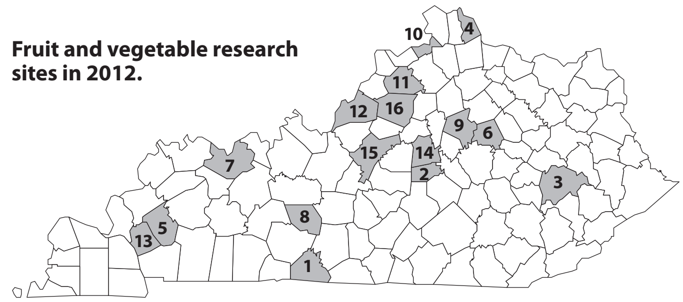
Our Yields vs. Your Yields

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

Statistics

Often yield or quality data will be presented in tables followed by a series of letters (a, ab, bc, etc.). These letters indicate if the yields of the varieties are statistically different. Two varieties may have average yields that appear to be quite different. For example if tomato variety 1 has an average yield of 2000 boxes per acre and variety 2 yields 2300 boxes per acre one would assume that variety 2 had a greater yield. However, just because the two varieties had different average yields, does not mean that they are *statistically or significantly* different. In the tomato example, variety 1 may have consisted of four plots with yields of 1800, 1900, 2200, and 2100 boxes per acre. The average yield would then be 2000 boxes per acre. Tomato variety 2 may have had four plots with yields of 1700, 2500, 2800, and 2200 boxes per acre. The four plots together would average 2300 boxes per acre. The tomato varieties have plots with yield averages that overlap, and therefore would not be considered statistically different, even though the average per acre yields for the two varieties appear to be quite different. This example also demonstrates variability. Good varieties are those that not only yield well, but have little variation. Tomato variety 2 may have had similar yields as variety 1, but also had much greater variation. Therefore, all other things being equal, tomato variety 1 may be a better choice, due to less variation in the field.

Fruit and vegetable research sites in 2012.



1. Allen	*5. Caldwell*	*9. Fayette*	*13. Lyon*
2. Boyle	*6. Clark*	*10. Gallatin*	*14. Mercer*
3. Breathitt	*7. Daviess*	*11. Henry*	*15. Nelson*
4. Campbell	*8. Edmonson*	*12. Jefferson*	*16. Shelby*

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

Lastly when determining statistical significance we typically use a '*P*' value of 0.05. In this case, *P* stands for probability and the 0.05 means that we have a 5% chance that our results are real and not simply due to chance or error. Put another way, if two varieties are said to be different at $P<0.05$, then at least 95% of the time those varieties will be different. If the *P* value is 0.01, then 99% of the time those varieties will be different. Different *P* values can be used, but typically $P < 0.05$ is considered standard practice.

This may be confusing, but without statistics our results wouldn't be useful. Using statistics ensures that we can make more accurate recommendations for farmers in Kentucky.

On-Farm Commercial Vegetable Demonstrations in Central Kentucky

Dave Spalding and Timothy Coolong, Department of Horticulture

Introduction

Six on-farm commercial demonstrations were conducted in central and northern Kentucky in 2012. Grower/cooperators were from Boyle, Campbell, Clark, Gallatin, Mercer, and Nelson counties. The grower/cooperator in Campbell County grew 4.0 acre of mixed vegetables for distribution to local area feeding programs for the poor and elderly. The grower/cooperator in Boyle County grew 1.00 acre of mixed organic vegetables for local farmers markets and auction market. The grower/cooperator in Clark County grew about 2.0 acre of bell peppers for the Central Kentucky Growers Co-op in Georgetown, Kentucky. The grower/cooperator in Gallatin County grew 2.0 acre of tomatoes, 0.5 acre of cantaloupe, and 0.5 acre of watermelon for the local wholesale and retail markets. The Mercer County grower/cooperator grew about 1.0 acres of mixed vegetables for the local market and the Nelson County grower/cooperator grew about 0.25 acre of tomatoes, green beans and melons to supplement their sweet corn sales.

Materials and Methods

Grower/cooperators were provided with black plastic mulch and drip lines for up to 1 acre and the use of the University of Kentucky Horticulture Department's equipment for raised-bed preparation and transplanting. The cooperators supplied all other inputs, including labor and management of the crop. In addition to identifying and working closely with cooperators, county Extension agents took soil samples 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.

Five of the six demonstration plots consisted of a mix of vegetables (tomatoes, peppers, squash, melons, green beans, and sweet corn) while the other plot consisted of bell peppers only. The plots were planted into raised beds covered with black plastic mulch and drip lines under the plastic in the center of the beds. The mixed vegetable plots were planted at the appropriate spacing for the vegetable being grown (i.e. tomatoes were planted in a single row 18 inches apart; beans were planted in double rows 12 inches apart, etc.). The bell pepper only plot was planted into raised beds with the bell peppers planted in double rows 18 inches apart in the row. Except for the organic plots, the plots were sprayed with the appropriate fungicides and insecticides on an as needed basis, and cooperators were asked to follow the fertigation schedule provided.

Table 1. Costs and returns of grower/cooperators.

Inputs	Boyle (1.0 acre)	Campbell (5.0 acre)	Clark (2.0 acre)	Gallatin (3.0 acre)	Mercer (1.0 acre)	Nelson (0.25 acre)
Plants and Seeds	$180.00	$5,290.00	$2,100.00	$2,200.00	$750.00	$60.00
Fertilizer	80.00	-------------[z]	450.00	820.00	275.00	-----------
Black Plastic	186.00	930.00	372.00	558.00	186.00	48.00
Drip Lines	162.00	810.00	324.00	486.00	162.00	42.00
Fertilizer Injector[y]	------------	300.00	60.00	60.00	60.00	-----------
Herbicide	------------	320.00	25.00	120.00	75.00	-----------
Insecticide	25.00	290.00	245.00	475.00	30.00	-----------
Fungicide	25.00	366.00	205.00	206.00	16.00	-----------
Water	325.00 (160,000 gal)	950.00 (840,00 gal)	340.00 (410,000 gal)	4,000.00 (650,000 gal)	620.00 (218,250 gal)[x]	45.00 (3,600 gal)
Labor	------------ (400.0 hr)[w]	5,600.00 (1,272.5 hrs)[v]	1,380.00 (228.0 hrs)[v]	6,884.00 (2,200.0 hrs)	460.00 (227.5 hrs)[v]	----------- (80.0 hrs)[w]
Machine	134.40 (14.0 hrs)	201.60 (21.0 hrs)	164.80 (16.5 hrs)	576.00 (60.0 hrs)	163.20 (17.0 hrs)	72.00 (5.0 hrs)
Marketing	225.00	150.00	2,880.00	2,900.00	40.00	50.00
Total Expenses	1,162.40	15,207.60	8,545.80	19,285.00	2,837.20	317.00
Income	2,429.74	170,000 lb	4,287.80	43,807.10	6,300.00	550.00
Net Income	1,267.34	N/A	(4,258.00)	24,522.10	3,462.80	233.00
Net Income/Acre	1,267.34	N/A	(2,129.00)	8,174.03	3,462.80	932.00
Dollar Return/Dollar Input	2.09	N/A	0.50	2.27	2.22	1.74

z Organic fertilizer donated by Griffin Industries.
y Costs amortized over three years.
x Cost of electric usage and 5 year amortized cost of pump.
w Includes unpaid volunteer or family labor.
v All unpaid family labor.

Results and Discussion

Weather conditions in 2012 were less than ideal for vegetable production. An abnormally warm and wet spring gave way to a very hot and dry summer for a lot of central Kentucky. Despite the wet condition, crops were planted in a timely fashion. After planting, the weather turned very hot and dry for a several weeks. The very high temperatures and dry conditions adversely impacted the yield of most vegetable crops from sunscald to blossom drop and premature ripening. The hot and dry conditions, however, reduce weed and disease problems for most growers.

The grower/cooperators in Boyle, Gallatin and Mercer counties used white plastic mulch for part of their production. White plastic use in early season production did not appear to perform as well as the tradition black plastic. However, when used in latter plantings the results were better with most of the improvement coming from a higher survival rate of transplants.

The Campbell County plot was unique in that the land was donated for use by a non-profit who arranged for volunteers to plant, maintain and harvest the produce. The non-profit then donated the produce that was harvested to area feeding programs for the economically disadvantaged and elderly. Production potentially could have been higher but the persistently wet nature of the plot affected production particularly for the peppers and tomatoes. Vegetable production was expanded to about five acres this year from about two acres last year. Also, a number of fruit trees and brambles were planted this year for future production.

Funding for this demonstration program was provided by the Kentucky Agricultural Development Board through a grant to the Kentucky Horticulture Council.

Fruit and Vegetable Disease Observations from the Plant Disease Diagnostic Laboratory—2012

Julie Beale, Paul Bachi, Brenda Kennedy, Sara Long, Kenny Seebold, and Nicole Ward, Department of Plant Pathology

Introduction

Diagnosing plant diseases and providing recommendations for their control are the result of U.K. 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 (PDDL), one on the U.K. campus in Lexington, and one at the U.K. Research and Education Center in Princeton. Two full-time diagnosticians and a full-time diagnostic assistant are employed in the PDDL, while Extension Specialists, Drs. Kenny Seebold and Nicole Ward provide diagnostic and disease management expertise in vegetable and fruit crops, respectively.

Of the approximately 3,500 plant specimens examined in 2012, one-third were fruits and vegetables, and 40% of those were from commercial growers (1). In addition to receiving physical diagnostic samples, the PDDL also provides a web-based digital consulting system in which Extension agents can submit images for consultation on plant disease problems. In 2012, 31% of digital cases involved fruit and vegetable diseases and disorders.

Materials and Methods

Diagnosis of fruit and vegetable diseases involves significant research into the possible causes of problems. Most visual diagnoses include microscopy to determine plant parts affected and to identify the pathogen(s) involved. In addition, many specimens require special tests such as moist chamber incubation, isolation onto culture media, enzyme-linked immunosorbant assay (ELISA), polymerase chain reaction (PCR) assay, nematode extraction, or soil pH and soluble salts tests. Fruits and vegetables are high value crops for which a high proportion of diagnostic samples require specialized testing and/or consultation with U.K. faculty plant pathologists and horticulturists. The PDDL also has a role in monitoring pathogen resistance to fungicides and bactericides. Furthermore, computer-based laboratory records are maintained to provide information used in conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs. Homeland security rules require reporting of all diagnoses of plant diseases to a national repository on a real-time basis.

Unusual weather patterns during 2012 impacted all crops, including fruits and vegetables. The onset of warm temperatures occurred earlier than normal in spring, and heat and drought conditions characterized spring through early summer weather. March was the warmest on record in Kentucky, while June was the second driest on record (2). The absence of early season rains and cool temperatures at the time of leaf emergence in fruit trees reduced the incidence of scab and certain other fungal foliar diseases. However, high temperatures and high humidity with low rainfall favored development of powdery mildew and many soil-borne diseases of the roots and vascular systems of both fruit and vegetable crops. Even though drought did abate in most of the state (with the exception of far western Kentucky) by late July to August, timing of rains prompted serious outbreaks of downy mildew in cucurbits well into September.

Results and Discussion

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

Grape downy mildew (*Plasmopara viticola*) was diagnosed on June 1, 2012 in central Kentucky, a much earlier diagnosis than typical. Although downy mildew was not widespread and was limited to shaded valleys in vineyards with limited or poorly-timed spray programs, the disease was detected in various regions of the state despite drought conditions. In addition, one particular case consisted of fungicide-resistant *P. viticola*. This is the first report of resistance of *P. viticola* to FRAC 11 QoI (strobilurin) class fungicides in Kentucky.

Blueberry mosaic virus was diagnosed from a large blueberry planting. This is the first report of the virus in Kentucky. Although the disease has been observed in northern states, this is the farthest south that the virus has been reported. Details of its geographic range are not yet known. At this point, the virus has not been completely characterized, and its means of transmission and potential impact are unknown.

Bacterial fruit blotch (*Acidovorax avenae* subsp. *citrulli*) was diagnosed in 2011 on 'Matrix' watermelon as an isolated occurrence in Allen county (one farm affected). This disease recurred in the Allen county location on 'Utopia' watermelon in 2012 and was also diagnosed in Casey county (also on 'Utopia') this year.

Bacterial wilt (*Ralstonia solanacearum*) was detected in tomato in high tunnel production systems in May (two locations in Madison county). The disease was also found in pepper (Morgan county) in late summer, which had not been reported previously in Kentucky. Early soil warming resulting from higher-than-average spring temperatures likely favored disease development, particularly in high tunnel systems.

Tomato spotted wilt virus (TSWV) was observed in twenty-eight different counties on solanaceous vegetables (tomato, pepper), as well as tobacco. Incidence of the disease was low in any given field, but many different farms in each county were affected. Early arrival of the vectors of TSWV (thrips) is suspected to have increased disease incidence.

Downy mildew (*Pseudoperonospora cubensis*) developed in late summer and became widespread in many cucurbits (cucumber, pumpkin, winter squash) in 2012. The range of hosts infected indicated that multiple strains of the pathogen were present simultaneously.

Tree Fruit Diseases

Pome Fruits. Unseasonably warm spring temperatures and rain events occurring during bloom favored fire blight (*Erwinia amylovora*) on both apple and pear, with clear visual symptoms of blighting appearing on pear as early as the second week of April. Infection in ornamental pear was extensive, but fruit pears were also affected in some locations. Levels of scab (*Venturia inaequalis*) were very low; frogeye leaf spot (*Botryosphaeria obtusa*) and cedar-apple rust (*Gymnosporangium juniperi-virginianae*) occurred at low to moderate levels on apple. Fruit rots—especially bitter rot (*Glomerella cingulata*)—were common in late summer.

Stone Fruits. Diseases were less common on stone fruits than in previous years. Limited incidence and severity of bacterial leaf spot (*Xanthomonas campestris* pv. *pruni*), leaf curl (*Taphrina deformans*) and scab (*Venturia carpophila*) were recorded on peach. Powdery mildew (*Podosphaera* sp.) of sweet cherry was an uncommon occurrence due to the limited number of sweet cherries grown in Kentucky.

Small Fruit Diseases

Grapes. Anthracnose (*Elsinoe ampelina*) was widespread for the third consecutive year but was diagnosed most often in home fruit plantings rather than in commercial vineyards. Black rot (*Guignardia bidwellii*) was not a severe problem. Downy mildew (*Plasmopara viticola*) was first diagnosed in early June, although it is typically a later season disease in Kentucky (see above). Powdery mildew (*Uncinula necator*) was more common than downy mildew.

Brambles. Few infectious diseases were diagnosed on brambles. One or two samples each of cane blight (*Leptosphaeria coniothyrium*), spur blight (*Didymella applanata*), orange rust (*Gymnoconia nitens*) and late leaf rust (*Pucciniastrum americanum*) were diagnosed on blackberry and/or raspberry. More common was the physiological disorder known as "white drupelet" in which scattered drupelets within an aggregate expand to a normal size but fail to ripen; high temperatures and intense solar radiation promote this disorder.

Blueberries. Blueberry mosaic virus (first report in Kentucky—see above) and blueberry red ringspot virus were diagnosed. Despite dry conditions during 2012, root and collar rot caused by *Phytophthora* spp. was common. Botyrosphaeria stem dieback (*Botryosphaeria* spp.) was diagnosed occasionally on blueberry.

Strawberries. The crown rot phase as well as the fruit/petiole rot phase of anthracnose (*Colletotrichum fragariae*) were diagnosed. Angular leaf spot (*Xanthomonas fragariae*) and common leaf spot (*Mycosphaerella fragariae*) were observed occasionally but were not serious problems.

Vegetable diseases

Beans. Foliar/pod diseases, including angular leaf spot (*Phaeoisariopsis griseola*) and anthracnose (*Glomerella lindemuthiana*), were common in areas where rain was more frequent. In western Kentucky where drought conditions persisted throughout most of the summer, ashy stem blight (*Macrophomina phaseolina*) occurred in numerous locations.

Cole crops. Few diseases were observed on cole crops, with the exception of black rot (*Xanothomonas campestris* pv. *campestris*), which was diagnosed in cabbage and kale from commercial and home garden plantings. Alternaria blight (*Alternaria japonica*) was observed in a few locations in late summer.

Cucurbits. Bacterial wilt (*Erwinia tracheiphila*) was problematic on cantaloupe early in the season in areas where striped cucumber beetle pressure was high. Downy mildew (*Pseudoperonospora cubensis*—see above) and powdery mildew (*Sphaerotheca fuliginea*) became problematic later in the season; Plectosporium blight (*Plectosporium cucumerina*) on pumpkins was also severe during late summer. Because foliar/vine diseases such as downy mildew, powdery mildew and Plectosporium blight tend to reduce rind hardening in pumpkin and winter squash, some growers were forced to harvest early rather than risk severe losses from Fusarium rot (*Fusarium* spp.) and other fruit rots. Bacterial fruit blotch (*Acidovorax avenae* subsp. *citrulli*) was diagnosed on watermelon from two locations (see above).

Peppers. Southern blight (*Sclerotium rolfsii*) and bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*) were diagnosed on pepper, although neither disease was widespread. Tomato spotted wilt virus and bacterial wilt (*Ralstonia solanacearum*) were unusual observations (see above).

Tomatoes. Foliar diseases such as early blight (*Alternaria solani*) and Septoria leaf spot (*Septoria lycopersici*) were much less common than average, while leaf mold (*Fulvia fulva*) was unusually prevalent in greenhouse/high tunnel systems and even field plantings. Timber rot (*Sclerotinia sclerotiorum*) was fairly common in the early part of the season; also prevalent were stem/vascular problems such as southern blight (*Sclerotium rolfsii*) and Fusarium wilt (*Fusarium oxysporum*). High incidence of tomato spotted wilt virus and two isolated cases of bacterial wilt (*Ralstonia solanacearum*) are described above.

Other vegetables. Cercospora leaf blight (*Cercospora asparagi*) and Fusarium crown rot (*Fusarium oxysporum* f. sp. *asparagi*) were diagnosed in asparagus plantings in 2012. Phytophthora crown rot (*Phytophthora dreschleri* or *Phytophthora cryptogea*) was diagnosed on lettuce from a hydroponic system. Root knot nematode (*Meloidogyne incognita*) was seen frequently on potato.

Fruits and vegetables are high value crops. Because many of them are new or expanding crops in Kentucky and involve unfamiliar production systems for Kentucky growers, disease diagnosis and management is even more critical. The PDDL is an important resource for Extension agents and the growers they assist. The information gained from diagnostic analyses will help improve production practices and reduce disease occurrences and epidemics in the future. The PDDL encourages county Extension agents to include in their programming the importance of accurate disease diagnosis and timely sample submission in order to provide fruit and vegetable producers in Kentucky with the best possible disease management information.

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Peach Variety Demonstration

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

Introduction

One of the initial and most important decisions every fruit grower makes is the choice of cultivars. Although cultivar performance and fruit quality information is very useful, obtaining this information is time-consuming, due to the time required for fruit trees to begin bearing fruit. It is also expensive due to the large number of cultivars available. One way of reducing this cost is to conduct a variety trial of the most recent cultivars with potential to performing well in Kentucky.

Materials and Methods

In 2004, a block of 37 peach cultivars was planted in the orchard of the UK Research and Education Center at Princeton, Kentucky (1). This planting consisted of two trees per variety spaced 6 ft apart within rows 18 ft apart. All trees receive trickle irrigation. The phenology (timing of flowering, etc.) of each cultivar was recorded in 2005 (1), in 2006 (2), and again in 2007 and 2008 (3). In spring of 2009, one tree per variety was removed in order to allow adequate spacing for future growth.

Table 1. Results of the 2008 thru 2012 harvest from the 2004 peach cultivar trial at Princeton, Kentucky.

	Date of Harvest					Cumulative Yield^z (lb/tree)	Yield (lb/tree)				
Cultivar	2008	2009	2010	2011	2012		2008	2009	2010	2011	2012
Allstar	Aug 4	July 27	July 22	July 25	July 3	455.3	111	30	90	71	98
Blushingstar	Aug 7	July 30	July 21	July 27	July 9	394.1	56	78	34	96	83
Contender	Aug 4	July 26	July 21	July 27	July 9	491.7	119	45	100	108	72
Coralstar	Aug 1	July 21	July 15	July 27	July 3	356.0	90	29	32	68	101
Cresthaven	Aug 18	Aug 7	Aug 9	Aug 23	July 23	293.1	49	40	61	2	107
Crimson Rocket	July 30	July 30	July 29	Aug 1	June 27	36.4	8	7	7	4	7
Encore	Aug 26	Aug 17	Aug 16	Aug 23	Aug 8	313.5	80	26	41	39	76
Ernie's Choice	July 30	July 24	July 21	July 25	July 3	65.8	3	8	8	18	28
Flat Wonderful*	July 14	June 20	July 15	July 5	June 13	108.2	17	17	21	14	40
Galaxy*	Aug 21	July 27	July 15	July 5	July 2	304.0	72	1	117	70	44
Glowingstar	Aug 7	July 30	July 21	July 27	July 11	486.0	112	75	25	108	97
John Boy	July 28	July 22	July 15	July 18	July 2	348.9	47	105	36	53	93
John Boy II	Aug 1	July 27	July 12	July 20	July 2	291.9	74	22	9	55	105
Klondike White	July 30	July 24	July 22	July 12	July 9	324.1	107	3	92	22	83
Laurol	Aug 28	Aug 28	Aug 16	Aug 23	Aug 8	372.7	87	46	47	78	58
PF 1	June 29	June 24	June 10	June 22	June 4	332.5	57	49	57	89	56
PF 15A	July 28	July 2	July 20	July 25	June 27	196.2	75	11	25	33	15
PF 17	Aug 4	July 28	July 21	July 27	June 27	427.3	76	75	69	87	78
PF 20-007	Aug 1	July 20	July 21	July 27	July 3	390.5	87	32	125	31	59
PF 24C	Aug 11	Aug 5	no harvest	Aug 1	July 9	203.9	42	58	0	14	64
PF 25	Aug 21	Aug 7	Aug 16	Aug 23	July 30	281.4	80	29	72	27	54
PF 27 A	Aug 15	Aug 7	Aug 16	Aug 23	Aug 6	323.1	58	2	106	78	66
PF 35-007	Aug 15	Aug 13	July 12	Aug 23	July 30	396.0	37	55	77	117	85
PF 5B	June 29	June 10	June 10	June 22	June 7	195.2	60	18	18	46	30
PF 7	July 11	June 30	June 30	July 9	June 7	208.3	51	33	5	47	62
PF Lucky 13	July 21	July 2	July 1	July 12	June 27	312.0	86	8	20	80	81
PF Lucky 21	Aug 4	July 4	July 29	Aug 1	July 2	353.6	84	58	69	38	74
Redhaven	July 22	July 15	July 12	July 15	June 27	298.6	81	8	21	51	97
RedStar	July 22	July 16	July 12	July 11	June 27	281.9	49	14	3	67	121
Reliance*	July 14	July 14	July 15	July 10	June 27	294.1	28	8	72	57	129
Snow Brite	July 14	no harvest		July 5	Aug 8	96.2	26	0	0	20	23
Snow Giant	Aug 25	Aug 25	Aug 16	Aug 23	June 11	290.6	82	55	35	48	53
Spring Snow*	June 27	June 5	June 18	no harvest	May 27	59.0	5	8	24	0	22
Sugar Giant	Aug 15	July 27	July 29	July 27	June 3	74.4	17	1	22	17	17
Sugar May*	July 8	June 5	June	June 27	May 30	89.1	21	4	1	37	26
Summer Breeze	July 25	July 18	July 15	July 18	July 2	273.7	70	28	41	33	78
Sweet-N-Up	Aug 7	July 30	Aug 9	Aug 1	July 11	118.6	30	16	0.9	27	46
True Gold	Aug 11	Aug 10	July 21	Aug 1	July 11	241.7	66	48	4	11	43
White Lady	Aug 7	July 20	July 21	July 18	July 3	209.8	77	9	1	12	72

z 2006, 2008, 2009, 2010, 2011 and 2012. There was no harvest in 2007 due to the spring freeze.
* Indicates first harvested in 2008.

