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Fruit and Vegetable

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2015 Fruit and Vegetable Crops Research Report

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Cover: Harvest Moon watermelon variety, a seedless version of the Moon and Stars. Yellow spots on the fruit and leaves are expected with this variety, not to be confused with disease.

Acknowledgments

Grants from the Agricultural Development Board through the Kentucky Horticulture Council have allowed an expansion of the field research and demonstration program to meet the informational and educational needs of our growing vegetable and fruit industries. The editors would also like to thank the Kentucky Vegetable Growers Association and the Kentucky State Horticulture Society for providing funds to cover the costs of printing in 2015.

Important note to readers
The majority of research reports in this volume do not include treatments with experimental pesticides. It should be understood that any experimental pesticide must first be labeled for the crop in question before it can be used by growers, regardless of how it might have been used in research trials. The most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information. Contact your county's Cooperative Extension office if you need assistance in interpreting pesticide labels.
This is a progress report and may not reflect exactly the final outcome of ongoing projects. Please do not reproduce project reports for distribution without permission of the authors.

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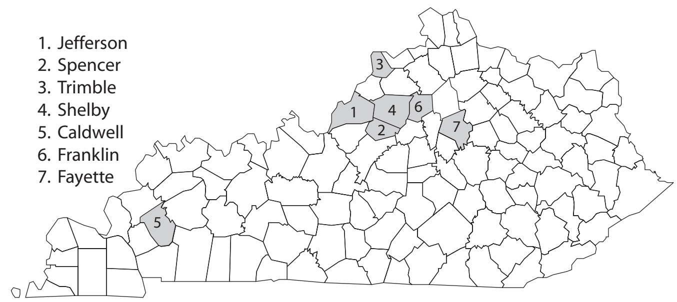
The 2015 Fruit and Vegetable Crops Research Program

Shubin K. Saha, Horticulture

Fruit and vegetable production in Kentucky continues to grow. The 2015 Fruit and Vegetable Crops research report includes results for more than 19 field research plots and demonstration trials. This year fruit and vegetable research and demonstration trials were conducted in seven counties in Kentucky: Jefferson, Spencer, Trimble, Shelby, Caldwell, Franklin, and Fayette (see map, right). Research was conducted by faculty and staff from several departments in the University of Kentucky College of Agriculture, including Horticulture and Plant Pathology. This report also includes collaborative research projects conducted with faculty and staff at Kentucky State University.

Fruit and vegetable research sites in 2015.



Variety trials included in this year's publication include sweet corn, seedless watermelon, cantaloupe, fall squash, blueberries, blackberries, raspberries, apples, peaches, and grapes. Additional research trials include evaluation of mulch in sweet corn production, and evaluating attractants for natural enemies of arthropod pests. 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 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. Following are some helpful guidelines for interpreting the results of fruit and vegetable variety trials.

Our Yields vs. Your Yields

Yields reported in variety trial results are extrapolated from small plots. Depending on the crop, individual plots range from 8 to 200 plants. Our yields are calculated by multiplying the yields in these small plots by correction factors to estimate per-acre yield. For example, if you can plant 4,200 tomato plants per acre (assuming 18" 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 whether the yields of the varieties are statistically different. Two varieties may have average yields that appear to be quite different. For example, if tomato variety 1 has an average yield of 2,000 boxes per acre, and variety 2 yields 2,300 boxes per acre, one would assume that variety 2 had a greater yield. However, just because the two varieties had different average yields does not mean that they are statistically or significantly different. In the tomato example, variety 1 may have consisted of four plots with yields of 1,800; 1,900; 2,200; and 2,100 boxes per acre. The average yield would then be 2,000 boxes per acre. Tomato variety 2 may have had four plots with yields of 1,700; 2,500; 2,800; and 2,200 boxes per acre. The four plots together would average 2,300 boxes per acre. The tomato varieties have plots with yield averages that overlap, and therefore would not be considered statistically different, even though the average per acre yields for the two varieties appear to be quite different. This example also demonstrates variability. Good varieties are those that not only yield well but have little variation. Tomato variety 2 may have had yields similar to variety 1 but also much greater variation. Therefore, all other things being equal, tomato variety 1 may be a better choice due to less variation in the field.

Statistical significance is shown in tables by the letters that follow a given number. For example, when two varieties have yields followed by completely different letters, they are significantly different; however, if they share even one letter, 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 followed by the letters "abc" would be different from yield data followed by "efg."

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 percent 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 percent of the time those varieties will be different. If the P value is 0.01, then 99 percent of the time those varieties will be different. Different P values can be used, but typically $P < 0.05$ is considered standard practice.

This approach 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

Ty Cato and Shubin K. Saha, Horticulture

Introduction

In 2015, four on-farm commercial vegetable production demonstrations were conducted in north-central Kentucky in Trimble, Spencer, Jefferson, and Shelby counties. These locations were chosen due to their proximity to Jefferson County and the recent surge in demand for locally grown food in the Louisville area. The Trimble County grower produced 3.82 acres of bell peppers for wholesale. The Spencer County grower produced 0.34 acres of tomatoes, peppers, bush beans, watermelons, and cauliflower for farmers markets and charitable donations. The Jefferson County grower produced 0.03 acres of garlic and 0.22 acres of strawberries for farmers markets. The Shelby County grower produced 1.04 acres of heirloom tomatoes, cherry tomatoes, eggplant, summer squash, and cucumbers for wholesale to grocery stores in Louisville.