Yield, fruit size (average weight of 25 fruits), and Brix readings of three fruits were recorded at harvest in 2006, 2008 thru 2012. No fruit was harvested in 2007 due to a series of freezes from April 5 through April 10, 2007 that affected all fruit crops in Kentucky. Bacterial spot ratings recorded in July of 2009 were reported in previous reports (4, 5).

Results and Discussion

The date of harvest generally ranged from two to four weeks earlier in 2012 than it did in 2011 (Table 1). 'Contender,' 'Glowingstar,' and 'Allstar,' have the highest cumulative yields. 'Reliance,' 'RedStar,' had the highest yield in 2012. 'PF 35-007,' 'Contender,' and 'Glowingstar' were among the top three in yield per tree in 2011. 'PF 20-007' and 'Galaxy' were the highest in 2010. 'John Boy' and 'Blushingstar' were the highest in 2009, and 'Contender,' 'Glowingstar,' and 'Allstar' averaged the highest yields per tree in 2008.

About two-thirds of the cultivars had higher yields in 2012 than in 2011. However, a few cultivars had light crops in 2012, due to poor winter flower bud survival and possibly due to poor pollination. Fruit averaged about 4.6 ounces per fruit in 2012, versus 5.0 ounces in 2011, 4.6 ounces per fruit in 2010, 6.2 ounces per fruit in 2009, and 4.8 ounces in 2008 (Table 2). Brix readings averaged 12.8 in 2012, versus 11.5 in 2011, 13.8 in 2010, 11.4 in 2009 and 11.9 in 2008. The hot dry weather resulted in both a decrease in fruit size and an increase in concentration of sugars during fruit development.

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

Table 2. Results of the 2008 thru 2012 harvest from the 2004 peach cultivar trial at Princeton, Kentucky.

	Fruit Wt (oz)					Brix (%)				
Cultivar	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Allstar	5.1	6.8	4.0	4.2	3.4	12.3	9.9	11.9	11.0	11.1
Blushingstar	4.8	7.1	5.9	4.5	4.2	12.4	9.2	14.3	11.8	13.6
Contender	4.5	6.8	4.5	5.6	2.8	12.0	10.6	12.9	13.5	12.7
Coralstar	5.4	9.6	7.1	5.9	4.2	14.8	11.3	14.4	11.3	12.7
Cresthaven	7.1	7.6	5.9	1.6	4.2	12.0	11.9	12.8	9.4	11.8
Crimson Rocket	3.7	.	3.1	2.8	4.9	14.8	12.3	.	12.6	8.3
Encore	6.9	7.1	6.8	8.5	3.8	12.7	13.0	15.0	13.1	12.7
Ernie's Choice	3.4	5.1	4.5	4.5	3.7	16.8	10.9	16.3	11.9	13.0
Flat Wonderful	3.8	3.4	2.3	2.5	3.7	12.0	13.5	13.3	10.1	11.1
Galaxy	4.9	.	3.7	4.8	4.5	13.8	18.0	13.4	12.1	16.1
Glowingstar	5.6	6.2	5.1	4.8	4.0	10.9	11.6	13.7	11.4	13.1
John Boy	6.0	6.1	8.5	6.5	4.8	13.7	11.9	14.7	11.9	14.3
John Boy II	4.8	5.4	5.1	6.1	4.5	12.5	9.3	16.2	11.9	11.9
Klondike White	4.7	5.6	2.5	5.9	4.8	16.0	12.8	15.1	9.9	14.0
Laurol	6.2	7.9	5.1	5.4	4.8	12.7	12.9	14.8	13.3	12.7
PF 1	3.4	5.2	4.2	4.0	3.1	8.2	.	9.4	8.2	10.5
PF 15A	3.5	4.9	5.2	3.4	6.1	8.0	10.9	12.7	11.8	13.1
PF 17	5.4	5.9	4.5	4.8	6.6	10.7	10.7	12.5	11.9	12.7
PF 20-007	6.5	9.6	4.8	7.9	5.5	10.1	10.4	10.7	12.6	11.9
PF 24C	6.2	4.5	.	4.5	4.5	11.1	.	.	13.1	13.3
PF 25	4.9	8.0	3.7	5.4	4.4	13.2	12.6	13.1	11.3	14.9
PF 27 A	4.5	.	4.0	6.3	4.5	12.3	.	13.7	13.3	13.5
PF 35-007	5.1	10.2	4.8	5.9	6.2	13.8	12.7	13.0	10.7	14.3
PF 5B	3.4	4.4	4.0	4.2	3.7	10.0	9.8	11.2	19.0	11.3
PF 7	3.8	5.6	.	4.7	5.1	10.2	8.3	10.1	9.2	11.5
PF Lucky 13	3.1	4.2	5.1	4.8	4.5	11.0	11.5	11.0	7.7	11.3
PF Lucky 21	6.5	5.6	3.4	5.1	4.8	11.8	10.3	.	12.2	13.7
Redhaven	3.7	4.9	13.9	6.3	4.8	11.5	11.7	13.9	10.4	11.1
RedStar	4.0	5.4	14.1	6.2	5.1	12.1	9.7	14.1	10.4	12.3
Reliance	4.2	4.8	4.8	7.1	5.4	11.0	11.9	13.3	11.9	13.3
Snow Brite	2.5	.	.	3.1	5.6	10.6	.	.	9.0	17.5
Snow Giant	7.9	7.9	6.5	4.5	5.4	13.3	10.5	16.8	11.7	12.1
Spring Snow	3.1	3.8	5.2	5.1	4.2	9.6	13.1	11.7	13.2	13.9
Sugar Giant	5.4	.	4.5	4.2	4.2	11.3	10.9	.	10.2	11.5
Sugar May	2.5	4.4	.	3.4	4.1	9.2	11.9	13.4	7.3	12.0
Summer Breeze	5.0	5.4	3.7	4.9	3.1	10.8	9.9	16.6	10.9	11.1
Sweet-N-Up	7.3	8.5	.	5.6	4.5	14.7	11.8	16.8	13.1	15.4
True Gold	7.2	6.5	5.9	5.7	5.6	11.7	10.0	13.3	.	13.5
White Lady	3.1	5.6	.	5.8	4.2	10.1	11.7	21.7	11.6	13.2

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Rootstock Effects on Apple and Peach Tree Growth and Yield

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Introduction

Apple and peach are the principal tree fruits grown in Kentucky, although the hot and humid summers and heavy clay soils make apple and peach production more difficult in Kentucky than in some neighboring tree fruit producing regions. The hot and humid summers lead to high disease and insect pressure in Kentucky orchards. Despite these challenges, productive orchards offer high per-acre income and are suitable for rolling hills and upland soils.

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

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

Materials and Methods

Grafts of known cultivars on the various rootstocks were produced by nurseries on the west coast and distributed to cooperators. Kentucky's NC-140 rootstock plantings are located at the UK Research and Education Center (UKREC) at Princeton. They are:

1. The 2003 apple rootstock trial compares eleven rootstocks with 'Golden Delicious' as the scion. Two trees of each rootstock were planted in a randomized complete block design with four replications (blocks). Trees were planted on 8 ft x 15 ft spacing.

Table 1. 2003 NC-140 apple rootstock trial, UKREC, Princeton, Kentucky.

Rootstock[1]	Percent Survival (number of trees planted)	Cumulative Yield (2005-2012)[2] (lb/tree)	Yield (lb/tree)	Fruit Weight (oz)	Number of Root Suckers	TCSA (sq. in.)	Cumulative Yield Efficiency (lb/sq. in.)
PiAu56-83	100 (8)	935	125.6	7.0	0.5	45.9	20.4
PiAu51-4	100 (7)	968	189.6	7.1	0.6	39.2	24.9
M.9 Pajam2	88 (8)	763	115.1	6.5	0.7	19.7	39.4
M.26	75 (8)	623	85.1	6.5	0.0	18.1	34.9
G.16	50 (8)	651	96.6	6.5	0.0	16.0	40.6
J-TE-H	100 (8)	733	100.3	6.5	0.9	15.9	45.8
M.9 NAKBT337	75 (8)	730	84.9	6.4	1.3	14.4	45.4
CG.41	88 (8)	669	86.7	6.9	0.0	14.2	47.2
Bud.62-396	100 (8)	682	80.5	6.5	0.0	13.5	50.7
CG.5935	75 (8)	651	106.0	6.7	0.0	11.4	55.2
B.9	50 (8)	176	12.1	5.1	1.8	3.3	54.8
Mean	77	722	102.3	6.7	0.5	21.0	40.2
LSD (5%)	31	172	64.7	1.3	NS	5.4	10.1

1 Arranged in descending order of trunk cross-sectional area (TCSA).
2 There was no yield in 2007 due to a spring freeze and extensive bird damage during that season.

Table 2. 2009 NC-140 peach rootstock planting, Princeton, Kentucky.

Rootstock[1]	Tree Mortality (% lost)	Julian Date of 90% Bloom	Julian Date of 10% Maturity	Cumulative Yield (2011-2012) (lb/tree)	Yield (lb/tree)	Number of Root Suckers	TCSA (sq. in)	Cumulative Yield Efficiency (2011-2012) (lb/sq in TCSA)
Microbac	0	89.0	167.8	57.2	54.6	1.4	13.9	4.12
Krymsk 86	0	87.0	168.0	51.7	50.8	0.0	13.1	3.83
Bright's Hybrid	50	90.0	167.6	51.5	47.3	0.0	13.0	3.97
Guardian	0	89.0	168.6	48.8	46.4	0.0	13.0	3.69
Viking	25	90.2	168.3	54.6	51.3	0.0	12.8	4.12
Atlas	0	89.8	168.9	54.1	51.5	0.0	12.0	4.54
Lovell	0	90.5	169.0	55.2	52.1	0.0	11.8	4.83
KV010-127	0	90.4	168.5	50.4	48.0	0.1	11.5	4.26
KV010-123	12.5	92.1	168.7	49.7	47.5	0.0	11.0	4.54
HBOK 32	12.5	91.7	167.0	40.0	36.1	0.0	9.9	4.12
HBOK 10	0	92.3	165.1	38.1	33.9	0.0	8.5	4.68
P. american	12.5	92.6	164.9	39.6	35.2	4.9	7.4	5.54
Controller	0	93.0	168.0	41.4	38.7	0.0	7.3	5.68
Krymsk 1	0	93.0	166.8	23.1	20.2	3.6	4.5	5.39
Mean	8.0	90.8	167.6	46.6	43.6	0.7	10.6	4.54
LSD (5%)	24.4	2.8	0.7	13.9	13.4	2.4	1.9	1.28

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

2. The 2009 peach rootstock trial compares fourteen rootstocks with 'Redhaven' as the scion cultivar. Eight trees of each rootstock were planted in a randomized complete block design with eight replications (blocks). Trees were planted March 2009, on 16 ft x 20 ft spacing.
3. The 2010 apple rootstock trial is a planting of 'Aztec Fuji' apple on thirty-one different rootstocks with four blocks per rootstock and up to 3 trees per rootstock per block. It was planted in March 2010. The experimental design was a randomized complete block design, and trickle irrigation was installed a month after planting. Heavy spring rains resulted in many of the graft unions sinking below ground level. Many of the trees were replanted and allowed to resettle through the summer. The height of the graft unions above the soil line now average 5 inches with a range of from 3 to 7 inches.

Orchard floor management for these trials consists of 6.5 ft bare ground herbicide-treated strips with mowed sod alleyways. Trees are fertilized and sprayed with pesticides according to local recommendations (1, 2). Yield and trunk circumference measurements are recorded for all of the rootstock trials, and trunk cross-sectional area (TCSA) is calculated from the trunk circumference measurements taken 12 inches above the graft union for apple, and 6 inches above the graft union for peach. Cumulative yield efficiency is the cumulative yield divided by the trunk cross-sectional area of the tree. It is an indicator of the proportion of nutrient resources a tree is putting into fruit production relative to vegetative growth. Tree height and canopy spread (the average of the within row and across row tree widths) are recorded at the end of the 5th and final (usually the 10th) seasons of each trial. Fruit size is calculated as the average weight (oz) of 50 fruits.

Results and Discussion

The 2012 growing season in Kentucky had greater than normal temperatures and below normal rainfall. Spring freezes on 11 and 12 April caused tree fruit crop yields and fruit quality to be quite variable between varieties and from orchard to orchard. Monthly precipitation averages across the state were below normal for all but July, which was 0.6 inches above normal. Western Kentucky received far less rainfall during the summer than other areas of the state, to the extent of extreme drought conditions. Monthly temperature averages were well above normal from December through July compounding the affects of the drought. January, February, and March were (6, 4, and 11°F above normal, respectively. At the experiment station at Princeton, Kentucky, temperatures reached 32.2°C (90°F) or greater for 50 of the 92 days in June through August. The early start to the growing season and hot summer accelerated fruit maturity date so that most fruit crops ripened roughly three weeks earlier than normal throughout the season.

1. 2003 Apple Rootstock Trial

Mortality, cumulative yield, fruit weight, trunk cross-sectional area (TCSA), and cumulative yield efficiency varied significantly among the rootstocks in the 2003 apple rootstock trial (Table 1). Scions on B.9 and CG.5935 rootstocks are the smallest trees and, along with G.16, have had the highest mortality (50 to 75%). Cumulative yield was the most for scions on PiAu 56-83 and PiAu 51-4, which were also the largest trees in this trial. Trees on these two rootstocks are too vigorous for high density plantings in Kentucky. Average yield in 2012 over the whole trial was about the same as last year, but biennial bearing was evident in that about 21% of the trees yielded half as much or less than last year, and about 19% of the trees yielded twice as much or more than last year. The number of root suckers per tree did not vary significantly among the different rootstocks in this trial, and averaged less than one per tree.

2. 2009 Peach Rootstock Trial

Last year (2011) was the first year yield data was collected from this trial, but due to poor weather conditions (hail damage, etc.), and the emergence of the cicada brood XIX, most of the peaches harvested would not have been considered commercial quality even though they met the commercial size requirements as per protocol for this trial. In 2012, a crop that was of commercial size and quality was harvested, in spite of the early season and season-long drought.

No significant differences were observed for fruit size, but mortality, Julian date of 90% bloom and 10% fruit maturity, cumulative yield, yield, number of root suckers, TCSA, and cumulative yield efficiency varied significantly among the fourteen rootstocks in this trial (Table 2). Trees on Bright's Hybrid and Viking have had the highest mortality rates, 50% and 25%, respectively. The time of 90% bloom averaged less than two days from first to last with scions on Microbac being the earliest and those on Lovell being the latest to bloom. Maturity was the latest for scions on Lovell, and earliest by about four days for scions on P. americana. Scions on P. americana and Krymsk1 averaged the greatest number of root suckers. Microbac was the most vigorous rootstock, and Krymsk1 the least vigorous. Yield per tree was significantly lower for scions on Krymsk1 than for any of the other rootstocks in this trial. Yield was highest for Microbac, but was not significantly different from that of Lovell, Atlas, Viking, Bright's Hybrid, KV010-127, KV010-123, Krymsk86, or Guardian.

Table 3. 2010 NC-140 apple rootstock trial, Princeton, Kentucky.

Rootstock[1]	Initial Number of Trees	Tree Mortality (% lost)	Yield (kg/tree)	Fruit Weight (oz/fruit)	Number of Root Suckers	TCSA (sq. in.)	Yield Efficiency (lb/sq in TCSA)
PiAu 9-90	4	0	8.8	5.3	1.0	6.7	1.31
B.70-20-20	12	0	6.4	4.9	1.8	6.6	0.97
PiAu 51-11	11	0	12.5	5.5	0.9	5.2	2.43
B.70-6-8	12	0	13.2	5.3	0.0	4.5	2.94
B.7-3-150	12	0	11.7	5.8	0.0	4.4	2.68
B.67-5-32	12	0	6.6	6.0	0.3	4.3	1.52
G.202 N	8	0	16.9	5.6	1.4	4.3	3.96
M.26 EMLA	11	0	13.2	5.8	0.2	4.0	3.34
CG.935 N	10	0	20.5	4.9	0.1	3.9	5.22
B.64-194	7	0	9.7	5.3	1.0	3.8	2.54
CG.5222	8	0	19.8	5.1	3.8	3.8	5.26
CG.4004	4	0	7.0	6.0	1.8	3.6	1.93
CG.3001	3	0	14.7	6.3	1.7	3.5	4.19
M.9 Pajam2	9	0	8.6	5.8	7.7	3.5	2.46
CG.4814	4	0	15.0	5.1	5.5	3.5	4.33
G.935 TC	4	0	10.6	5.6	5.5	3.3	3.17
G.41 TC	1	0	0.9	7.1	2.0	3.2	0.27
Supp.3	5	0	12.5	5.9	0.4	3.1	4.09
M.9 NAKBT337	12	17	14.7	5.9	0.7	3.1	4.83
G.202 TC	12	0	13.6	5.5	0.9	3.0	4.49
G.11	8	13	14.5	5.8	0.3	3.0	4.88
B.10	12	0	8.4	6.5	0.0	2.7	3.10
CG.4214	4	0	6.2	7.0	0.8	2.5	2.42
CG.5087	2	0	9.2	5.3	2.5	2.5	3.66
CG.4013	2	0	4.0	4.9	1.0	2.3	1.74
CG.4003	7	0	9.5	6.2	0.0	1.9	5.00
G.41 N	3	0	4.8	6.0	0.3	1.5	3.19
CG.2034	2	0	3.5	7.5	0.5	1.5	2.42
B.9	12	8	2.6	7.0	1.5	1.3	2.10
B.7-20-21	12	0	0.7	4.3	0.2	1.0	0.68
B.71-7-22	10	0	0.2	5.9	0.8	0.6	0.35
Means	NA	13	10.1	5.7	1.1	3.4	2.95
LSD (0.05)	NS	NS	10.6	1.4	3.1	1.2	8.96

[1] Arranged in descending order of the fall trunk cross-sectional area (TCSA) for each rootstock.

3. 2010 Apple Rootstock Trial

No significant difference were observed for mortality, but yield per tree, average weight per fruit, TCSA, and yield efficiency varied significantly among the 31 rootstocks (Table 3). Trees with PiAu 9-90, and B70-20-20 rootstocks are the largest, and trees with B.7-20-21 and B.71.7-22 are the smallest. This was the first year that these trees were harvested, and yield was greatest for scions on G.935N, G.5222 and G. 202N, and lowest for scions on B.7-20-21 and B.71-7-22. Except for G.4814 and G.935 TC., M.9 Pajam2 had significantly more root suckers than all of the other rootstocks.

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Wine and Table Grape Cultivar Evaluation Trial in Kentucky

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Introduction

The climate in Kentucky is well suited to produce a variety of wine and table grape cultivars. However, spring frosts, cold winter temperature fluctuations and long, warm, humid summers pose challenges to growing grapes in KY. Successful production is determined by the use of proper cultural practices and matching cultivar and rootstock to a specific site. The primary types of grapes grown in Kentucky are *Vitis vinifera* (European), interspecific hybrids, and *Vitis aestavalis* (Norton). Although interspecific hybrids and Norton are less sensitive to the continental climate in Kentucky, *V. vinifera* cultivars often produce more desirable wines and potentially have the highest economic gain for grape growers and wine makers. However, *V. vinifera* cultivars are more susceptible to winter injury and diseases, often resulting in a lower yield and increased labor inputs. A cultivar trial consisting of table, interspecific hybrid, and *V. vinifera* grape cultivars was conducted to assess and improve fruit and wine quality through cultural management, rootstock and clone selection. The following research update is intended to provide the 2012 season production and cultivar performance results.

Materials and Methods

Two research vineyards were planted in the spring of 2006 at the University of Kentucky Horticulture Research Farm in Lexington, Kentucky. Vineyard one consists of five table-grape and 20 American/hybrid cultivars. Each cultivar in vineyard one has four replications with three vines per replication (12 vines total) in a randomized complete block design. All cultivars were planted at 545 vines/acre (8 ft. between vines and 10 ft. between rows) and trained to a 6-foot single high wire bilateral cordon. Vines were planted as own-rooted vines with the exception of Chambourcin, Chardonel, Vidal Blanc and Traminette that were additionally planted on the rootstocks 101-14, 3309 and 5C respectively. Additional hybrid cultivars including: own-rooted Chambourcin, Frontenac Gris, and Marquette were added to this planting in 2008. Vineyard two was established in 2006 and consists of 15 European cultivars (*Vitis vinifera*) and 21 different clones. Each cultivar and clone of cultivar has four replications with four vines per replication (16 vines total) in a randomized complete block design. All vines were planted on the rootstock 101-14, spaced at 622 vines/acre (7 ft. between vines and 10 ft. between rows) and trained to vertically shoot positioned (VSP) bilateral cordons. Additional European cultivars including: Cabernet Sauvignon #8, Malbec, Petite Verdot, Rkatsitelli, Touriga, Tinto Cao, and Pinot Noir were added to this planting in 2008.

Table 1. Yield components for the 2012 American/hybrid winegrape cultivar trial, UK Horticulture Research Farm.

Cultivar/ Rootstock	Harvest Date	Yield per Acre[1] (tons)	Yield per Foot[2] (lb)	Shoots Per Foot of Cordon[3]	% Culled Clusters[4]	Cluster Weight (g)
White						
NY76.084	07/31	3.0	1.4	5.9	11	113
Cayuga	07/31	4.1	1.9	5.8	5	182
Seyval blanc	08/08	3.9	1.8	5.7	15	263
Vignoles	08/13	3.4	1.6	6.7	5	92
Chardonel/C-3309	08/30	4.3	2.0	5.9	2	242
Chardonel/OR	08/30	2.7	1.2	5.2	0	176
Vidal/5C	08/14	4.9	2.3	5.0	15	229
Vidal/OR	08/14	4.6	2.1	5.5	16	206
Villard	08/14	4.7	2.1	5.7	0	185
Traminette	08/09	4.6	2.1	6.6	2	116
Traminette/5C	08/09	5.7	2.6	6.5	1	152
Frontenac Gris	08/07	1.6	0.7	5.7	32	103
Red						
Marquette	08/13	0.5	0.2	6.5	62	51
Foch	07/30	0.2	0.1	6.4	87	40
Corot Noir	08/14	5.1	2.3	5.1	2	204
Frontenac	08/07	2.9	1.3	6.6	31	117
GR7	07/30	1.3	0.6	6.6	41	59
Chancellor	08/15	3.5	1.6	6.4	15	144
Noiret	08/14	3.5	1.6	5.3	4	174
Chamb/101-14	09/14	6.3	2.9	5.7	4	269
Chamb/OR	09/14	1.5	0.7	4.1	1	139
Norton	10/04	4.8	2.2	8.2	6	76
St. Vincent	09/12	5.4	2.5	6.5	1	190

1 Yield per acre calculated using 8 ft x 10 ft vine/row spacing, with 545 vines per acre.
2 Total yield divided by the total length of cordon = yield per linear foot of cordon.
3 Total number of shoots divided by the total length of cordon = shoots per linear foot of cordon.
4 Percentage of harvested clusters having ≥ 30% damage.

Table 2. Yield components for the 2012 table grape cultivar trial, UK Horticulture Research Farm.

Cultivar/ Rootstock	Harvest Date	Yield per Acre[1] (tons)	Yield per Foot[2] (lb)	Shoots Per Foot of Cordon[3]	% Culled Clusters[4]	Cluster Weight (g)
Einset	07/25	0.8	0.4	4.9	23	66
Reliance	07/25	1.6	0.7	5.9	43	121
Jupiter	07/25	1.8	0.8	5.5	29	107
Marquis	07/28	3.3	1.5	4.8	4	171
Neptune	07/31	2.5	1.1	4.4	8	217

1 Yield per acre calculated using 8 ft x 10 ft vine/row spacing, with 545 vines per acre.
2 Total yield divided by the total length of cordon = yield per linear foot of cordon.
3 Total number of shoots divided by the total length of cordon = shoots per linear foot of cordon.
4 Percentage of harvested clusters having ≥ 30% damage.

Standard commercial cultural management practices were implemented in both vineyards. In March of 2012 vines were spur pruned to retain approximately 8 count buds per linear foot of vineyard row. No herbicide or tillage was utilized to control winter annual weeds. Summer annual weeds were controlled with a single banded application of post-emergent herbicide (glyphosate) in July and followed by single spot spray where necessary. Vines expressed normal to high vigor and no nitrogen fertilizer was applied during any part of the 2011growing season. Disease and pest control were in accordance with the Midwest Commercial Small Fruit and Grape Spray Guide (ID-94).

Crop and vine balance were achieved by shoot thinning to 4-6 shoots per foot of cordon (*V. vinifera*) and 5-7 shoots per foot of cordon (hybrid) in mid-May and cluster thinned to appropriate crop loads post fruit set (berries bb size). Bird netting was not applied in the 2012 growing season due to very little bird pressure. Fruit maturity and harvest dates were determined by taking 100 berry samples starting at veraison to monitor the progression of total soluble solids (TSS) (Atago Digital Refractometer), pH (Hannah 222 pH meter) and titratable acidity (TA) (end point titration of pH 8.2 using .100 N sodium hydroxide) until harvest. Each vine was harvested separately to determine the number of clusters and yield/vine. Table grape clusters were selectively harvested at two to three harvest times dependent upon fruit chemistry. A final 100-berry sample was taken at harvest to determine fruit chemistry (TSS, pH and TA) and berry weight.

Table 3. Yield components for the 2012 Vinifera winegrape cultivar trial, UK Horticulture Research Farm.

Cultivar/Clone	Harvest Date	Yield per Acre[1] (tons)	Yield per Foot[2] (lb)	Shoots Per Foot of Cordon[3]	% Culled Clusters[4]	Cluster Weight (g)
White						
Pinot Grigio #146	08/08	5.4	2.5	6.1	5	154
Pinot Grigio #152	08/08	4.9	2.2	6.2	5	146
Pinot Grigio #4	08/08	5.3	2.4	6.7	3	142
Chardonnay #15	08/29	2.0	0.9	5.3	0	107
Chardonnay #37	08/29	1.7	0.8	5.6	1	108
Chardonnay #4	08/29	1.6	0.7	5.1	30	151
Chardonnay #43	08/29	2.0	0.9	5.5	3	118
Chardonnay #76	08/29	2.1	1.0	5.7	1	119
Viognier	08/13	1.0	0.4	2.0	1	117
Rkatsiteli	08/29	3.2	1.5	5.0	0	168
Riesling #12	09/07	1.4	0.6	5.7	61	107
Riesling #17	09/07	1.0	0.5	5.3	73	150
Riesling #9	09/07	1.8	0.8	5.4	52	107
Red						
Limberger	08/31	3.2	1.5	4.6	2	169
Petite Verdot #2	09/15	1.8	0.8	4.6	0	55
Tinto Cao	09/07	1.3	0.6	3.2	2	114
Touriga	09/07	3.5	1.6	4.9	0	105
Cabernet Franc #214	09/15	2.9	1.3	5.9	2	96
Cabernet Franc #312	09/15	2.7	1.2	5.8	2	102
Cabernet Franc #4	09/15	2.6	1.2	6.2	2	97
Cabernet Franc #5	09/15	2.9	1.3	6.0	1	101
Cabernet Sauvignon #337	10/05	2.9	1.3	5.5	3	96
Cabernet Sauvignon #8	10/05	2.8	1.3	5.9	8	80

1 Yield per acre calculated using 7 ft x 10 ft vine/row spacing, with 622 vines per acre.
2 Total yield divided by the total length of cordon = yield per linear foot of cordon.
3 Total number of shoots divided by the total length of cordon = shoots per linear foot of cordon.
4 Percentage of harvested clusters having ≥ 30% damage.

Results and Discussion

Freezing temperatures experienced during the week of April 9, 2012 resulted in extensively more damage to *V. vinifera* vines trained to a low cordon as compared to hybrid cultivars trained to a high cordon training system. On average *V. vinifera* vines trained to 36" fruiting wire sustained 54% primary shoot injury, while hybrid and *V. vinifera* vines trained to 72" fruiting wire expressed little to no injury as a result of the spring frost event. The 54% primary shoot injury caused by the frost event resulted in a 38% reduction in the number of clusters per shoot and a nearly 50% reduction in average yield of *V. vinifera* vines as compared to 2011 yield data (Table 3).

Average yields of hybrid vines were also nearly 50% lower than 2011 yields as a result of reduced vine vigor caused by the warmer and drier than average summer especially during the month of July (Table 1). Substantial reductions in vine vigor and total leaf area caused by the abnormally warm and dry conditions required increased cluster thinning in order to ensure complete fruit ripening and to prevent over-cropping of highly fruitful hybrid cultivars. Reductions in yield also resulted from damage to clusters associated with Green June Beetle feeding, which was especially high on the earliest ripening wine grape cultivars, such as: Frontenac, Frontenac gris, Marquette, Foch, and GR7. Table grape cultivars including Einset, Reliance, and Jupiter were also substantially affected by damage caused by Green June Beetles (Table 2). Although average yields were reduced at the UKHRF, the fruit chemistry for hybrid (Table 4), *V. vinifera* (Table 5) and table grape (Table 6) cultivars were within commercially acceptable ranges and wines produced from 2012 season grapes has the potential to be of exceptional quality.

The vineyards at the University of Kentucky Horticulture Research Farm are planted in an excellent site where most varieties can reach full production potential. All sites in Kentucky will not be able to sustain an economically viable crop of all varieties. It is imperative to evaluate each grape growing site and match variety and rootstock to that specific site.

Table 4. Fruit composition for the 2012 American/hybrid winegrape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar/ Rootstock	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
White				
NY76.084	190	16.3	3.0	11.2
Cayuga	279	18.4	3.2	7.5
Seyval blanc	204	21.4	3.2	6.5
Frontenac Gris	106	25.3	3.3	11.6
Vignoles	156	22.0	2.9	11.1
Chardonel/C-3309	240	25.5	3.4	9.2
Chardonel/OR	240	26.1	3.4	8.0
Vidal/5C	229	19.1	3.3	8.1
Vidal/OR	225	18.9	3.1	9.0
Villard	338	17.5	3.0	11.1
Traminette	191	20.3	3.0	6.9
Traminette/5C	193	19.4	3.0	7.4
Red				
Marquette	106	27.1	3.4	6.5
Foch	110	22.6	3.4	8.5
Corot Noir	288	18.4	3.5	5.6
Frontenac	114	24.0	3.3	11.6
GR7	136	21.2	3.3	8.7
Chancellor	188	20.4	3.5	7.2
Noiret	272	20.1	3.3	6.9
Chamb/101-14	250	23.7	3.5	6.8
Chamb/OR	228	24.1	3.5	5.9
Norton	144	23.4	3.6	9.2
St. Vincent	345	21.6	3.4	6.3

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

Table 5. Fruit composition for the 2012 vinifera winegrape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar/Clone #	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
White				
Pinot Grigio #146	158	22.0	3.4	5.9
Pinot Grigio #152	165	22.2	3.4	5.7
Pinot Grigio #4	161	22.4	3.5	5.6
Chardonnay #15	170	23.4	3.5	7.2
Chardonnay #37	161	23.0	3.6	6.8
Chardonnay #4	175	22.9	3.4	8.9
Chardonnay #43	161	23.3	3.5	6.9
Chardonnay #76	170	22.9	3.6	6.5
Viognier	168	22.2	3.2	6.5
Rkatsiteli	233	22.3	3.4	7.1
Riesling #12	180	18.3	3.4	5.7
Riesling #17	188	18.9	3.4	5.6
Riesling #9	186	17.6	3.4	5.6
Red				
Limberger	197	23.2	3.5	6.2
Petite Verdot #2	121	24.5	3.6	6.5
Tinto Cao	164	23.0	3.8	5.1
Touriga	171	22.0	3.7	5.1
Cabernet Franc #214	155	25.2	3.7	4.5
Cabernet Franc #312	171	24.4	3.8	4.7
Cabernet Franc #4	194	25.0	3.8	4.4
Cabernet Franc #5	189	24.4	3.7	4.2
Cabernet Sauvignon #337	149	22.0	3.6	5.1
Cabernet Sauvignon #8	159	23.7	3.7	5.3

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

Table 6. Fruit composition for the 2012 table grape cultivar trial, UK Horticulture Research Farm.[1]

Cultivar/ Rootstock	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
Einset	187	19.7	3.1	6.2
Reliance	209	18.9	3.2	5.1
Jupiter	302	18.7	3.5	4.4
Marquis	370	16.3	3.3	4.7
Neptune	308	19.3	3.1	9.2

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

Rabbiteye Blueberry Variety Evaluations

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

Introduction

Blueberries are a profitable and rapidly expanding small fruit crop in Kentucky. Previous University of Kentucky trials have evaluated primarily highbush blueberries. Home plantings of the less hardy rabbiteye blueberries, which are planted commercially from Tennessee southward, have done well in the Princeton and Henderson areas of Kentucky. This trial was established to evaluate seven rabbiteye blueberry varieties for performance in Central Kentucky.

Table 1. Rabbiteye blueberry yield, fruit size, taste, appearance ratings and harvest dates, Lexington, Kentucky, 2012.

Variety	Yield (lb/A)[1]		Berry Wt (oz/25 berries)		Berry Taste (1-5)[2]		Berry Appearance (1-5)[2]		First Harvest Date	Harvest Midpoint Date[3]
Powderblue	3174.9	a	0.7	bcd	4.1	b	4.6	a	10 July	29 July
Spartan[4]	2969.5	ab	0.8	ab	3.7	cd	3.5	e	1 June	10 June
Onslow	2929.7	ab	0.9	a	3.6	d	4.4	ab	29 June	28 July
Tifblue	1192.8	abc	0.7	bc	4.1	b	4.2	c	29 June	28 July
NC-1827	1050.3	bc	0.6	de	4.0	bc	4.3	bc	5 June	18 June
Climax	743.6	c	0.6	e	4.3	a	3.8	d	23 June	5 July
Columbus	349.3	c	0.8	ab	3.7	d	4.4	ab	5 July	16 July
Ira	244.8	c	0.6	cde	3.7	d	3.9	d	29 June	10 July

1 Numbers followed by the same letter are not significantly different (Waller-Duncan Multiple Range Test LSD P = 0.05).
2 Berry taste and appearance ratings: 1 = poor; 5 = excellent.
3 Date by which half of the total season's harvest was picked.
4 Spartan is a highbush blueberry variety.

Materials and Methods

Plants were acquired from Finch Nursery, Bailey, NC and from Dr. Jim Ballington at North Carolina State University, Raleigh, NC. They ranged in age from one-year rooted cuttings to two-year-old plants. They were planted at the Horticultural Research Farm in Lexington in the spring of 2004. Plants were set on raised beds of Maury silt loam soil into which peat and composted pine bark mulch had been incorporated. The soil pH was adjusted from 5.6 to 4.6 by applying 653 lb/A of sulfur. Seventy pounds of phosphorus per acre were incorporated into the field prior to bed shaping and planting. Five replications of single-plant plots were set in rows running east to west in a randomized block design. The spacing was 6 ft between plants and 12 ft. between rows. All plants were mulched with a three foot wide, six inch layer of wood chips. Plots were drip irrigated using point source emitters (1 gal/hr/plant).

Plants showing iron chlorosis were fertilized with Peters Professional Acid fertilizer (24-12-12) and iron chelate the first year. Plants have been fertilized yearly with Osmocote Plus 5-6 month controlled release (15-9-12) fertilizer that contains six trace elements and magnesium at the rate of 1 oz per plant in March, April, May, June and July. Ammonium sulfate was applied in early spring of 2012 as a nitrogen source and to help lower soil pH.

Fungicide applications included lime sulfur and Rally. Roundup and Oryzalin were applied for weed control. Netting was used over the planting for bird control.

Fruit were harvested once a week. Twenty five berries from each plant were weighed to determine average berry size at each harvest. In this trial the highbush variety Spartan was used for comparison purposes. Harvested fruit were rated for taste and appearance several times.

Results

The 2012 growing season began two to three weeks earlier than normal. Rainfall was normal in January, July and August, below normal in February, March, April and June, and above normal in May. Temperatures from March to August were above normal. A frost on 11 and 12 April may have reduced yields somewhat.

Harvest and fruit characteristic data are shown in Table 1. Varieties ripened two to three weeks earlier than in previous years for this trial (Tables 2, 3, 4). Powderblue, Onslow Tifblue, and NC-1827 had the largest yields. There were no significant differences between their yields and that of the highbush variety Spartan. In the four seasons that data has been collected, Pow-

Table 2. Rabbiteye blueberry yield, fruit size, taste, appearance ratings and harvest dates, Lexington, Kentucky, 2010.

Variety	Yield (lb/A)[1]		Berry Wt (oz/25 berries)		Berry Taste (1-5)[2]		Berry Appearance (1-5)[2]		Harvest date	Harvest Midpoint Date[3]
NC-1827	2,940	a	0.7	c	3.5	a	4.6	a	25 June	13 July
Columbus	990	b	1.4	ab	3.1	a	4.8	a	30 June	27 July
Climax	430	b	0.7	c	2.6	a	4.5	a	8 July	22 July
Onslow	310	b	1.3	ab	2.8	a	4.5	a	15 July	04 Aug
Ira	150	b	1.7	a	3.0	a	4.5	a	29 July	29 July
Tifblue	80	b	1.5	a	2.8	a	4.5	a	29 July	29 July
Powderblue	40	b	1.0	bc	3.5	a	5.0	a	29 July	29 July

1 Numbers followed by the same letter are not significantly different (Waller-Duncan Multiple Range Test LSD P = 0.05).
2 Berry taste and appearance ratings: 1 = poor; 5 = excellent.
3 Date by which half of the total season's harvest was picked.

derblue and NC-1827 have tended to be the higher yielders. Onslow, Columbus and Spartan had the highest berry weights. Onslow and Columbus have consistently had top rabbiteye berry weights in this trial. Climax had a significantly higher taste rating than any other rabbiteye, and Spartan, this season. In previous years, all the rabbiteye varieties have had mostly similar taste ratings. They tend to have a grittier texture and thicker skins. Powderblue, Onslow and Columbus were the most attractive varieties this season. Rabbiteye varieties tend to have very attractive berries with a heavy waxy bloom.

Rabbiteye blueberries generally mature later than those of highbush and southern highbush varieties. NC-1827 was the first rabbiteye harvested, as in all previous trial seasons. Powderblue has had the latest first-harvest date in three of the four trial seasons.

Table 3. Rabbiteye blueberry yield, fruit size, taste, appearance ratings and harvest dates, Lexington, Kentucky, 2009.

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

1 Numbers followed by the same letter are not significantly different (Waller-Duncan Multiple Range Test LSD P = 0.05).
2 Berry taste and appearance ratings: 1 = poor; 5 = excellent.
3 Date by which half of the total season's harvest was picked.

Table 4. Rabbiteye blueberry yield, fruit size, taste, appearance ratings and harvest dates, Lexington, Kentucky, 2008.

Variety	Yield (lb/A)[1]	Berry Wt (oz/25 berries)	Berry Taste (1-5)[2]	Berry Appearance (1-5)[2]	First Harvest Date	Harvest Midpoint Date[3]
Powderblue	2856 a	0.8 bcd	3.3 ab	3.4 b	12 July	3 August
NC-1827	2745 a	0.6 d	3.2 ab	3.7 ab	27 June	10 July
Climax	2154 ab	0.8 bcd	3.3 ab	3.6 ab	29 June	17 July
Onslow	1926 ab	1.1 ab	3.5 a	4.3 a	17 July	12 August
Tifblue	1147 ab	1.0 abc	3.6 a	3.6 ab	17 July	3 August
Columbus	840 ab	1.3 a	3.0 ab	3.6 ab	7 July	28 July
Ira	52 b	0.8 cd	2.5 b	3.2 b	23 July	31 July

1 Numbers followed by the same letter are not significantly different (Waller-Duncan Multiple Range Test LSD P = 0.05).
2 Berry taste and appearance ratings: 1 = poor; 5 = excellent.
3 Date by which half of the total season's harvest was picked.

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Advanced Thorny and Thornless Primocane-fruiting Blackberry Selection Trial at Kentucky State University

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Introduction

Blackberry plants are unusual among fruit crops in that they have perennial root systems, but have biennial canes. There are two cane types, primocanes, or first year canes, which are usually vegetative, and floricanes, which are the same canes and flower and produce fruit the next growing season. Floricanes then die after fruiting and need to be removed. Primocane-fruiting blackberries have the potential to produce two crops per year, with a normal summer crop (floricane) and a later crop on the current season primocanes. Primocane-fruiting blackberries flower and fruit from mid-summer until frost, depending on temperatures, plant health, and the location in which they are grown. Growers can reduce pruning costs by mowing canes in late winter to obtain a primocane crop only; this also provides anthracnose, cane blight and red-necked cane borer control without pesticides. Relying only on a primocane crop also avoids potential winter injury of floricanes.

The first commercially available primocane-fruiting blackberry varieties, 'Prime-Jim®' and 'Prime-Jan®', were released by the University of Arkansas in 2004 (Clark et al., 2005; Clark, 2008). 'Prime-Ark®45' was released for commercial use in 2009. Fruit size and quality of primocane-fruiting blackberries can be affected by the environment. Summer temperatures above 85°F can greatly reduce fruit set, size and quality on primocanes; which results in substantial reductions in yield and fruit quality in areas with this temperature range in summer and fall (Clark et al., 2005; Stanton et al., 2007). All currently available primocane-fruiting blackberry selections are thorny and erect. The objective of this study was to determine if thorny and thornless advanced selections developed by the University of Arkansas (UARK) Blackberry Breeding Program were superior to 'Prime-Ark®45' in terms of yield and fruit quality under Kentucky growing conditions.

Materials and Methods

In June 2011, a blackberry variety trial was established at Kentucky State University (KSU). Plants of the commercially available primocane-fruiting cultivar 'Prime-Ark 45®' (thorny erect, primocane-fruiting) and the Arkansas Primocane-fruiting (APF) selections of thorny or thornless (T) advanced selections (APF-153 T, APF-156 T, APF-158, APF-172 T, APF-185 T, APF-190 T, and APF-205 T) from the UARK blackberry breeding program, were planted at the KSU Research and Demonstration Farm, in Frankfort, Kentucky. Plants were arranged in a randomized complete block design, with 4 blocks, including 5 plants of each cultivar per block (total of 20 plants of each cultivar) in a 10 foot plot. Spacing was 2 feet between each plant, and 5 feet between groups of 5 plants; with each row being 70 feet in length. Rows were spaced 14 feet apart. This trial was planted on the certified organic land and managed with organic practices following the National Organic Program standards. Weed control was achieved by placing a 6-8 inch deep layer of straw around plants, adding straw when necessary and hand weeding. Plants were irrigated weekly with t-tape laid in the rows.

There were few fruit on primocanes in the fall of 2011 or on floricanes in the spring of 2012, so fruit were not harvested. Primocanes began producing ripe fruit in late-July, 2012, for most selections and were harvested each Monday and Thursday until a killing frost (28°F) on October 11, 2012.

Results and Discussion

Primocane fruit production began in late-July or early-August for most selections except APF-185 T which began producing fruit in September. Fruit production continued until frost; however, yields were quite low and likely reflected the poor production conditions in 2012 and the young age of the plants (Table 1). APF-158 had the highest yield at 2559 lb/acre. However, all other selections had yields that were much lower. Yields of other selections in this trial ranged from 62-575 lb/acre. Prime-Ark 45® had a yield of 583 lb/acre. APF-185 T had the largest average berry size at 4.6 g. Prime-Ark 45® had the smallest berry at 3.0 g. Extreme high temperatures were seen during extended periods of the summer and fall; there were 64 out of 122 days with a daily high temperature above 85°F from June through September. The average high in July was 91.1°F with three days that the temperature was over 100°F and only five days in that month had high temperatures that were below 85°F. These high temperatures likely reduced fruit and drupelet set, fruit size, and yields in addition to young plant age. APF-185 T in particular, was observed to suffer from reduced fruit set with no fruit harvested until September 10th despite frequent flowering and vigorous primocane growth. However, berry size was large once fruit did set. Overall, APF-158, APF-172, and APF-205 T were comparable or superior to Prime-Ark 45® in regards to yield and average berry weight. Year to year yield and fruit quality characteristics will need to be further evaluated and none of these advanced selections have yet been released for commercial production.

Table 1. Yield and berry weight in 2012 for seven advanced primocane-fruiting selections from the University of Arkansas Blackberry Breeding Program and the primocane-fruiting cultivar 'Prime-Jan®' that were established at the Kentucky State University Research Farm in June 2011.

Selection	Fruit Weight (g)	Yield (lb/acre)	Harvest Date
Prime-Ark 45	3.0 d	583 b	7/26-10/11
APF-153 T	3.8 abc	156 cd	7/26-10/4
APF-156 T	3.5 cd	256 bcd	7/30-10/11
APF-158	4.2 ab	2559 a	7/26-10/11
APF-172	3.6 bcd	575 b	8/2-10/11
APF-185 T	4.6 a	62 d	9/10-10/11
APF-190 T	3.9 abc	269 bcd	8/9-10/11
APF-205 T	4.5 a	560 bc	7/26-10/11

[1] Numbers followed by the same letter are not significantly different (Least Significant Difference P = 0.05).

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The 'Prime-Jan®' and 'Prime-Ark®45' Thorny Primocane-fruiting Blackberry Trial at Kentucky State University

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Introduction

Kentucky's climate is well-suited for blackberry production and small-scale commercial production for "U-Pick", Community Supported Agriculture (CSAs), and farmer's markets. Blackberry plants are unusual among fruit crops in that they have perennial root systems, but have biennial canes. There are two cane types, primocanes, or first year canes, which are usually vegetative, and floricanes, which are the same canes and flower and produce fruit the next growing season. Floricanes then die after fruiting and need to be removed. Primocane-fruiting blackberries have the potential to produce two crops per year, with a normal summer crop (floricane) and a later crop on the current season primocanes. Primocane-fruiting blackberries flower and fruit from mid-summer until frost, depending on temperatures, plant health, and the location in which they are grown. Growers can reduce pruning costs by mowing canes in late winter to obtain a primocane crop only; this also provides anthracnose, cane blight and red-necked cane borer control without pesticides. Relying only on a primocane crop also avoids potential winter injury of floricanes.

The first commercially available thorny primocane-fruiting blackberry varieties, 'Prime-Jim®' and 'Prime-Jan®', were released by the University of Arkansas in 2004 (Clark et al., 2005; Clark, 2008). In Kentucky trials, 'Prime-Jan®' has higher yields and larger fruit than 'Prime-Jim®'. 'Prime-Ark®45' was recently released for commercial production by the University of Arkansas, but has not been tested in Kentucky (Clark and Perkins-Veazie, 2011). Fruit size and quality of primocane-fruiting blackberries can be affected by the environment. Summer temperatures above 85°F can greatly reduce fruit set, size and quality on primocanes; which results in substantial reductions in yield and fruit quality in areas with this temperature range in summer and fall (Clark et al., 2005; Stanton et al., 2007). The objective of this study was to determine if 'Prime-Ark®45' is superior to 'Prime-Jan®' in terms of yield and fruit quality under Kentucky growing conditions.

Materials and Methods

In April 2010, a blackberry variety trial was established at Kentucky State University (KSU). Plants of the commercially available primocane-fruiting cultivars 'Prime-Jan®' and 'Prime-Ark®45', both are thorny erect, primocane-fruiting selections, were planted at the KSU Research and Demonstration Farm, in Frankfort, Kentucky. Plants were arranged in a randomized complete block design, with 4 blocks, including 5 plants of each cultivar per block (total of 20 plants of each cultivar) in a 10 foot plot. Spacing was 2 feet between each plant, and 5 feet between groups of 5 plants; with each row being 125 feet in length. Rows were spaced 14 feet apart. This trial was planted on certified organic land and managed with organic practices following the National Organic Program standards. Weed control was achieved by placing a 6-8 inch deep layer of straw around plants, adding straw when necessary and hand weeding. Plants were irrigated weekly with t-tape laid in the rows.

In an effort to improve plant establishment in 2011, both floricane and primocane were maintained, and fruit were harvested from all these canes. In 2012, dormant canes were mown in mid-March and only primocanes were allowed to emerge for summer cropping. Therefore, only primocane fruit were harvest in 2012. Primocanes began producing ripe fruit in late-July, 2012, which were harvested each Monday and Thursday until a killing frost of 28°F on October 11, 2012.

Table 1. Yield and berry weight in 2012 for the thorny primocane-fruiting blackberry cultivars 'Prime-Jan®' and 'Prime-Ark®45' from the University of Arkansas Blackberry Breeding Program that were established at the Kentucky State University Research Farm in June 2010.

Selection	Fruit Weight (g)	Yield (lb/acre)	Harvest Dates
'Prime-Ark®45'	3.3 a	2213 a	7/26-10/11
'Prime-Jan®'	2.6 b	572 b	7/26-10/11

1 Numbers followed by the same letter are not significantly different (Least Significant Difference P = 0.05)

Results and Discussion

Primocane fruit were harvested from late-July until frost in mid-October (Table 1). Primocane production of 'Prime-Ark®45' out yielded 'Prime-Jan®' by almost a four-fold margin and berry size was also larger for 'Prime-Ark®45'. There were extreme high temperatures during extended periods of the summer and fall; there were 64 out of 122 days with a daily high temperature above 85°F from June through September. The average high in July was 91°F with three days that the temperature was over 100°F and only five days in that month had high temperatures that were below 85°F. Visual inspections of the developing fruit on inflorescences of both cultivars indicated that high temperatures reduced drupelet set in 'Prime-Jan®' to a greater extent than 'Prime-Ark®45', thereby reducing yields in 'Prime-Jan®'. The University of Arkansas Blackberry Breeding Program already recommends that commercial producers plant 'Prime-Ark®45' instead of 'Prime-Jan®', due to the superior shipping quality of the firmer fruit of 'Prime-Ark®45'. Year to year yield characteristics will need to be further evaluated; however, the 2012 data suggests that 'Prime-Ark®45' yields well in Kentucky and that fruit set is less affected by hot summer temperatures than 'Prime-Jan®'. 'Prime-Ark®45' should be considered by commercial growers interested in producing primocane fruiting blackberries.

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Consumer Evaluation of Thornless Erect and Thorny Blackberry Varieties Based on Flavor, Color, Texture, and Overall Taste

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Introduction

A common perception in Kentucky is that thorny blackberries taste better than thornless cultivars. However breeding advances have resulted in better thornless blackberry quality and flavor since the release of the first semi-erect thornless cultivars. In order to evaluate the validity of this perception, a study was initiated to determine how consumers would rate thornless verses thorny blackberry cultivars based on flavor, color, texture, and overall taste.

Materials and Methods

The thornless erect cultivars, 'Apache,' and 'Ouachita,' and the thorny cultivars, 'Chesapeake,' 'OAL-W6,' 'Kiowa,' and 'Chickasaw' were used in this study. Semi-erect cultivars were not included because fruit from these cultivars were not ripe at the time of evaluation. Prior to the evaluation, fresh blackberries of 'OAL-W6,' 'Chesapeake,' 'Kiowa, and 'Chickasaw' were harvested from a blackberry trial at the University of Kentucky Research and Education Center, Princeton, Kentucky, refrigerated at 40°F and transported in coolers to the University of Kentucky campus in Lexington, Kentucky. Berries were refrigerated for testing the next day. Fresh fruit from 'Apache,' and 'Ouachita,' were harvested and purchased from Caludi's Fields a Lexington, Kentucky blackberry grower a day prior to evaluation and kept refrigerated at 30-32°F. In order to determine consumers' preferences, the six cultivars were evaluated in the sensory lab at the Food Systems Innovation Center (FSIC), Lexington, Kentucky.

Sixty panelists were recruited by the FSIC ranging in age from 20 to 60. The panelists were each randomly assigned four-separate trials. Each trial consisted of one berry of three randomly selected different blackberry cultivars. Each cultivar was rated for flavor, texture, and color. The scores ranged from 1 to 8 for least to most preferred, respectively. Panelists then provided an overall score for taste, with 1 being least appealing and 12 being most appealing. A data set of 660 observations was compiled and subjected to analysis of variance (ANOVA) before using Tukey's HSD (Honestly Significant Difference) test to compare the means of the six blackberry varieties.

Table 1. Blackberry evaluation on flavor, color, texture, and overall ranking, Lexington, Kentucky., 2012.

	Flavor[1]		Color[1]		Texture[1]		Overall Ranking[2]	
Apache[4]	5.641	a[5]	6.525	be	5.838	a	7.864	a
Ouachita	5.297	ab	6.572	c	5.666	a	7.846	a
Chesapeake	5.585	a	6.136	abc	5.809	a	7.648	a
OAL-W6	5.271	ab	5.864	ad	5.621	a	7.330	ab
Kiowa	4.728	be	5.990	ab	5.311	ab	6.750	ab
Chickasaw	4.440	c	5.366	d	4.917	b	6.100	b
ANOVA F-test	6.22	***[3]	10.76	***	4.63	***	4.95	***

1 Blackberry flavor, color,texture:1 = Least preferred; 8 = Most preferred.
2 Rating blackberry for overall appeal:1 = Unappealing; 12 = Most appealing.
3 Asterisks indicate levels of significance:*** = 0.01.
4 The order of varieties followed by Overall rankings' mean.
5 Means within a column followed by the same letter are not significantly different (Tukey's HSD, $P < 0.05$).

Results and Discussion

Significant differences in flavor, color, texture, and overall taste were observed among the six varieties, but differences were greatest for flavor and color (Table 1). Texture and overall taste ranking were not significantly different among 'Apache,' 'Ouachita,' 'Chesapeake,' 'OAL-W6,' and 'Kiowa.' 'Apache' scored highest in flavor, texture, and overall taste. In color, 'Ouachita' scored highest, and 'Apache' second. Interestingly, 'Chickasaw,' a popular thorny erect cultivar, scored last in flavor, color, texture, and overall taste. More importantly, the thornless erect varieties of 'Apache' and 'Ouachita' were ranked first and second as most appealing to consumers, respectively. Both in this study and in the work of Fernandez (1), 'Apache' scored higher than 'Chickasaw' in flavor, color, texture (or firmness), and overall taste. Fernandez compared eight cultivars, three thornless and five thorny types. In general, the thornless cultivars rated as good as or better than the thorny ones. Studies have shown that blackberry aroma profiles vary between blackberry types as well as for 'Chickasaw' thorny blackberry grown in different areas of the U.S.(2). If one tastes a number of blackberries of one cultivar it is apparent that flavor, color and texture often varies from berry to berry due to harvest maturity, growing conditions and postharvest handling. In this study the large number of panelists and samples helped to account for this variation.

This data significantly shows that the thorny blackberry cultivars evaluated in this study do not have a better flavor or texture than the thornless erect cultivars 'Apache' and 'Ouachita.'

Acknowledgments

The authors would like to thank Suzanne Anandappa, June Johnston, Jesse Mattingly, Gregg Rentfrow, Chris Smigell, and Ginny Travis and for their help with this project.

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Incidence of Stink Bug Species in Organically Grown 'Prime-Jam®' and 'Prime Jim®' Blackberry Plantings in Central Kentucky

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Introduction

Primocane-fruiting blackberries produce fruit on current-season canes. They fruit from late-summer until frost, and have the potential to produce two "crops" per year: first the normal summer crop on floricanes and then a later crop on primocanes (Clark et al. 2005). Organic primocane blackberry production has great potential for small-scale commercial growers, Community Supported Agriculture, and farmer's markets.

Brown and green stink bugs (Hemiptera: Pentatomidae) are pests of blackberries in Kentucky. These insects insert their beaks into drupelets and suck the juice (Gomez and Mizell 2008, Townsend and Bessin 2010), as well as leaving a foul odor and taste (Johnson and Lewis 2005). Stink bug species have not been well studied in blackberries in Kentucky although damage has been noted by growers and researchers. The objective of this study was to identify and quantify stink bug species in organically managed blackberries using two methods of collection of either hand collecting stink bugs in each plot or using Florida Stink Bug Traps.

Materials and Methods

An existing plot of primocane-fruiting blackberry cultivars 'Prime-Jim®' and 'Prime-Jan®' was used as the study site at the Kentucky State University Research and Demonstration Farm in Frankfort, Kentucky. A completely randomized design of 3 plots of each cultivar replicated 3 times was used. Each plot was 9 m and the rows were 4.3 m apart. The plots were managed in 2012 with organic growing practices following the National Organic Program standards. Weed control was achieved by hand weeding and using a weed eater. Three replicate plots of each variety were mowed on March 21. Subsequent mowing was not performed due to the negative impact of multiple mowings on blackberry growth and fruit set in 2011.

We used visual inspection and hand collecting stink bugs in each plot and Florida Stink Bug Traps to quantify stink bugs weekly in blackberry bushes. Visual and hand collection began May 21 and ended October 1, 2012. Florida stink bug traps were deployed June 4, 2012 and checked weekly from June 11 through October 1. Stink bugs were identified, counted and the results were tabulated.

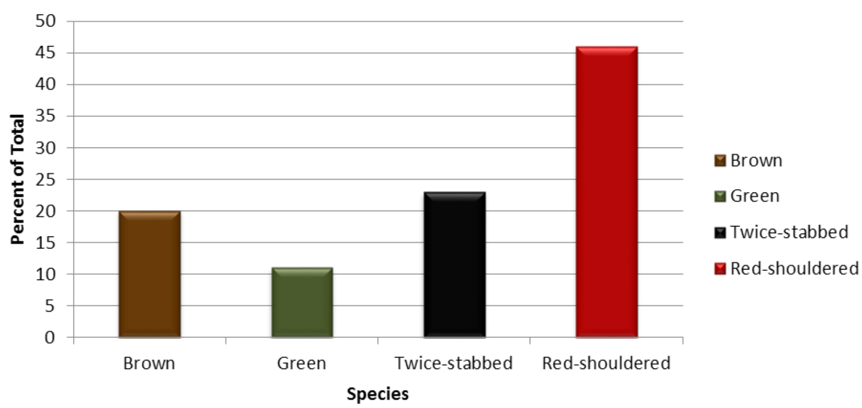

Figure 1. Relative abundance of stink bug species.

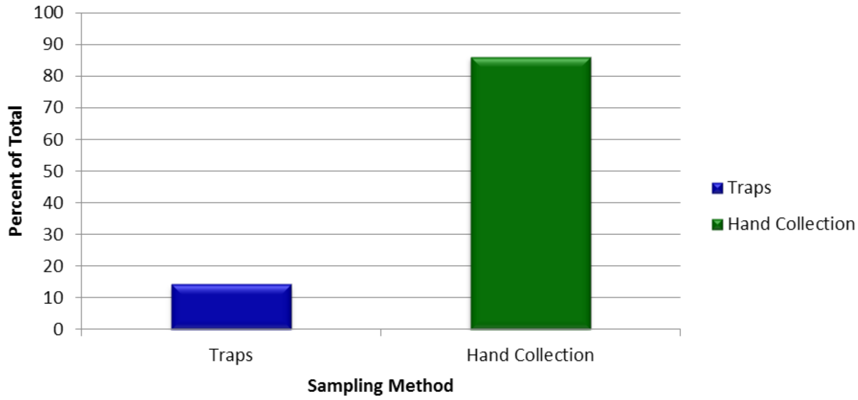

Figure 2. Relative abundance of all species combined by sampling method.

Results and Discussion

Stink bugs were found in both 'Prime Jan®' and 'Prime Jim®' in the 2012 sampling period which extended from May 21st until October 1st. Four stink bug species were identified during the period of fruit ripening in the planting. The red shouldered stink bug was the most abundant, followed by the twice stabbed stink bug, brown and green bugs at 46%, 23%, 20%, and 11%, respectively. Brown marmorated stinkbug, however, was again not identified in the planting this year. Both visual inspection and hand collection of stink bugs, as well as the use of the Florida Stink Bug Traps, resulted in the capture of stink bugs. Although hand collecting required more time, more than six times as many stink bugs were captured compared to the stink bug trap, at 86% and 14%, respectively. Populations of stink bug species vary year to year and may cause serious damage. Therefore, we will continue to monitor stink bug incidence in blackberry plantings.

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Spring Turnip Variety Evaluation

John Strang, Chris Smigell, Ben Abell, and John Snyder, Department of Horticulture; Pam Sigler, Family and Consumer Sciences

Eleven turnip varieties were evaluated in a replicated trial for their performance under central Kentucky conditions. These included white salad and conventional turnips.

Materials and Methods

Varieties were seeded in the field on 9 April at the Horticulture Research Farm in Lexington. Seeds were placed in 20 foot long shallow furrows and lightly covered with soil. Rows were 20 inches apart. Each treatment was replicated four times in a randomized complete block design. Seventy-five pounds of nitrogen per acre were applied as calcium nitrate. Dacthal herbicide was preplant incorporated at a rate of 10 lb/acre for weed control. The plot was drip irrigated as needed. Permethrin at 8 oz/acre was applied 7 June for flea beetle control.

Ten turnips from each replication were evaluated for uniformity of size, uniformity of shape and exterior appearance. One turnip from each replication was evaluated for flavor (raw) by two evaluators. Soluble solids or sugar content was measured with a refractometer on juice squeezed from a section taken horizontally through the midsection of the turnip. Ten turnips were measured to obtain a length/width ratio.

Additional taste evaluations were conducted by a Family and Consumer Science panel which consisted of 17 females and 7 males. Participants rated the turnips for visual appeal, raw turnip, cooked turnip and sautéed turnip greens taste. For the visual rating the turnips were washed and displayed as they appeared from the field or would be displayed at a farmers' market. Turnips were diced into ½ inch cubes and one cup of turnips was cooked in a stainless steel pan with ½ cup of water for 10 minutes. Turnips were drained and chilled until the consumer panel met. Participants were presented chilled ½ inch diced turnip pieces for tasting. The turnip greens from one turnip were sautéed in a non-stick skillet with 1 teaspoon of unsalted butter and then refrigerated until the consumer panel met.

Results and Discussion

The 2012 growing season was hot and dry. Turnips were harvested at diameters ranging between 1.5 and 3 inches. Harvest and evaluation data for the replicated trial are shown in Table 1 and data for whole plant appearance, cooked turnip roots and greens in Table 2.

Turnip root evaluations in Table 1 were conducted by a horticulture department panel of two individuals based on ten turnip roots from each of four replications. The raw taste evaluations were based on one turnip from each replication. Varieties are ranked by exterior appearance since this would be a primary consumer selection characteristic. Hakuri, Purple Crown, Royal Crown, Purple Prince, White Lady and Purple Top White Globe

Table 1. Horticulture department panel, spring turnip variety characteristics 2012.

Cultivar	Days Maturity[1]	Seed Source	Exterior Appearance (1-5)[2,4]		Length/Width Ratio[3]	Internal Appearance (1-5)[2]	Taste Raw (1-5)[2,4]		Sugar (%)	Comments
Hakuri	38	KI	3.9	a	0.98	4.3	5.0	a	4.9	White, very sweet, mild, juicy, tender
Purple Crown	50-55	SI	3.9	a	0.72	4.0	4.4	abc	6.0	Purple top, mild, crunchy
Royal Crown	45-50	SW	3.8	ab	0.96	5.0	3.7	bcd	6.2	Purple top, strong turnip flavor, dry
Purple Prince	55-65	SW	3.8	ab	0.96	3.7	3.4	cd	5.6	Purple top, stronger turnip flavor, some internal browning
White Lady	28-35	SW	3.6	abc	0.83	4.5	4.6	ab	4.3	White, slightly rough pitted exterior, mild, sweet, juicy, not crisp
Purple Top White Globe	50-57	ST	3.3	abcd	1.01	4.2	3.6	cd	5.7	Purple top, variable color, shape and taste, moderately juicy, some internal browning
Tokyo Cross	35	RU	3.1	bcd	0.86	3.3	3.8	bcd	4.2	White, moderate turnip flavor, juicy to dry, irregular shape, slight internal browning
Just Right	50-70	SW	2.9	cd	1.08	4.7	3.9	bcd	4.8	White, moderate turnip flavor, crunchy, very large greens
White Egg	50	RU	2.6	de	1.25	4.6	3.8	bcd	5.4	White, slightly sweet, moderate to strong turnip flavor, variable shape, crunchy, dry
Tokyo Market	30	RU	2.1	e	0.94	4.0	3.3	d	4.0	White, rough and pitted, irregular shape, crunchy and dry, some splitting
Shogoin	60	RU								White, fall turnip, all plants went to seed

1 Days to maturity from seed supplier.
2 Appearance and taste ratings: 1 = poor; 5 = excellent.
3 Length/Width ratio based on the length and width of 10 turnips; Larger numbers indicate rounder roots and smaller numbers indicate wider or squatter roots.
4 Numbers in each column with a letter in common are not significantly different from each other (Waller-Duncan Multiple Range Test LSD P=0.05).

were judged to be the more attractive turnips. There were no statistical differences between varieties in internal appearance. Hakuri, Purple Crown, Just Right, Tokyo Cross, White Egg, and Royal Crown were determined to have the most desirable taste when consumed raw. It is interesting to note that desirable taste did not correlate well with root sugar content. The length/width ratio provides information on root shape. Varieties with rounder roots like Purple Top White Globe have higher ratios, and shorter wider varieties like Purple Crown have smaller ratios. All plants of Shogoin bolted and did not produce marketable roots since this is a variety meant for fall production.

Table 2 shows the results of taste tests by the Family and Consumer Science panel. Fifty-three percent of the consumer panel had tasted a turnip prior to this evaluation. Thirty-three percent (8) ate turnips an average of 3.25 times per year and 29% (7) prepared turnips. Purple Crown followed by Purple Prince and Just Right tended to have the highest appearance ratings. Turnip varieties receiving the highest raw taste rating were Hakuri, White Lady, Just Right, White Egg and Tokyo Cross. Participants that had never tasted a turnip prior to this noted that the raw turnips tasted like a radish. Fifty-seven percent (8) of the participants responded that they would consider purchasing and serving raw turnips following this evaluation.

Purple Crown, Hakuri, Purple Prince, and White Lady received the highest taste ratings for cold cooked turnips. Seventy-one percent responded that they would consider preparing and serving cooked turnips.

Cooked greens of Just Right, Purple Crown, Tokyo Cross and Hakuri were ranked as the most pleasing. Greens volume reduction after cooking is also shown in Table 2. There does not seem to be any correlation between volume reduction and the greens acceptability ranking. Fifty-seven percent of the participants would consider preparing turnip greens in the future. All participants would consider serving turnip greens to friends and family following this evaluation.

Top Performers

A comparison of variety preferences shows that Hakuri was highly preferred in terms of raw and cooked roots by both tasting panels, appearance by one panel and cooked greens taste. Purple Crown was rated highly for appearance by both panels, taste raw by one panel, cooked root and cooked greens taste. Just Right was rated highly for appearance by one panel, raw taste by both panels and also for cooked greens taste.

Greens Consumption

Seventy-four percent of the participants had tasted greens prior to the Family and Consumer Science panel evaluation. Fifty-eight percent ate greens (collard greens, spinach, kale, mustard greens, turnip greens and Swiss chard) (Table 3). It is interesting to note the types of greens that are consumed more often in Kentucky, spinach, collards, kale, and mustard greens. This information should give producers an idea of which greens have the greatest sales potential. Those greens consumed in smaller amounts, beet greens and Swiss chard indicate potential new greens types that might be introduced to consumers. Greens are generally more nutritious than the root portion of the plant.

Acknowledgments

The authors would like to thank Dave Lowry and Joseph Tucker for their hard work and assistance in the successful completion of this trial.

Table 2. Family and Consumer Science spring turnip appearance, root and greens taste evaluations.

Variety	Exterior Appearance (1-5)[1]	Taste Raw (1-5)[1]	Taste Cooked (1-5)[1]	Greens Taste Cooked (1-5)[1]	Greens Volume Reduction after Cooking (%)
Purple Crown	4.1	2.7	3.2	2.8	80
Purple Prince	3.4	2.8	3.0	2.0	56
Just Right	3.4	3.2	2.5	2.9	81
White Lady	3.1	3.2	2.9	2.1	75
Royal Crown	3.1	2.9	2.3	2.0	75
Hakuri	3.0	3.9	3.2	2.6	83
Purple Top White Globe	3.0	2.8	2.3	1.6	83
Tokyo Cross	2.5	3.1	2.2	2.6	75
White Egg	2.4	3.2	2.4	2.0	75
Tokyo Market	2.3	1.9	2.1	2.1	83

1 Appearance and flavor mean ratings: 1 = poor; 5 = excellent. Roots and greens were rated by 24 evaluators (17 females and 7 males).

Table 3. Family and Consumer Science taste panel greens consumption survey.

Greens Type	Greens Consumed (%)[1]
Collard greens	79
Beet greens	0
Kale	43
Mustard greens	43
Radish greens	0
Spinach	86
Swiss Chard	14
Turnip greens	29

1 Types of greens consumed as a percentage of those on the taste panel (58%) that eat greens.

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Supersweet Corn Variety Evaluation

Timothy Coolong, and Zheng Wang, Department of Horticulture

Introduction

Sweet corn is the most popular vegetable grown in Kentucky with more than 3000 acres in production in 2012. At one time supersweet varieties, those containing the recessive *sh2*—"shrunken 2" gene, were primarily used for shipping because they stored well, but were not as creamy as comparable sugary enhanced (se) varieties and were not widely used for those selling direct to consumers. However, significant improvements in the quality of supersweet varieties mean that they are now commonplace in Kentucky markets. Thirty varieties of supersweet corn were evaluated in Lexington KY in 2012. This trial includes yellow, white, and bicolor kernel color varieties as well as several containing genes for insect resistance and two new varieties (Obsession II and Passion II) which include insect and herbicide (glyphosate) resistance genes. All varieties were treated similarly, which meant that despite having the presence of an herbicide resistance gene, Obsession II and Passion II were not subjected to broadcast applications of glyphosate herbicide during growth.

Table 1. Germination percentage, vigor and tiller (sucker) ratings, and height to tassel and base of ear for 30 varieties of supersweet (*sh2*) corn grown in Lexington, Kentucky 2012.

Variety	Vigor[z] (1-5)		Germ.[y] %		Tiller[x] (1-5)	Ear Height[w] (inches)	Tassel Height[w]	Seed Source[v]
BSS 0977	4.8	a[u]	95.0	a	1.0	24	76	SY
Passion	4.5	ab	94.5	ab	1.7	25	79	S
Awesome	4.5	ab	89.5	a-e	2.7	20	62	IFSI
Yosemite	4.5	ab	78.0	e-h	1.0	30	85	HM
GSS 0966	4.4	a-c	86.0	a-f	1.7	27	77	SY
8902MR	4.3	a-d	91.0	a-d	1.0	23	70	AC
Ice Queen	4.3	a-d	90.0	a-e	2.0	26	70	HM
Passion II	4.3	a-d	89.5	a-e	1.3	28	79	S
Vision	4.3	a-d	84.5	a-f	2.3	20	72	IFSI
Obsession	4.0	a-e	92.0	a-c	1.0	26	76	S
Pickett	4.0	a-e	91.0	a-d	1.7	24	70	SW
EX8767143 (7143)	4.0	a-e	88.5	a-e	1.7	24	76	S
WSS0987	4.0	a-e	84.5	a-f	1.4	30	85	SY
7112R	3.9	a-f	90.0	a-e	1.7	23	74	AC
Traveler	3.8	b-g	91.5	a-d	2.0	25	76	SW
Sentinel	3.8	b-g	87.5	a-f	1.0	36	92	HM
Legion	3.6	b-h	90.0	a-e	1.7	27	73	SY
2012MR	3.5	d-h	90.5	a-d	1.7	23	71	AC
7932MR	3.5	d-i	82.5	b-f	1.0	21	70	AC
Bueno	3.4	d-i	81.0	c-h	2.0	22	72	CR
Polaris	3.4	d-i	79.5	d-h	1.0	30	82	HM
Bandit	3.4	d-i	72.5	g-i	2.3	32	83	HM
Obsession II	3.3	e-i	84.5	a-f	1.7	29	79	S
Heavenly	3.1	e-i	78.0	e-h	2.3	25	84	SY
BSS 0982	3.0	f-i	71.3	g-i	3.0	22	78	SY
Tahoe	2.9	g-i	76.0	f-i	1.3	28	84	SW
Marquette	2.9	g-i	71.0	hi	2.0	20	66	HM
Biscayne	2.8	hi	72.5	g-i	1.3	23	73	HM
7602MR	2.6	i	76.5	f-i	1.0	26	73	AC
Garrison	2.6	i	66.0	i	1.0	26	74	SY

z Vigor rated on a scale of 1-5 with 1 = least vigor, 5 = most vigor, rated approximately 3 weeks after seeding.
y Germination percentage based on seeding 50 seeds in each replication for each variety in the field and recording plants emerged 2 weeks after seeding.
x Tillers (suckers) rated on a scale of 1-5 with 1 = no suckers present, 5 = suckers routinely apparent on a sample of 10 plants per plot.
w Height to base of ear and tip of tassel on mature plants shortly after pollination
v Seed source available in Appendix A.
u Means in the same column followed by different letters were significantly different at $P < 0.05$ as determined by Duncan's multiple range test.

Materials and Methods

Varieties were hand seeded on 10May into rows spaced 30 inches on-center. Individual plots were 20 feet-long and received 50 seeds at planting. The trial was arranged as a randomized complete block design with four blocks per variety and 30 varieties evaluated for a total of 120 treatment plots. Border rows (WSS 0987 and Obsession II) were planted completely around the plot. A 20-foot buffer zone (WSS 0987) was planted at either end of the field to ensure adequate pollination in all treatment plots. Pre-plant fertility (19-19-19, N-P_2O_5-K_2O) was applied at a rate of 75 lb/acre nitrogen (N) during ground preparation, which included spading (Imants, Reusel, Netherlands) followed by disking and roto-tilling. Immediately after planting and before seed germination, Bicep II Magnum (Syngenta Crop Protection, Greensboro, NC) was applied according to labeled rates. Drip irrigation was applied with drip lines located equidistant between rows watered as needed. During the last week of May, germination data were collected and plants were thinned to 30 per plot (8-inch in-row spacing). Vigor data were taken the first week of June. Ammonium nitrate was broadcast over the plot on 19 June at a rate of 50 lb/acre N. Insecticides were applied at the earliest signs of silking and continued until harvest according to University of Kentucky recommendations for commercial sweet corn production (Coolong 2011). No evidence of insect damage was observed on any harvested ears. Tassel and ear height data were taken from 5 plants in each plot on 16 July. The propensity of a variety to sucker was evaluated on 10 plants per plot on 16 July. An electric fence was placed around the trial field to keep vertebrate pests (raccoons) out on 18 July. Harvests were initiated on 20 July and were conducted twice-weekly until 2 August. Only commercially marketable ears were harvested. After harvest, ears were immediately counted and length and width measurements taken. Tip coverage and overall kernel fill data were taken at harvest as well. Yield data were calculated based on a plant population of 26,137 plants/acre (spacing used in this study). Statistics were performed using the GLM and Duncan's multiple comparisons procedures of SAS statistical software. Results were considered significantly different if P< 0.05.

Results and Discussion

The growing season of 2012 was exceptionally hot and dry with several days during pollination with air temperatures in excess of 100°F. Despite high temperatures and drought conditions, tip fill on all harvested ears was at or near 100%. This was likely due to adequate irrigation during the production cycle. Insecticides were regularly applied and there was no evidence of any insect damage on any harvested ears, despite high corn ear worm numbers. In general, all the varieties performed well and produced high quality ears. Vigor, which was rated on a 1-5 scale (1 = poor vigor, 5 = high vigor) was related to germination percentage (Table 1), but not necessarily yield (Table 2). Most varieties germinated well and were vigorous. BSS 0977, a bi-color variety with insect resistance was the most vigorous and had a germination percentage of 95%. Some of the most vigorous varieties were not necessarily the tallest plants at maturity, however. Sentinel, a yellow kernel variety, was the tallest plant with an average tassel height of 92 inches and an average height to the base of the ear of 36 inches, although it was not necessarily the most vigorous variety at three weeks after planting. Yosemite, a yellow variety had an average tassel height of 85 inches and was a vigorous variety with strong germination rates. Garrison, a yellow kernel variety, had relatively poor germination and low vigor. The propensity of a particular variety to tiller (sucker) was also evaluated on a scale of 1-5 (1 = no suckering observed, 5 = suckering on all plants). In general, there was little suckering observed on most varieties, however Awesome, an early bi-color variety, and BSS 0982, a mid-season bi-color variety with insect resistance tended to have more suckers than others on average. Several varieties, including BSS 0977, Yosemite, 8902MR, Obsession, Sentinel, 7932MR, Polaris, 7602MR and Garrison had no observed suckers.

Table 2. Yield, average ear length and diameter and ear coverage for 31 varieties of supersweet (*sh2*) corn grown in Lexington, Kentucky 2012.

Variety	Kernel Color	Total Yield[z] (Crates/Acre)		Average Ear Length[y] (inches)	Average Ear Width[y] (inches)	Ear Coverage[x] (inches)	Comments
Legion	BC[w]	520	a[v]	7.7	1.8	0.5	Nice ear, little tip coverage
Yosemite	Y	500	ab	9.3	1.9	0.3	Largest most attractive ear, large flags, shanks stay on, little tip coverage
WSS0987	W	490	a-c	7.4	1.8	1.3	Sweet and crunchy
Passion II	Y	470	a-d	8.5	1.9	0.4	Small flags, tight husk, little tip coverage
GSS 0966	Y	470	a-d	7.7	1.9	0.6	Slightly harder to pick
Polaris	BC	470	a-d	8.4	1.9	1.3	Lots of flags, large kernels, shank stay on, attractive ear
BSS 0977	BC	470	a-d	7.4	1.9	0.7	Smaller ears than other BSS varieties
Obsession II	BC	460	a-d	8.2	2.0	0.4	Large ear, few flags, very consistent
Marquette	BC	460	a-d	8.3	1.9	0.9	Big flags, very creamy
Vision	Y	450	a-e	7.6	1.9	0.7	Early, very good flavor, short, thicker ear
Ice Queen	W	440	a-e	8.5	1.9	0.4	Large ear, big flags, dark green husk, crunchy
7112R	BC	440	a-e	7.7	1.8	1.6	Very creamy, large flags
Passion	Y	430	a-e	8.3	1.9	0.4	Large ear, little tip coverage
Obsession	BC	430	a-e	8.2	2.0	0.6	Uniform, small flags
Sentinel	Y	430	a-e	8.6	2.0	1.0	Nice large ears, very attractive good flags
8902MR	BC	430	a-e	9.2	1.8	0.3	Shanks stay on, tight husk with little tip coverage, large flags
Bueno	BC	420	a-e	7.9	1.8	2.0	Creamy and sweet, few shanks, tight husk, long flags
EX8767143 (7143)	BC	420	a-e	8.6	1.8	0.4	Tight husk, uniform, shank stays on, little tip coverage
BSS 0982	BC	420	a-e	8.4	2.0	1.3	Large ears, good coverage, sweet
Awesome	BC	410	b-f	7.5	2.0	1.5	Thick, sweet ears, dark green husk, long flags
7932MR	BC	400	b-f	8.3	1.8	1.8	Tight husk, nice flags, good tip coverage, big kernels, nice ear
Tahoe	W	400	b-f	8.0	1.9	0.5	Small flags, very sweet for white variety
7602MR	BC	400	b-f	8.2	1.9	1.5	Very tight husk, good coverage, creamy, shanks stay on
Bandit	Y	400	b-f	7.7	1.8	2.1	Small flags, loose but significant coverage
Garrison	Y	380	c-g	7.8	1.8	1.3	Attractive, sweet ears, small flags
Pickett	BC	380	d-g	7.6	1.9	1.4	Very easy to pick, good flavor
Heavenly	W	380	d-g	8.1	1.9	1.0	Very sweet, variable productivity
2012MR	BC	340	e-g	7.6	1.7	0.4	Sweet, creamy, long flags
Traveler	W	310	fg	8.2	1.9	1.3	Very creamy, sweet, larger ears, some variability
Biscayne	W	300	g	8.1	1.9	0.8	Small flags, lighter green husk

z Yields based on a plant population of 26,137 plants per acre; 1 crate = 5 dozen ears.
y Average length and width determined from 5 ears sampled from each replication of each variety.
x Tip coverage determined by averaging the distance between the tip of each ear and husk for 5 ears from each replication.
w Y = yellow, W = white, and BC = bi-color kernels, respectively.
v Means in the same column followed by different letters were significantly different at P < 0.05 as determined by Duncan's multiple range test.

Legion, a bi-color variety was the highest yielder at 520 crates (5 dozen ears per crate) per acre. However, 19 varieties were not significantly different than Legion in terms of yield. Yields were high, with most varieties producing more than one marketable ear per plant on average. At the population used in the trial (26,137 plants per acre), one marketable ear per plant would result in a yield of 435 crates per acre. Yosemite, Passion II, GSS 0966, Vision, Passion, and Sentinel were the highest yielding yellow kernel varieties. Yosemite had the largest ear length at 9.3 inches and produced a very attractive ear with large flags. Shanks did tend to remain on the ears of Yosemite requiring additional effort for removal. GSS 0966, a yellow variety with insect resistance, yielded well and had an average ear length of 7.4 inches. Vision was an earlier yellow kernel variety that had good flavor. WSS 0987 and Ice Queen were the highest yielding white kernel varieties. Ice Queen produced larger ears on average than WSS 0987; however, WSS 0987 tended to have better tip coverage. Bi-color kernel varieties constituted the largest segment of this trial (16 entries). Legion, Polaris, BSS 0977, Obsession II and Marquette were some of the highest yielding bi-color varieties. Awesome yielded 410 crates per acre and produced thicker shorter ears but had a very high eating quality. 7112R was a bi-color with good tip coverage and a creamy taste, with very large flags. 8902 MR had the longest ears (9.2 inches) of any bi-color and very tight husk coverage. Picket, a bi-color with slightly lower yields, was the easiest variety to pick. Two new entries with resistance for the herbicide glyphosate, Obsession II and Passion II performed well. Obsession II, a bi-color was one of the most uniform varieties trialed and produced a high quality ear.

No single variety performed the best at every category measured. Some varieties may have yielded well, but had poor tip coverage, which could leave a grower open to insect damage if a rigorous spray schedule were not followed. Others produced extremely large attractive ears, which may sell well in a retail setting, but would be too large to pack for wholesale distribution. However, there are many varieties which could suit the needs of most growers depending on their production and marketing needs. Growers should consider that the results presented are only from one year of trials in a single location when determining, which varieties to include for the upcoming season.

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Bell Pepper Cultivar Screening Trial, Central Kentucky

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

Introduction

Our last University of Kentucky bell pepper variety trials were conducted in 2005 and a number of new varieties have been released since then. This study was a preliminary screening trial to evaluate 26 bacterial spot resistant bell pepper varieties in preparation for a replicated trial using fewer varieties in 2013.

Materials and Methods

Varieties were seeded on 23 March into plastic plug trays (72 cells per tray) at the UK Horticultural Research Farm in Lexington. Greenhouse-grown transplants were set into black plastic-covered, raised beds using a water wheel setter on 31 May. Each plot was 30 ft. long and contained 48 plants set 15 in. apart in double rows spaced 15 inches apart in the bed. Beds were 6 ft. apart. Thirty pounds of nitrogen/A as 19-19-19 was applied prior to plastic laying. At planting each transplant was watered in with a pint of starter solution (6 lb of 10-30-20 in 100 gallons of water). Calcium nitrate was applied via fertigation weekly at a rate of 8 lb nitrogen/A. Sandea and Dual II Magnum herbicides were applied on 22 June between beds. Weekly foliar fungicide applications included Bravo, Cabrio, Bravo Weatherstik, and Manzate Pro-Stick. Fixed copper as Champ 2 was added to most of the weekly fungicide sprays. Ridomil Gold EC was applied through the drip lines 1 July to control pythium disease that had been promoted by extremely hot weather and elevated soil moisture levels from irrigation. Coragen was chemagated on 20 July at a rate of 5 oz/A for insect control.

The plot was harvested four times during the season, 31 July, 21 August, 13 September and 7 October. Marketable fruit were graded and weighed according to size class U.S. No. 1 large and extra large (>3 inches diameter), total marketable yield (>2.5 inches diameter) plus misshapen but sound fruit which could be sold as 'choppers' to food service buyers and cull fruit.

Results

The weather turned very hot and dry immediately after transplanting. Drip irrigation was applied shortly after transplanting and all varieties but one had very good transplant survival rates. Bacterial spot was not found in the planting.

Total marketable yields for the season for most varieties were high, even at the last harvest on 8 October. However yields were considerably reduced for the 21 August harvest due to extremely high temperatures and flower drop. Varieties are ranked in table

Table 1. Pepper variety yield data and characteristic ratings, sorted by percent of extra-large fruit, 2012.

Variety	Seed Source	Large + XL (%)[1]	Total Market Yield (tons/A)[2]	Cull (%)	Silvering (%)[3]	Uniform Fruit Shape[4]	Fruit Appearance[5]	Fruit Size Maintained[6]	Fruit Color		Fruit Comments
									Green	Ripe	
Alliance	HM	94	32.1	6.7	0.0	3.5	6.5	3	med gr	red	Blocky, v large, 3-4 lobed, size held up well
Archimedes X3R	ST	90	36.3	5.8	0.9	4.5	5.5	3	med gr	red	V large to exceptionally large, mostly 3 lobed, few flat fruit, size held up
Lafayette	SI	90	32.8	7.9	0.8	3.5	6	2	lt-med gr	yel	Blocky, heavy, mostly 3 lobed, bright deep yellow, size held up well
Mysterio	HM	87	31.9	11.7	0.0	4	7	1	med gr	red	Exceptionally large, 4 lobed, heavy, blocky, attractive
Plato	RU	85	27.7	8.7	2.6	2	4	2	med gr	red	V large, variable size and shape, mostly 4 lobed, some elongated
Snapper	RU	85	27.0	7.7	2.2	4	5.5	2	med gr	red	Blocky, size held up well, many fruit folded in on bottom, 3-4 lobed
Hunter	SI	84	29.6	10.1	10.0	3	6	2	med gr	red	Fairly blocky, mostly 3 lobed
Declaration	HM	84	34.2	7.1	0.4	4.5	6	2	med gr	red	Blocky, v large, attractive, mostly 4 lobed
Revolution	HM	83	34.2	8.2	5.6	4	6.5	3	med-dk gr	red	Blocky, few v large, mostly 3 lobed, attractive
PS09941819 X5R	RU	83	32.9	10.4	9.1	4.5	7	2	med-dk gr	red	Blocky, some v large, attractive, 3-4 lobed; few stinkbug culls
Intruder	RU	82	28.2	9.2	4.5	3	5	1	med gr	red	medium sized fruit, v heavy, solid, 3-4 lobed, stinkbug culls
Tomcat	SI	80	31.1	7.1	9.3	3	5.5	1	med-dk gr	red	Most blocky, 4 lobed, some 2 lobed, few flattened,
Vanguard	HM	80	30.0	9.5	7.8	4.5	6	3	med gr	red	Blocky, some large fruit, mostly 3 lobed, some short
Heritage	HM	80	17.0	13.6	0.9	2.5	5.5	1	lt gr	red	Small fruit, mostly 3 lobed, considerable pythium disease 2 wks after planting
HMX 8637	HM	80	29.7	11.2	1.5	4	6	1	med gr	red	Few flattened, mostly 4 lobed, small fruit culls
Aristotle X3R	ST	78	33.7	6.5	5.8	4	5.5	2	lt-med gr	red	medium size, mostly 3 lobed, some short fruit 2nd harvest
PS9928302	RU	77	25.8	13.0	0.0	3.5	5.5	1	dk gr	red	V large fruit, mostly 4 lobed, variable plant size
Patriot	HM	75	28.4	9.9	0.4	3	4	1	med gr	red	Medium size, mostly 4 lobed, a lot of short fruit
Allegiance	HM	74	33.1	12.9	11.6	4	6	2	med-dk gr	red	Blocky, v firm large fruit, mostly 4 lobed, lot of short, squatty fruit
4 Star	RU	74	31.1	8.3	8.1	2.5	5	1	lt-gr	red	Some fruit v large, variable shape, 3-4 lobed, elongated
Crusader	RU	69	23.3	11.2	7.2	3.5	5	1	med-dk gr	red	Blocky, 3-4 lobed, medium size
HMX 2641	HM	66	35.0	4.4	7.7	3.5	4	1	med gr	red	Small fruit, blocky, mostly 4 lobed, lot of short fruit 1st & 2nd harvest
Mecate	ST	66	28.1	7.3	15.1	3	4.5	1	med gr	yel	Blocky, medium size, 3-4 lobed, bright yellow
Classic	SI	64	29.1	8.5	2.5	4	6	1	med gr	red	Blocky, mostly 4 lobed, lot of squatty choppers; small fruit culls
Red Knight X3R	RU	63	35.3	8.6	11.7	4.5	6	1	med-dk gr	red	Small to medium-sized fruit, mostly 4 lobed
Delirio	SI	62	24.4	8.7	12.3	2.5	4	1	lt gr	or	Small to medium sized fruit, mostly 4 lobed

1 Percent of total marketable yield weight that was graded as large and extra large (>3 inches diameter).
2 Total marketable yield included yields of U.S. Fancy and No. 1 fruits of medium (>2.5 inches diameter) size and larger plus misshapen but sound fruit which could be sold as 'choppers' to food service buyers.
3 Percent of total marketable yield weight that showed slivering or very fine, light colored streaking in the last three harvests.
4 Uniformity of fruit shape: 1 = poor, 5 = excellent.
5 Fruit appearance: 1 = poor, 9 = excellent.
6 Maintenance of fruit size at last harvest: 1 = poor, 3 = excellent.

1 by the percentage of large and extra large fruit (by weight) since growers make most of their income from these two size classes. Alliance, Archimedes X3R and Lafayette yielded 90% or more large and extra-large fruit. Their total marketable yields were among the ten highest and their fruit size was still very good at the last harvest, but fruit were mostly three to four lobed. These three varieties also had fruit with low levels of silvering, high uniformity of shape and appearance ratings, relatively low numbers of culls and look very promising. Red Night X3R had the second highest total marketable yield, 35.3 tons/A, but had only 63 percent fruit in the large and extra large size categories. Declaration, Revolution and PS09941819X5R also looked very promising. Aristotle, which has been the primary bacterial spot resistant pepper planted in Kentucky for a number of years, had the sixth highest total marketable yield, 33.7 tons/A and had 78 percent of its fruit in the large and extra large category. Another 12 varieties yielded between 80% and 90% extra-large fruit. Cull fruit were mostly a result of sun scald and European corn borer damage.

This was a preliminary, non-replicated screening trial. Better performing varieties from this trial will be included in next year's replicated trial and more emphasis will be placed on assessing bacterial spot resistance as fungicide/bactericide sprays will not be used. At that time, more information will be available for possible new variety recommendations.

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Organic Garlic Variety Evaluation

Timothy Coolong and Ty Cato, Department of Horticulture

Introduction

Garlic is a popular crop for market growers in Kentucky. Typically planted in early fall, it can be overwintered successfully and harvested in early to mid June. Generally there are two types of garlic grown in Kentucky, softneck and hardneck. As the name indicates softneck garlic has a softer neck, allowing it to be braided, while hardneck garlic will send up a flower stalk or scape during production which gives these varieties a rigid neck. Softneck garlic is widely grown in the Western U.S., under relatively mild conditions. Softneck garlic also stores better than hardneck garlic. It is typically cheaper to produce as well, due to the fact that the bulbs are made up of more cloves than hardneck types, lowering planting costs. However, while most of the garlic that is purchased in grocery stores is of the softneck-type; empirical observations have indicated that hardneck-type garlic varieties tend to perform better in Kentucky. Because of the added expense, however, many growers choose to produce softneck garlic instead. This trial was conducted to compare several varieties of commonly available hardneck and softneck garlic for production in Kentucky. The trial was conducted using organic production methods, though these results should be readily transferrable to conventional growers.

Table 1. Yield, overwintering survival, average clove number and weight per bulb and bulb diameter for 14 varieties of softneck and hardneck garlic grown organically in Lexington, Kentucky in 2011 and 2012.

Variety	Type[z]	Yield[y] (lb/100 row feet)		Survival[x] (%)		Average Bulb Diameter (in./bulb)		Average Bulb Weight (oz.)		Average Clove No. (No./bulb)
Polish Softneck	S	43	a[w]	90	a	2.3	bcd	2.6	cd	19
Music	H	42	a	86	a	2.3	bcd	2.7	bc	9
Bogatyr	H	41	a	73	ab	2.4	abc	2.9	ab	8
Siberian	H	40	a	75	ab	2.2	cd	2.9	ab	11
California Early	S	37	a	88	a	2.3	bcd	2.2	ef	12
Metechi	H	37	a	67	ab	2.4	abc	2.9	ab	11
Russian Red	H	35	a	59	ab	2.6	a	3.2	a	10
German Red	H	31	ab	94	a	2.2	d	1.8	gh	8
Georgian Fire	H	28	ab	57	ab	2.5	ab	2.8	bc	9
St. Helens	S	28	ab	67	ab	2.1	d	2.2	de	6
Western Rose	S	26	ab	75	ab	1.7	ef	1.9	fg	18
Italian Late	S	25	ab	65	ab	1.9	e	2.0	efg	16
California Late	S	18	b	72	ab	1.7	f	1.4	h	17
Chinese Pink	S	17	b	43	b	2.3	bcd	2.1	efg	14

[z] Type of garlic H = hardneck, S = softneck.
[y] Yield based on a plant population of 21,780 bulbs per acre.
[x] Survival calculated based on number of bulbs per plot that survived the winter divided by number planted per plot.
[w] Means in the same column followed by different letters were significantly different at $P < 0.05$ as determined by Duncan's multiple range test.

Materials and Methods

Fourteen varieties (7 hardneck, 7 softneck) were planted into black plastic mulch at two locations in Central Kentucky. The locations were the Horticulture Research Farm in Lexington, Kentucky and Courtney Farms in Bagdad, Kentucky. Similar production practices were followed at each site. Cloves were planted into raised beds covered with black plastic mulch on 25 October (Lexington) and 7 November (Bagdad). Cloves

Table 2. Yield, overwintering survival, average clove number and weight per bulb and bulb diameter for 14 varieties of softneck and hardneck garlic grown organically in at the Courtney Farm in Bagdad, Kentucky in 2011/2012.

Variety	Type[z]	Yield[y] (lb/100 row feet)		Survival[x] (%)		Average Bulb Weight (oz.)		Average Clove No. (No./bulb)	Comments
Georgian Fire	H	44	a[w]	92	a	2.5	ab	6	Very spicy, uniform large bulbs
Music	H	43	ab	100	a	2.1	bc	7	Mild flavor, uniform bulbs with large cloves
Metechi	H	43	ab	90	ab	2.6	a	8	Very spicy, uniform large bulbs
Polish Softneck	S	35	abc	100	a	1.6	de	18	Mild flavor, little spice, small to medium bulbs with some very large bulbs
Bogatyr	H	34	bcd	79	ab	2.2	abc	7	Large bulbs with large cloves, medium spice
Russian Red	H	33	cd	81	ab	2.1	bc	6	Good flavor, medium spice, large bulbs, uniform
Siberian	H	32	cd	92	a	1.9	cd	9	Mild flavor, medium to large bulbs
German Red	H	26	de	98	a	1.3	e	6	Spicy but mild garlic flavor, small to medium bulbs
Western Rose	S	22	ef	95	a	1.2	e	13	Medium spice, small bulbs with significant rot
Early California	S	21	ef	85	ab	-	-	27	Must harvest early or will split
Late California	S	19	ef	85	ab	1.2	e	27	Pungent, small bulbs with many small cloves
Italian Late	S	19	ef	83	ab	1.2	e	18	Very spicy, small bulbs with some rot
Chinese Pink	S	19	ef	67	bc	1.6	de	12	Medium spice, must harvest early or will split
St. Helens	S	16	f	53	c	1.5	de	11	Mild flavor, small bulbs

z Type of garlic H = hardneck, S = sofneck.
y Yield based on a plant population of 21,780 bulbs per acre.
x Survival calculated based on number of bulbs per plot that survived the winter divided by number planted per plot.
w Means in the same column followed by different letters were significantly different at P < 0.05 as determined by Duncan's multiple range test.

were planted on a double-row with in-row spacing of 8 inches and approximately 14 inches between rows on the black plastic mulch. Mulched rows were spaced on 6-foot centers. This resulted in population of 21,780 bulbs per acre. Varieties were planted in a randomized complete block design with three replicates (blocks) of each variety. Twenty cloves were planted in each plot for softneck varieties, while 16 cloves were planted per plot for the hardneck varieties. Cloves were watered as needed. Plants were managed organically with pyrethrum (Pyganic) sprays for insects (thrips) and OMRI approved copper (Nordox) applications for control of fungal pathogens during the spring season. Sprays were not made in fall or winter. Notes on performance of each variety were made during winter months and harvest occurred on 7 and 14 June in the Lexington and Bagdad locations, respectively. Winter survival, yield, and quality data were obtained at harvest. Yield data was determined for a 100-foot row length based on the previously discussed plant population. Statistics were performed using the GLM and Duncan's multiple comparisons procedures of SAS statistical software. Results were considered significantly different if P< 0.05.

Table 3. Yield, overwintering survival, average clove number and weight per bulb and bulb diameter comparisons between hardneck and sofneck garlic varieties grown in Lexington and Bagdad, Kentucky in 2011/2012.

Type	Yield[z] (lb/100 row feet)		Survival[y] (%)		Average Bulb Diameter (in./bulb)		Average Bulb Weight (oz.)		Average Clove No. (No./bulb)
Hardneck	36	a[x]	80	a	2.3	a	2.4	a	8
Softneck	25	b	76	a	2.0	b	1.8	b	16

z Yield based on a plant population of 21,780 bulbs per acre.
y Survival calculated based on number of bulbs per plot that survived the winter divided by number planted per plot.
x Means in the same column followed by different letters were significantly different at P < 0.05 as determined by Duncan's multiple range test.

Results and Discussion

The winter of 2011/2012 was mild, with high spring temperatures resulting in many crops maturing faster than is normally expected. However, the garlic varieties in this trial matured in early June, which is typical for Central Kentucky. Although the winter of 2012 was mild, several varieties still had poor rates of survival (Tables 1 and 2). Although visual observations indicated that hardneck varieties tended to perform better through the winter, actual survival rates were not significantly different between hardneck and softneck varieties (Table 3) Survival rates ranged from 53%-100% at the Bagdad location and from 43%-94% in the Lexington location. Overall, yields between the two locations were similar. Yields in Lexington ranged from 17-43 lb/100-row feet, while yields ranged from 16-44 lb/100 row feet in Bagdad. Polish Softneck, Music, Siberian and Bogatyr all yielded more than 40 lb/100-row feet for the Lexington location, while Georgian Fire, Music, and Metechi yielded more than 40 lb/100-row feet for the Bagdad location. Polish Softneck was the only softneck variety that performed well, while several hardneck varieties were good performers. In every yield and quality measurement, except for winter survival, hardneck varieties performed better than softneck varieties (Table 3). Music was the most consistent variety, yielding 42 and 43 lb/100-row feet at the two locations. Average bulb weight was generally greater in the Lexington location where Bogatyr, Siberian, and Russian Red were part of the group of bulbs with the greatest weight. In Bagdad, Bogatyr, Metechi, and Georgian Fire were the largest bulbs. In general, the highest quality and highest yielding varieties trialed were hardneck types. Music, a commonly grown hardneck variety was a consistent performer in both locations and should be utilized for production in Kentucky. Bogatyr was another high-quality variety. Although hardneck-types of garlic are significantly more expensive than softneck-types, they offer superior yields and quality when overwintering in Kentucky. Polish Softneck was the best performing softneck-type; however, the bulbs were of a slightly lower quality than several hardneck-types. If seed cost is a significant concern this may be a softneck type worth trialing on a limited basis. This trial clearly demonstrated that hardneck garlic, although costlier, would be preferred over softneck varieties for direct market production in Kentucky.

Acknowledgments

The authors would like to recognize Shane and Mary Courtney for participating in this trial as well as Mr. Lucas Hanks for assistance with management of the trial in the Bagdad location. Garlic seed was obtained from Peaceful Valley Organics or Territorial Seed Companies.

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Effects of Plastic and Hay Mulches on Soil Temperature and Moisture in Organic Heirloom Tomato and Watermelon Production

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Introduction

Mulches are often used for weed suppression in organic and conventional vegetable production systems. Black polyethylene film is widely used because it offers excellent weed control, retains soil moisture, limits erosion, and warms soil. Although national organic standards allow the use of polyethylene mulch, it represents a petroleum-based input that must be removed from the field at the end of each growing season, running counter to the organic standards' stated goals of promoting resource cycling and improving soil quality. Sufficient quantities of biomass-based mulch can also suppress weeds, limit erosion, and conserve soil moisture (Merwin et al. 1995, Rathore et al. 1998, Law et al. 2006, Mulvaney et al. 2011). Our objective was to compare the impact of hay mulch and polyethylene mulches on soil temperature, soil moisture, and yield in organic production of heirloom tomato (*Lycopersicon esculentum* L.) and watermelon (*Citrullus lanatus* Thunb.).

Materials and Methods

Studies were carried out on certified organic land at the Kentucky State Research and Demonstration Farm in 2011 and 2012. Sixteen, 3 by 44-foot raised beds were constructed on 6-foot centers, with a single line of drip irrigation tape along the center of each bed. Beds were divided into four replicate blocks, each containing one of four randomly assigned treatments: 1) no mulch; 2) black polyethylene mulch; 3) silver polyethylene mulch; or 4) hay mulch, applied at approximately 32 tons per acre. Mulches covered the raised portion of each bed, leaving an unmulched path between beds.

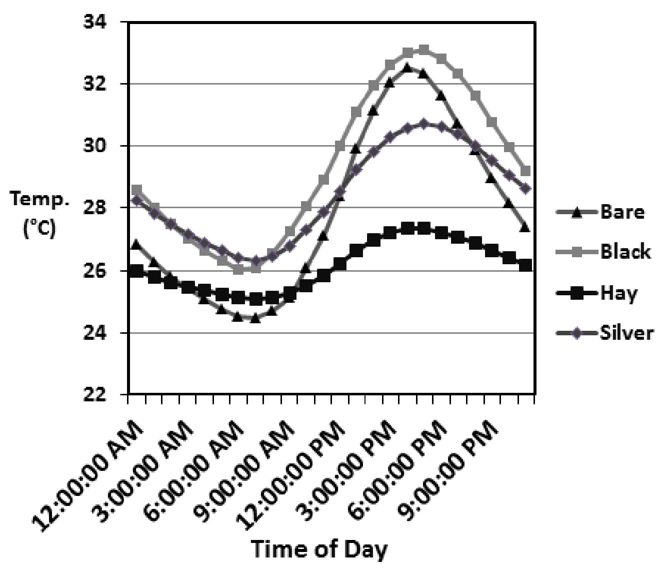
In 2011 each bed was divided into 6-foot sub-plots, which were randomly assigned to one of six heirloom tomato varieties: 1) Green Zebra, 2) Pruden's Purple, 3) Red Pear, 4) Rose de Berne, 5) Yellow Pear and 6) Yellow Perfection. Four 6-week-old tomato seedlings were transplanted into each subplot on 22 June, spaced 18 inches apart. In 2012, 4-week-old seedlings of

Table 1. Mean soil moisture content by mulch type.

Treatment	Soil Moisture Content (%)
Bare control	23.6 b[z]
Black plastic mulch	27.5 a
Hay mulch	28.6 a
Silver plastic mulch	28.8 a
S.E.	0.9

z Means followed by the same letter are not significantly different (Tukey test, $P < 0.05$).

Figure 1. Daily soil temperature flux by mulch treatment.



a single watermelon variety (cv. 'Sugar Baby') were transplanted 36 inches apart in each bed.

Soil moisture in the top six inches was recorded weekly between transplanting and harvest using a soil moisture meter (Field Scout TDR-300, Spectrum Technologies, Plainfield IL). Soil moisture readings were taken from each tomato sub-plot in 2011, and five weekly readings were taken from each watermelon bed in 2012.

Soil temperature probes were positioned one inch below the soil surface in the center of each bed in two replicate blocks. Probes were attached to a datalogger (CR-1000, Campbell Scientific, Logan UT) which recorded temperature hourly between 29 June and 11 July 2011, and between 2 July and 2 August 2012.

Tomatoes were harvested on 16 and 29 September, 2011. Watermelons were harvested on 17 and 24 August, 2012. All fruit was counted, graded, and weighed at harvest.

Results and Discussion

Soil moisture content was greater under all mulched plots than in bare plots (Table 1). Soil temperature was typically lowest at sunrise and highest in mid-afternoon (Figure 1). Daily soil temperature flux was less pronounced under hay mulch than other treatments. Black polyethylene mulch kept soil warmer throughout the day.

Tomato yield did not differ significantly between the heirloom varieties tested (Table 2). Pruden's Purple had a lower proportion of marketable fruit than the two pear varieties. Fruits from the pear varieties tended to weigh less than those of other varieties tested.

Yield was higher in plots mulched with hay than in bare plots in both years (Table 3). Watermelon yield was also higher in plots mulched with polyethylene than in unmulched plots, but this effect was not significant for tomato. Mulching had no effect on the marketable proportion of the harvest.

National organic standards allow polyethylene mulch to be used on organic farms; however it must be completely removed at the end of each season. Hay mulch represents a resource that can be produced on many farms, which does not have to be removed after use. Its decomposition builds soil quality by increasing soil organic matter content. Our results show the moderating effect of hay on daily soil temperature flux. We found that hay mulch maintained soil moisture content as effectively as polyethylene mulch. The yield benefit associated with hay mulch was similar or greater than that of polyethylene mulches in our tests with organic watermelon and heirloom tomato

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Table 2. Yield, marketable proportion, and fruit weight of heirloom tomato varieties.

Variety	Total Yield (103 lb/A)	Marketable Proportion (%)	Avg. Fruit Weight (g)
Green Zebra	3.5 a[z]	48 ab	71 ab
Pruden's Purple	5.0 a	35 b	115 a
Red Pear	4.7 a	53 a	22 c
Rose de Berne	4.0 a	49 ab	85 ab
Yellow Pear	3.9 a	64 a	12 c
Yellow Perfection	4.4 a	50 ab	41 bc
S.E.	0.6	4	11

[z] Means followed by the same letter are not significantly different (Tukey test, $P < 0.05$).

Table 3. Crop yield and marketable proportion by treatment.

	Yield (103 lb/A)		Marketable proportion (%)	
Treatment	Tomato	Watermelon	Tomato	Watermelon
Bare control	3.2 b[z]	18.3 b	48 a	92 a
Black plastic mulch	4.8 ab	29.1 a	49 a	89 a
Hay mulch	5.9 a	28.8 a	52 a	87 a
Silver plastic mulch	4.6 ab	30.7 a	46 a	87 a
S.E.	0.5	1.7	4	3

[z] Means followed by the same letter are not significantly different (Tukey test, $P < 0.05$).

Organic Production of Cucurbit Crops Using Row-covers

Mark Williams, Neal Wilson, and Timothy Coolong, Department of Horticulture

Introduction

Kentucky's warm and humid summer climate poses many challenges for organic vegetable producers. Organic cropping systems have been researched and developed by the University of Kentucky for many vegetable crops. Cucurbits, however, prove exceptionally difficult to produce organically. Some of the more commonly produced cucurbits such as squash, muskmelons, watermelons, cucumbers, and pumpkins are a major challenge for organic growers due to high incidences of bacterial wilt. The causal bacterium, *Erwinia tracheiphila*, is vectored by striped and spotted cucumber beetles (*Acalymma vittatum* and *Diabrotica undecimpunctata howardi*, respectively) and can lead to catastrophic crop failures depending upon beetle populations and infection rates.

Bacterial wilt is transmitted by cucumber beetles either depositing infected frass on plants, where the bacteria can enter plant wounds and proliferate, or by the transfer of bacteria directly into the plant from chewing mouthparts during feeding. Bacterial wilt progresses as xylem-inhabiting bacteria and ultimately leads to wilting and subsequent death of the plant. Vegetables harvested from infected plants typically develop internal rot after harvest and are unmarketable. Squash bug (*Anasa tristis*) feeding on cucurbits produces symptoms similar to those of bacterial wilt. However, this wilting is due to a toxin *Serratia marcescens* in the saliva that is injected during feeding, and causes cucurbit yellow vine decline.

Exclusion of the cucumber beetles from plants prevents infection of bacterial wilt from occurring. However, specific reliable organic crop production methods have not been developed for this region. To further develop successful production of organic cucurbits, this project was organized to develop an organic production system to control cucumber beetles and squash bugs with the implementation of a row-cover system.

Materials and Methods

The plots were located on the University of Kentucky Horticulture Research Farm located in Lexington, Kentucky, on the Organic Farming Unit, the 25-acre USDA certified organic portion of the farm. There were a total of 4 treatments for the melons and 3 treatments for the squash in this experiment. The plot plan was a randomized complete block with a split-split design. Each replication in the melon plot was 30 ft. long, and consisted of three rows spaced at 7 foot with 16 plants per row. There were 4 replications per treatment. Each replication in the squash plot was 30 ft. long, and consisted of three rows spaced at 7 foot with 16 plants per row. Melons and squash were transplanted in separate identical fields located adjacent to each other.

Four treatments were used for the melon plot in this experiment: Treatment 1 (T1)—control, with remay removed immediately after transplanting and no organic pesticides applied; Treatment 2 (T2)—standard organic, with remay removed completely at anthesis and organic pesticides applied for the duration of the growing season; Treatment 3 (T3)—on/off/on, with remay removed at anthesis, organic pesticides applied while the remay was removed, and the remay replaced two weeks after removal; and Treatment 4 (T4)—standard organic, with remay removed completely at anthesis and organic pesticides applied afterwards with the additional treatment of Blight Ban®A506, the antagonistic bacteria *Pseudomonas flourescens* (NuFarm, Dublin, OH).

Three treatments were used for the squash plot in this experiment: Treatment 1 (T1)—control, with remay removed immediately after transplanting and no organic pesticides applied; Treatment 2 (T2)—standard organic, with remay removed completely at anthesis and organic pesticides applied afterwards; and Treatment 3 (T3)—on/off/on, with the remay removed at anthesis and replaced 2 weeks later, and with organic pesticides applied while the remay was removed.

Plots were prepared using an Imants rotary spading machine. Melon 'Strike' and winter squash 'Betternut' seeds were obtained from Rupp Seeds (Wauseon, OH) and were sown in the certified organic University of Kentucky Organic Research and Education Unit greenhouse on 24 April; 20 flats of untreated 'Strike' melon seeds and 20 flats of untreated 'Betternut' squash seeds were sown into McEnroe Premium Organic Potting Soil (Seven Springs Farm, Check, VA) in black plastic 72-cell flats (Landmark Plastic Corporation, Akron, Ohio)

Plastic mulch with drip irrigation were placed in each plot on 10 May. NatureSafe 10-2-8 was applied as a pre-plant fertilizer at a rate of 125 lb/acre nitrogen. Additionally, 10 tons/A of composted manure was applied in late winter and incorporated in to the soil with the Imants rotary spading machine. Melon and squash plants were transplanted on 24 May and immediately covered with hoops and remay. On 30 May, remay was removed from T1, the control treatment, in both the melon and squash plots, and hand and mechanical weeding was conducted. On 21 June, at plant anthesis for melons, remay was removed completely from T2 and T4. Remay was also removed temporarily from T3, to be replaced in 2 weeks. The severely deteriorated DeWitt Deluxe .5 oz. remay on T3 was replaced with Agribon-19 (Deerfield Supplies, Elkton, Kentucky) on 5 July, after the 2-week period. Squash anthesis occurred at roughly the same time as for melons, on 22 June. Remay was removed for squash T2 and T3. The remay for squash T3 was replaced on 5 July.

Weed control was performed as needed, by both mechanical and hand weeding methods. Plants suffering from bacterial wilt (*Erwinia tracheiphila*) and yellow vine decline (*Serratia marcescens*) were flagged in the melon and squash plots. Dead plant counts were taken at harvest time.

All treatments excluding T1 (control) for both melon and squash were sprayed with Pyganic EC 5.0 (Peaceful Valley Farm and Garden Supply, Grass Valley, CA), an OMRI-listed

Table 1. Muskmelon 'Strike' organic practice 2012—treatment effects.

	Total Yield (No. fruit/ plot)	Marketable Yield	Marketable Yield (lb/plot)	Cull (No. fruit/ plot)	Cull Wt (lb/plot)	Sugar 7/28 (%)	Disease or Mortality[y] (No.)
Treatment 1[z]	16.8c[w]	7.5c	41.3c	9.3a	37.1ab	9.1a	13.3a
Treatment 2	42.8a	33.5a	181.4a	9.3a	39.7a	10.4a	4.5b
Treatment 3	31.5b	25.0b	136.5b	6.5c	29.3b	9.4a	4.5b
Treatment 4	42.8a	34.8a	180.8a	8b	30.8b	11.3 a	3.0b

z Treatment 1: Control, no pest management; Treatment 2: Standard organic pest management (remay removed at anthesis + insecticides); Treatment 3: On/Off/On; remay removed for 14 days at anthesis, then replaced; Treatment 4: Standard organic + Blight Ban (remay removed at anthesis + insecticides + Blight Ban (total of 3 applications).

y Disease/Mortality (out of 16 plants).

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

pyrethrum-based insecticide used to control cucumber beetles, squash bugs, and squash vine borer, as well as Surround WP (Seven Springs Farm, Check, VA), a barrier film made from Kaolin clay, and Trilogy (Seven Springs Farm, Check, VA), a fungicide/miticide/insecticide made from extract of Neem oil. Spray dates were 22 June, 3 July, 10 July, 23 July, and 5 August. Additional sprays of Blight Ban®A506, the antagonistic bacteria *Pseudomonas fluorescens* (NuFarm, Dublin, OH) were made to melon T4 on 25 June, 5 July, 11 July, and 23 July and was applied using a Solo® Backpack Sprayer 4-gallon Diaphragm Pump (Gemplers, Madison, WI).

Melon harvesting occurred on 23 July, 28 July, and 3 August, while squash harvest occurred on 2 August. All mature fruits were evaluated for total yield and quality parameters. Soluble sugar analysis was conducted using a handheld refractometer.

Results and Discussion

Muskmelon. There were significant differences for treatment effects, and as in previous years, the control (Treatment 1) was lowest in total and marketable yield and high in cull fruit and weight (Table 1). The on/off/on treatment (Treatment 3) was lower than all other treatments in cull number and weight, however, Treatment 3 was also consistently lower than all treatments except for the control in total and marketable fruit yield. This would suggest that the extra labor of recovering the vines with remay after pollination is not worth the time and effort, as both Treatment 2 and Treatment 4 outperformed the on/off/on treatment (Treatment 3) in terms of higher total and marketable fruit yield.

The spring and summer of 2012 were unusually hot and dry, which may have had a negative effect on the extended season row cover treatments. The unseasonably warm spring brought sightings of adult cucumber beetles in mid-March. When the remay was removed for harvests, it seemed exceedingly hot under the row cover, and the plants seemed more heat stressed than the other treatments. Additionally, the defective DeWitt Deluxe .5 oz. remay started to deteriorate about two weeks before anthesis, and although it was patched as much as possible it was seriously compromised by the time it was removed. All of these factors may have contributed to the lack of success with Treatment 3, however, without further data to indicate otherwise, the current data from this and previous years suggests that the standard organic practice (Treatment 2) produces a better result than extended season row covers in the production of muskmelons.

Squash. The squash bug (*Anasa tristis*) pressure on the field was overwhelming, and it is speculated that the overwintering adults were active much earlier in the season than usual which resulted in an early season population explosion and perhaps an extra generation of bugs for the year. Damage from the heavy feeding pressure coupled with the intense heat related stress resulted in a crop with no marketable fruit in any of the treatments. The only significant difference between treatments was in the cull numbers and cull weight. This is because virtually all of the plants died before the fruit reached maturity, As in previous years, it was found there was no advantage to using extended season row covers (Treatment 3) over the standard organic practice (Treatment 2), because although there were no marketable fruit in either treatment, there were more overall cull fruit produced in Treatment 2.

Soil Amended with Yard Waste and Chicken Manure Increased 2-Tridecanone Concentration in Field-Grown Onion

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Introduction

The genus *Allium* belongs to the *Liliaceae* family that has up to approximately 500 species. [1] Methyl ketones (MKs), a group of volatile compounds that has been detected on the leaves and stem of wild tomatoes, *Lycopersicon hirsutum* f. *glabratum* Mull, include: 2-undecanone and 2-tridecanone which are important to the flavor and fragrance industry. These compounds also have a variety of important natural roles including acting as natural insecticides in plants. [2]

On the other hand, composting of agricultural soil with sewage sludge or yard waste provides an organic amendment useful for improving soil structure and soil nutrient status [3] and generally increases soil organic matter and stimulates soil microbial activity. [4] The use of soil amendments in land farming could decrease dependence on synthetic fertilizers and provide alternatives to farmers dealing with the escalating production costs associated with increasing costs of energy and fertilizers and the negative impact of waste disposal.Yard waste and hen manure are commonly used soil amendments in the U.S. and because of the rapid growth of the poultry industry, poultry manure has become available in increasing quantities in recent years. The objectives of this study were to: 1) determine the concentrations of 2-undecanone and 2-tridecanone in onion bulbs at harvest and 2) investigate the effect of mixing soil with three amendments (sewage sludge, yard waste, and chicken manure) on concentrations of 2-undecanone and 2-tridecanone in onion.

Materials and Methods

A field study was conducted on a Lowell silty-loam soil (2.0% organic matter, pH 7) at Kentucky State University Research Farm, Franklin County, Kentucky. The soil has an average of 12% clay, 75% silt, and 13% sand. Plots (n = 20) of 2 ×10 m each were separated using 1m wide grass strips. The soil in five plots was mixed with sewage sludge (SS) obtained from Metropolitan Sewer District, Louisville, Kentucky at 15 t acre^{-1} (on dry weight basis). Soil from five plots was mixed yard waste (YW) compost made from yard and lawn trimmings, and vegetable remains (obtained from Con Robinson Co., Lexington, Kentucky) at 15 t acre^{-1} (on dry weight basis), and soil from five plots was mixed with caged laying hen manure obtained from University of Kentucky Poultry Research Facility, Lexington, Kentucky at 15 t acre^{-1}. Five plots was used as a no-mulch (NM) control treatment (roto-tilled bare soil) for comparison purposes. Amendments were incorporated into the topsoil with a plowing depth of 15 cm. Seeds of onion, *Allium cepa* var. Super Star F1 were planted in the greenhouse on April 19, 2008. Seedlings (45 days old) were replanted under four soil management practices (sewage sludge, yard compost, chicken manure, and no-mulch soil). Mature onion bulbs were harvested on August 10, 20, and 30, respectively. Representative samples of 10 cured bulbs were collected from each plot for chemical analysis. Bulb tops, tails and dry outer skins were removed, and a vertical wedge was taken from each bulb to form a representative sample of 50 g each. Samples were blended for 2 min with 150 mL of chloroform-methanol (1:1, v/v) at a high speed. Onion extracts were filtered under vacuum through Whatman No.1 filter paper in Buchner funnel. After filtration, each sample was transferred into a separatory funnel along with 10 mL of 4% NaCl. 2-Undecanone and 2-tridecanone were extracted from the mixture by liquid-liquid partition. The top layer contained the aqueous solution and the bottom layer contained the chloroform. Chloroform extracts were dried over anhydrous Na_2SO_4. A portion of each chloroform extract was subsequently passed through a 0.45 µm GD/X disposable syringe filter (Fisher Scientific, Pittsburg, PA). One µL (n = 3) of this filtrate was injected into a GC model 5890A equipped with a mass spectrometer detector (GC/MSD) model 5971A operated in total ion monitoring with electron impact ionization (EI) mode and 70 eV electron energy for identification and confirmation of individual peaks. GC separations were accomplished using a 25 m × 0.20 mm ID capillary column with 0.33 µm film thickness (HP-1).

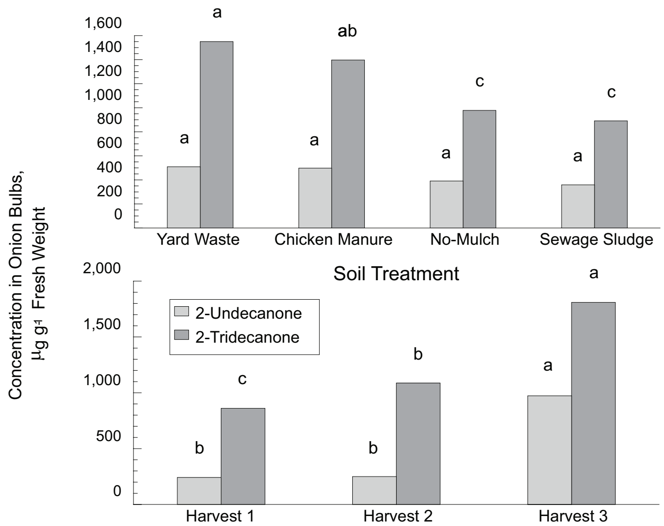
Quantifications were based on average peak areas of 1 µL injections obtained from external standard solutions of onion oil (Sigma-Aldrich, Milwaukee, WI 53201, USA). 2-undecanone (99% purity) and 2-tridecanone (98% purity) were obtained from Fisher Scientific). Concentrations of the two volatile compounds (2-undecanone and 2-tridecanone) in onion bulbs grown under the four soil management practices were statistically analyzed using ANOVA. Means were compared using Duncan's multiple range test (SAS 2003). [5]

Results and Discussion

Concentrations of 2-undecanone and 2-tridecanone were significantly higher ($P< 0.05$) in onion bulbs of plants grown in soil amended with yard waste or chicken manure compared to other soil treatments (Figure 1). This enhancement might be due to improved soil porosity, soil water holding capacity, and nutrient retention in yard waste and chicken manure treated soil or could be due to increased soil organic matter content after addition of soil amendments. Analysis of soil amended with sewage sludge, chicken manure, yard waste, and no-mulch control soil revealed that the organic matter contents were 3.1, 5.4, 6.7, and 2.0, respectively. Onion and other plants grown under elevated concentrations of soil organic matter might accumulate carbon from soil and, funnel at least a portion of this carbon into an increased production of volatile organic compounds in onion bulbs. Concentrations of 2-undecanone (509 and 498 µg g^{-1} fresh weight) and 2-tridecanone (1551 and 1397 µg g^{-1} fresh weight) were greatest in onion bulbs of plants grown in yard waste compost and chicken manure, respectively. Concentrations of 2-undecanone (359 and 390 µg g^{-1} fresh weight) and 2-tridecanone (890 and 978 µg g^{-1} fresh weight) were lowest in onion bulbs of plants grown in sewage sludge and unamended soil, respectively (Figure 1, upper graph). Soil amended with yard waste compost enhanced 2-undecanone and 2-tridecanone production by 31 and 59%, respectively. Soil amended with chicken manure enhanced 2-undecanone and 2-tridecanone production by 28 and 43%, respectively.

Average concentrations of 2-undecanone in onion bulbs across all soil treatments were 242, 250, and 973 µg 100 g^{-1} fresh onion bulbs for harvest 1, harvest 2, and harvest 3, respectively, regardless of soil treatment (Figure 1, lower graph). Similarly, concentrations of 2-tridecanone in onion bulbs across all soil treatments were 861, 1087, and 1810 µg 100 g^{-1} fresh onion bulb for harvest 1, harvest 2, and harvest 3, respectively (Figure 1, lower graph), indicating that onion plants rapidly accumulate these two methyl ketones during the growing season. These data also indicated that onion bulbs contained higher concentrations of 2-tridecanone compared to 2-undecanone. Chicken rearing facilities discard significant amounts of broiler and chicken manure waste that can be used as organic fertilizer to reduce dependance on synthetic inorganic fertilizers. The

Figure 1. Concentrations of 2-undecanone and 2-tridecanone in onion bulbs of plants grown under four soil management practices (upper graph) and concentrations of 2-undecanone and 2-tridecanone in onion bulbs collected at three harvests (lower graph). Statistical comparisons were carried out between soil treatments or onion harvest. Bars accompanied by different letter(s) are significantly different (P< 0.05), using Duncan's multiple range test. [5]



rapid growth in the poultry industry has resulted in significant manure generation. More than 11.4 million tons of poultry litter was generated in the United States and approximately 90% was applied to land as fertilizer. [6] Poultry litter contains all essential plant nutrients (N, P, K, S, Ca, Mg, B, Cu, Fe, Mn, Mo, and Zn) and has been documented as an excellent fertilizer. [7] Very limited work has been conducted on methyl ketones in onions. To the best of the author's knowledge no reports in the literature have documented the importance and value of chicken manure or yard waste compost in increasing 2-undecanone and 2-tridecanone in onion. Medium-length methyl ketones (MKs) such as 2-undecanone and 2-tridecanone have been recognized as some of the most effective naturally occurring pesticides. [8] These compounds have also been detected on the leaves of *Lycopersicon hirsutum f. glabratum* accessions and have shown broad pest control specificity. MKs contribute to host-plant resistance against insects and spider mites by a variety of mechanisms including insect toxicity [8] and repellency. [9] 2-Tridecanone reduced the infestation and caused 100% mortality of the potato aphid (*Macrosiphum euphorbiae*) over 24 h exposure. [10] The insecticidal and acaricidal performance of methylketones against the green peach aphid, *Myzus persicae*; tobacco hornworm, *Manduca sexta*; the corn earn worm, *Heliothis zea*; Colorado potato beetle, *Leptinotarsa decemlineata*; whiteflies, *B. tabaci*; and the two spotted spider mite, *Tetranychus urticae* have been documented. 2-Tridecanone, a principal constituent of *L. hirsutum* f. *glabratum* plants and one of the constituents of onion bulbs, as proven in this investigation, has an herbaceous, spicy-like odor. The FDA [11] has proposed the use of 2-tridecanone as a food flavor chemical. Accordingly, the detection of MKs in onion bulbs and the impact of soil amendments, such as yard waste and chicken manure, on concentrations of 2-undecanone and 2-tridecanone in onion bulb, as indicated in this investigation, could be exploited to increase onion resistance to insect infestation under field conditions. Breeding and screening onion genotypes for MKs content remain to be answered.

Acknowledgments

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Monitoring Trace-Elements Mobility from Soil into Bell Pepper and Melons Fruits

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Introduction

Total metal concentrations in municipal sewage sludge (SS also known as biosolids) or native soils do not necessarily furnish sufficient information regarding the potential availability of elements for plant uptake. Accumulation of trace elements in plants grown in SS varied among plant species. [1] Trace-elements are among the major contaminants of food supply. They are not biodegradable, have long biological half-lives and have the potential for accumulation in different body organs leading to potential adverse effects on human health. Biosolids are the nutrient-rich organic materials resulting from the treatment of SS. They are often rich in organic matter and act much like slow release organic fertilizers, maintaining productive soils and stimulating plant growth. Composting and land application of biosolids are increasingly popular ways for using organic waste and decreasing the amount of municipal waste being diverted into landfills. Recycling wastes provides amendments useful for improving soil structure and nutrient status. [2] Soil incorporation of composted SS usually results in a positive effect on the growth and yield of a wide variety of crops and promotes the restoration of ecologic and economic functions of soils. Agricultural uses of SS have shown promise for a variety of field crops (e.g., maize, sorghum, forage grasses), for production of vegetables (e.g., lettuce, cabbage, beans, potatoes, cucumbers [3] and sweet potato [4]) and for enhanced soil biological activities. [5] Optimal soil management represents an important strategy for sustainable agricultural systems and many government bodies have developed guidelines for application of biosolids to agricultural soils.[6] The Metropolitan Sewer District in Louisville, Kentucky, USA has turned human and pre-treated industrial waste into dried pellets that can be used as a fertilizer. Under rules set by the USEPA, these pellets can be used in the production of many different food, feed, and horticultural crops used for human consumption as well as those used for animal feed. [7] In addition to Kentucky and Indiana, the product known as "Louisville Green" has been licensed for use on farms in South Carolina, Georgia, Tennessee, Missouri, Arkansas, and Mississippi. However, while plants require necessary nutrients, such as N, P, and K, they also accumulate hazardous metals such as Pb, Ni, and Cd. Accordingly, beneficial use of SS depends on identifying a soil management strategy that supports crop production and warranties human safety and food quality. Thuy et al. [8] indicated that trace-elements are one of the pollutants of most concern around the world and their elevated concentrations in harvested plant tissue could expose consumers to excessive levels of potentially hazardous chemicals. The present study is a continuation of our previous work on recycling waste and use of soil amendments for land farming. The main objective of this investigation was to study the impact of mixing native agricultural soil with municipal sewage sludge (SS) or SS mixed with yard waste (SS+YW) compost on concentrations of seven trace-elements (Cd, Cr, Mo, Cu, Zn, Pb, and Ni) in pepper and melon fruits at harvest.

Materials and Methods

A field study was conducted in summer 2009 on a Lowell silty-loam soil (2% organic matter, pH 7) located at Kentucky State University Research Farm, Franklin County, Kentucky. The soil has an average of 12% clay, 75% silt, and 13% sand. Eighteen plots of 22 × 3.7 m each were established. Plots were separated using stainless steel borders 20 cm above ground level to prevent cross contamination between adjacent treatments. The soil in six plots was mixed with municipal sewage sludge (SS) pellets "Louisville Green" made from heated and dried human waste obtained from Metropolitan Sewer District, Louisville, Kentucky and used at 15 t acre^{-1} (on dry weight basis). Six plots were mixed with SS and yard waste (SS+YW) compost at 15 t acre^{-1} (on dry weight basis). Yard waste (YW) was made from a mixture of straw, grass, leaves and small broken tree branches obtained from Con Robinson Co., Lexington, Kentucky. Amendments were incorporated into the topsoil with a plowing depth of 15 cm. The native soil in six plots was used as a no-mulch (NM) control treatment (roto-tilled bare soil) for comparison purposes.

Plots were planted with seedlings of muskmelon (*Cucumis melo* cv. Athena) and bell pepper (*Capsicum annuum* cv. Aristotle) grown in the greenhouse for five and eight weeks, respectively, prior to transplant. Peppers and melons were planted with 30 and 60 cm in-row spacing, respectively at 10 rows plot-1 against the contour of the land slope. Rows were spaced 1.1 m apart. Plants were watered by a drip irrigation system and grown using standard production practices for Kentucky growers.[9] At harvest (September 25, October 1, and October 8, 2009) three melon and pepper fruits were collected at random from each harvest from each of the 18 field plots (six replicates for each soil treatment). Fruits were washed with tap and deionized water, cut into small cubes, and dried in an oven at 65°C for 48 h. [1] The dried samples were ground manually with ceramic mortar and pestle to pass through a 1 mm non-metal sieve. Samples were re-dried to constant weight using an oven. To 1 g of each dry sample, 10 mL of concentrated nitric acid (HNO_3) trace metal grade was added and the mixture was allowed to stand overnight and heated for 4 h at 125°C on a hot plate. The mixture was then diluted to 50 mL with double distilled water and filtered through filter paper No.1.

Native soil and soil incorporated with SS and SS+YW were collected to a depth of 15 cm from field plots using a soil core sampler equipped with a plastic liner (Clements Associates, Newton, IA, USA) of 2.5 cm i.d. Soil samples were oven-dried at 105°C to a constant weight and sieved through a non-metal sieve to a size of 2 mm. Total metal concentration in soil was extracted using nitric acid as described above. Since total metal concentration in soils is not a very useful predictor of bioavailability of soluble concentrations of metal uptake by plants, the calcium chloride ($CaCl_2$)—extracted metal fraction was used to determine the readily soluble and extractable metal ions. Ten g dried soil samples were suspended in 25 mL of 0.01 $CaCl_2$ and heated at 90°C on a hot plate for 30 min. The resulting supernatants were filtered hot through Whatman filter paper #42, and 2 drops of 1 M HNO_3 trace metal grade were added to prevent metal precipitation and to inhibit microbial growth in samples.

Concentrations of Cd, Cr, Ni, Pb, Zn, Cu, and Mo were determined using inductively coupled plasma-mass spectrometer (ICP-MS) following the U.S. EPA method 6020a. [10] Elemental concentrations in soil and plants grown under three soil management practices were statistically analyzed using SAS procedure. Means were compared using Duncan's multiple range test. [11]

Results and Discussion

Total Ni concentration (26.7 μg g^{-1} dry soil) extracted from soil amended with SS using nitric acid was significantly greater than SS+YW and no-mulch (NM) treatments (Table 1), while Ni available to plants was greatest in SS+YW and lowest in SS and NM treatment (Table 2). These findings revealed that total Ni in SS mixed with soil could be in a complex form that was not soluble in the mild $CaCl_2$ solution used to extract metal ions from soil indicating that total concentration of Ni in soil do not necessarilyy reflect Ni ions available to plants. Similarly, total Cd concentration (0.29 μg g^{-1} dry soil) was significantly greater in SS compared to the other soil treatments (Table 1). However, concentrations of Cd ions available to plants were very low (Table 2). These findings revealed that total Ni and Cd in SS or SS+YW treatments may not reflect ions in soil available to melon and pepper plants.

One might consider that the aggressive nitric acid used in extracting trace-metals greatly altered the soil chemical environment, dissolving much greater quantities of metals from the soil solid phase than the amounts that are plant-available. Thus, nonaggressive solutions such as $CaCl_2$ used in the present investigation, which extracted small quantities of trace-metals from soil, may approximate the short-term bioavailable pool more directly than aggressive extractants.

The overall distribution of each of the seven trace-elements in melon and pepper fruits, regardless of the soil treatment, is presented in Figure 1. While, no significant differences were found in Cr, Cu, and Mo accumulation between melon and pepper fruits, Ni, Cd, Pb, and Zn were greater in melon than pepper fruits. Data of heavy metals in melon and pepper analyzed in this investigation are expressed on dry weight basis. Water contents of the melon and pepper fruits were 93 and 91%, respectively. Regardless of soil treatment, Pb concentrations in melon fruits was 3.8 μg g^{-1} on dry weight basis (Figure 1), equivalent to 0.27

Table 1. Trace-elements in sewage sludge (SS) mixed with native soil, SS mixed with yard waste (SS + YW) and native soil, and no-mulch (NM) native soil extracted with nitric acid.

Content	SS	SS + YW	NM
	mg g^{-1} on dry weight basis[z]		
Cr	26.31 a	18.03 b	16.58 b
Ni	26.65 a	17.88 b	17.33 b
Cu	54.78 a	15.29 b	13.87 b
Zn	124.85 a	74.54 b	66.17 b
Mo	0.05 a	0.08 a	0.04 a
Cd	0.29 a	0.19 b	0.17 b
Pb	36.91 a	30. 27 a	39.3 a
% Organic Matter	3.09 b	4.15 a	2.03 c
pH	7.60 a	7.31 a	6.90 b

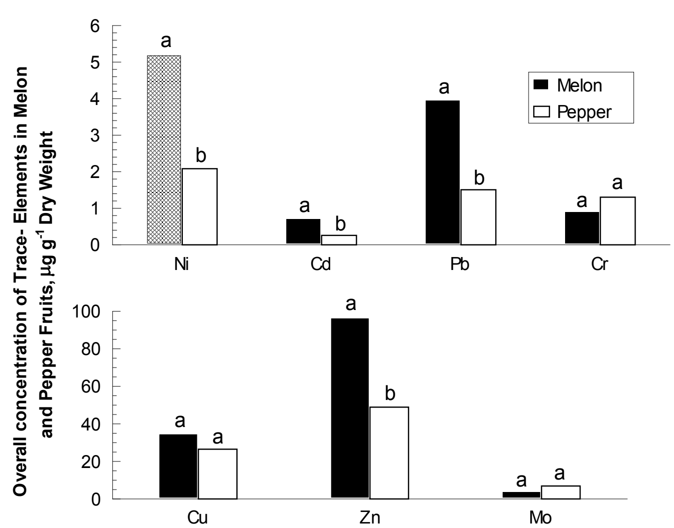
z Each value in the table is an average obtained from analysis of six samples. Organic matter was calculated as dry weight minus ash content. pH was determined using a glass electrode in a soil: distilled water slurry (1:5 W/V). Statistical comparisons were carried out between SS, SS + YW, and NM using Duncan's multiple range test. [11]

Table 2. Trace-elements in sewage sludge (SS) mixed with native soil, SS mixed with yard waste (SS + YW) and native soil, and no-mulch (NM) native soil extracted with Calcium Chloride.

Content	SS	SS + YW	NM
	mg g^{-1} on dry weight basis[z]		
Cr	0.1050 b	0.1318 ab	0.1423 a
Ni	0.1881 b	0.2955 a	0.1853 b
Cu	0.1490 a	0.0995 b	0.1599 a
Zn	0.1085 b	0.7012 a	0.1093 b
Mo	0.6239 b	0.8012 a	0.6101 b
Cd	0.0299 a	0.0321 a	0.0312 a
Pb	0.0830 b	0.0815 b	0.1958 a

z Each value in the table is an average obtained from analysis of six samples. Statistical comparisons were carried out between SS, SS + YW, and NM using Duncan's multiple range test. [11]

Figure 1. Overall concentrations of seven trace-elements in melon and bell pepper fruits, regardless of soil treatments. Statistical comparisons were carried out between the two crops for each element. Bars for each element accompanied by the same letter are not significantly different (*P*> 0.05) from each other using Duncan's multiple range test. [11]



μg g-1 on fresh weight basis, which exceeds the allowable limit of 0.1 μg g-1 in vegetables on fresh weight basis (Codex Alimentarius Commission). [12] Cadmium concentrations in melon fruits (0.6 μg g-1 on dry weight basis) were below the allowable limit of 0.05μg g-1 on fresh weight basis. Nickel concentration in melon fruits was 5.2 μg g-1 on dry weight basis, equivalent to 0.36 μg g-1 on fresh weight basis. Lead and Cd concentrations in pepper fruits were 1.2 and 0.2 μg g-1 on dry weight basis which are equivalent to 0.11 and 0.02 μg g-1 on fresh weight basis, respectively. Accordingly, Pb concentration in pepper fruits was at the permissible limit, while Cd was below the permissible limit (Codex Alimentarius Commission). [12]

Bioavailability is the proportion of the total metals in the soil that are available for the incorporation into biota. The bioaccumulation factor (BAF) is characterized by the ratio of the metal content in plant and total metal content in the soil. [13] Table 3 shows the BAF of seven heavy metals in melon and pepper fruits of plants grown under three soil management practices. BAF values below 1 are desirable and present levels that do not pose human health hazards. On average, regardless of soil treatments, melon and pepper fruits were poor accumulators of Cr, Ni, Cu, Cd, and Pb (BAF < 1), while BAF values were >1 for Zn and Mo. Assessing the bioavailability and speciation of trace-elements in soil amendments is crucial to determining the environmental impact of contaminated soils.

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Table 3. Bioaccumulation factor (BAF) of seven trace-elements by melon and pepper, regardless of soil treatments and BAF of seven metals by fruits of plants grown in sewage sludge (SS) mixed soil, SS + YW mixed soil, and no-mulch (NM) native soil. Statistical comparisons were carried out among SS, SS + YW, and NM treatments for each metal using Duncan's multiple range test. [11]

	Overall Bioaccumulation Factor[z]		
Metal	**Melon Fruits**	**Pepper Fruits**	
Cr	0.06 a	0.03 a	
Ni	0.30 a	0.77 a	
Cu	0.81 a	0.99 a	
Zn	1.14 b	2.55 a	
Mo	4.39 b	7.14 a	
Cd	0.63 a	0.47 a	
Pb	0.03 a	0.03 a	
	Melon Bioaccumulation Factor		
Metal	**SS**	**SS+YW mix**	**NM**
Cr	0.35 a	0.26 a	0.13 a
Ni	0.19 b	1.68 a	0.62 b
Cu	0.82 b	1.14 a	1.12 a
Zn	49.03 a	48.54 a	34.40 a
Mo	0.27 b	2.07 a	0.41 b
Cd	0.02 a	0.05 a	0.05 a
Pb	0.02 a	0.04 a	0.03 a
	Pepper Bioaccumulation Factor		
Metal	**SS**	**SS+YW mix**	**NM**
Cr	0.39 b	0.15 b	3.04 a
Ni	0.43 b	1.60 a	1.28 ab
Cu	2.24 b	2.61 ab	3.15 a
Zn	87.62 a	66.93 b	66.40 b
Mo	0.36 a	0.33 a	0.50 a
Cd	0.02 a	0.02 a	0.03 a
Pb	0.03 a	0.02 a	0.02 a

z BAF is the ratio of the metal content in plant and total metal content in soil. Each value in the table is an average obtained from analysis of six samples.

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Appendix A: Sources of Vegetable Seeds

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

AAS .... All America Selection Trials, 1311 Butterfield Road, Suite 310, Downers Grove, IL 60515
AS/ASG .... Formerly Asgrow Seed Co., now Seminis (see "S" below)
AC.................. Abbott and Cobb Inc., Box 307, Feasterville, PA 19047
AG.................. Agway Inc., P.O. Box 1333, Syracuse, NY 13201
AM................. American Sunmelon, P.O. Box 153, Hinton, OK 73047
AR.................. Aristogenes Inc., 23723 Fargo Road, Parma, ID 83660
AT................... American Takii Inc., 301 Natividad Road, Salinas, CA 93906
B..................... BHN Seed, Division of Gargiulo Inc., 16750 Bonita Beach Rd., Bonita Springs, FL 34135
BBS................ Baer's Best Seed, 154 Green St., Reading, MA 01867
BC.................. Baker Creek Heirloom Seeds, 2278 Baker Creek Rd., Mansfield, OH 65704
BK.................. Bakker Brothers of Idaho Inc., P.O. Box 1964, Twin Falls, ID 83303
BR.................. Bruinsma Seeds B.V., P.O. Box 1463, High River, Alberta, Canada, TOL 1B0
BS................... Bodger Seed Ltd., 1800 North Tyler Ave., South El Monte, CA 91733
BU.................. W. Atlee Burpee & Co., P.O. Box 6929, Philadelphia, PA 19132
BZ.................. Bejo Zaden B.V., 1722 ZG Noordscharwoude, P.O. Box 9, The Netherlands
CA.................. Castle Inc., 190 Mast St., Morgan Hill, CA 95037
CF.................. Cliftons Seed Co., 2586 NC 43 West, Faison, NC 28341
CG.................. Cooks Garden Seed, PO Box C5030 Warminster, PA 18974
CH.................. Alf Christianson, P.O. Box 98, Mt. Vernon, WA 98273
CIRT............... Campbell Inst. for Res. and Tech., P-152 R5 Rd 12, Napoleon, OH 43545
CL.................. Clause Semences Professionnelles, 100 Breen Road, San Juan Bautista, CA 95045
CN.................. Canners Seed Corp., (Nunhems) Lewisville, ID 83431
CR.................. Crookham Co., P.O. Box 520, Caldwell, ID 83605
CS.................. Chesmore Seed Co., P.O. Box 8368, St. Joseph, MO 64508
D.................... Daehnfeldt Inc., P.O. Box 947, Albany, OR 97321
DN................. Denholm Seeds, P.O. Box 1150, Lompoc, CA 93438-1150
DR.................. DeRuiter Seeds Inc., P.O. Box 20228, Columbus, OH 43320
EB................... Ernest Benery, P.O. Box 1127, Muenden, Germany
EV.................. Evergreen Seeds, Evergreen YH Enterprises, P.O. Box 17538, Anaheim, CA 92817
EX.................. Express Seed, 300 Artino Drive, Oberlin, OH 44074
EW................. East/West Seed International Limited, P.O. Box 3, Bang Bua Thong, Nonthaburi 1110, Thailand
EZ................... ENZA Zaden, P.O. Box 7, 1600 AA, Enkhuisen, The Netherlands 02280-15844
FED................ Fedco Seed Co., P.P. Box 520 Waterville, ME, 04903
FM................. Ferry-Morse Seed Co., P.O. Box 4938, Modesto, CA 95352
G.................... German Seeds Inc., Box 398, Smithport, PA 16749-9990
GB.................. Green Barn Seed, 18855 Park Ave., Deephaven, MN 55391
GL.................. Gloeckner, 15 East 26th St., New York, NY 10010
GO................. Goldsmith Seeds Inc., 2280 Hecker Pass Highway, P.O. Box 1349, Gilroy, CA 95020
GU................. Gurney's Seed and Nursery Co., P.O. Box 4178, Greendale, IN 47025-4178
HL/HOL......... Hollar & Co. Inc., P.O. Box 106, Rocky Ford, CO 81067
H/HM............ Harris Moran Seed Co., 3670 Buffalo Rd., Rochester, NY 14624, Ph: (716) 442-0424
HMS.............. High Mowing Organic Seeds, 76 Quarry Rd., Wlacott, VT 05680
HN................. HungNong Seed America Inc., 3065 Pacheco Pass Hwy., Gilroy, CA 95020
HO................. Holmes Seed Co., 2125-46th St., N.W., Canton, OH 44709
HR.................. Harris Seeds, 60 Saginaw Dr., P.O. Box 22960, Rochester, NY 14692-2960
HS.................. Heirloom Seeds, P O Box 245, W. Elizabeth PA 15088-0245
HZ.................. Hazera Seed, Ltd., P.O.B. 1565, Haifa, Israel
JU................... J. W. Jung Seed Co., 335 High St., Randolf, WI 53957
JS/JSS........... Johnny's Selected Seeds, Foss Hill Road, Albion, MA 04910-9731
KS................... Krummrey & Sons Inc., P.O. 158, Stockbridge, MI 49285
KU.................. Known-you Seed Co., 26 Chung Cheng 2nd Road, Kaushiung Taiwan, 80271
KY.................. Known-You Seed Co., Ltd. 26 Chung Cheng Second Rd., Kaohsiung, Taiwan, R.O.C. 07-2919106
KZ.................. Kitazawa Seed Co., PO Box 13220 Oakland, CA 94661-3220
LI.................... Liberty Seed, P.O. Box 806, New Philadelphia, OH 44663
LSL................. LSL Plant Science, 1200 North El Dorado Place, Suite D-440, Tucson, AZ 85715
MB................. Malmborg's Inc., 5120 N. Lilac Dr., Brooklyn Center, MN 55429
MK................. Mikado Seed Growers Co. Ltd., 1208 Hoshikuki, Chiba City 280, Japan 0472 65-4847
ML................. J. Mollema & Sons Inc., Grand Rapids, MI 49507
MM................ MarketMore Inc., 4305 32nd St. W., Bradenton, FL 34205
MN................ Dr. Dave Davis, 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.)
NS.................. New England Seed Co., 3580 Main St., Hartford, CT 06120
NZ.................. Nickerson-Zwaan, P.O. Box 19, 2990 AA Barendrecht, The Netherlands
OE.................. Ohlsens-Enke, NY Munkegard, DK-2630, Taastrup, Denmark
ON................. Osbourne Seed Co., 2428 Old Hwy 99 South Road Mount Vernon, WA 98273
OS.................. Outstanding Seed Co., 354 Center Grange Road, Monaca PA 15061
OLS................ L.L. Olds Seed Co., P.O. Box 7790, Madison, WI 53707-7790

OT .... Orsetti Seed Co., P.O. Box 2350, Hollister, CA 95024-2350
P .... Pacific Seed Production Co., P.O. Box 947, Albany, OR 97321
PA/PK .... Park Seed Co., 1 Parkton Ave., Greenwood, SC 29647-0002
PARA .... Paragon Seed Inc., P.O. Box 1906, Salinas CA, 93091
PE .... Peter-Edward Seed Co. Inc., 302 South Center St., Eustis, FL 32726
PF .... Pace Foods, P.O. Box 9200, Paris, TX 75460
PG .... The Pepper Gal, P.O. Box 23006, Ft. Lauderdale, FL 33307-3006
PL .... Pure Line Seeds Inc., Box 8866, Moscow, ID
PM .... Pan American Seed Company, P.O. Box 438, West Chicago, IL 60185
PR .... Pepper Research Inc., 980 SE 4 St., Belle Glade, FL 33430
PT .... Pinetree Garden Seeds, P.O. Box 300, New Gloucester, ME 04260
R .... Reed's Seeds, R.D. #2, Virgil Road, S. Cortland, NY 13045
RB/ROB .... Robson Seed Farms, P.O. Box 270, Hall, NY 14463
RC .... Rio Colorado Seeds Inc., 47801 Gila Ridge Rd., Yuma, AZ 85365
RE .... Reimer Seed Co., PO Box 236, Mt. Holly, NC 28120
RG .... Rogers Seed Co., P.O. Box 4727, Boise, ID 83711-4727
RI/RIS .... Rispens Seeds Inc., 3332 Ridge Rd., P.O. Box 5, Lansing, IL 60438
RS .... Royal Sluis, 1293 Harkins Road, Salinas, CA 93901
RU/RP/RUP .. Rupp Seeds Inc., 17919 Co. Rd. B, Wauseon, OH 43567
S .... Seminis Inc. (may include former Asgrow and Peto cultivars), 2700 Camino del Sol, Oxnard, CA 93030-7967
SE .... Southern Exposure Seed Exchange, P.O. Box 460Mineral, VA 23117
SHUM .... Shumway Seed Co., 334 W. Stroud St. Randolph, WI 53956
SI/SG .... Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503
SIT .... Seeds From Italy, P.O. Box 149, Winchester, MA 01890
SK .... Sakata Seed America Inc., P.O. Box 880, Morgan Hill, CA 95038
SN .... Snow Seed Co., 21855 Rosehart Way, Salinas, CA 93980
SO .... Southwestern Seeds, 5023 Hammock Trail, Lake Park, GA 31636
SOC .... Seeds of Change, Sante Fe, NM
SST .... Southern States, 6606 W. Broad St., Richmond, VA 23230
ST .... Stokes Seeds Inc., 737 Main St., Box 548, Buffalo, NY 14240
SU/SS .... Sunseeds, 18640 Sutter Blvd., P.O. Box 2078, Morgan Hill, CA 95038
SV .... Seed Savers Exchange, 3094 North Winn Rd., Decorah, IA 52101
SW .... Seedway Inc., 1225 Zeager Rd., Elizabethtown, PA 17022
SY .... Syngenta/Rogers, 600 North Armstrong Place (83704), P.O. Box 4188, Boise, ID 83711-4188
T/TR .... Territorial Seed Company, P.O. Box 158, Cottage Grove, OR 97424
TGS .... Tomato Growers Supply Co., P.O. Box 2237, Ft. Myers, FL 33902
TS .... Tokita Seed Company, Ltd., Nakagawa, Omiya-shi, Saitama-ken 300, Japan
TT .... Totally Tomatoes, P.O. Box 1626, Augusta, GA 30903
TW .... Twilley Seeds Co. Inc., P.O. Box 65, Trevose, PA 19047
UA .... US Agriseeds, San Luis Obispo, CA 93401.
UG .... United Genetics, 8000 Fairview Road, Hollister, CA 95023
US .... US Seedless, 12812 Westbrook Dr., Fairfax, VA 22030
V .... Vesey's Seed Limited, York, Prince Edward Island, Canada
VL .... Vilmorin Inc., 6104 Yorkshire Ter., Bethesda, MD 20814
VS .... Vaughans Seed Co., 5300 Katrine Ave., Downers Grove, IL 60515-4095
VTR .... VTR Seeds, P.O. Box 2392, Hollister, CA 95024
WI .... Willhite Seed Co., P.O. Box 23, Poolville, TX 76076
WP .... Woodpraire Farms, 49 Kinney Road, Bridgewater, ME 04735
ZR .... Zeraim Seed Growers Company Ltd., P.O. Box 103, Gedera 70 700, Israel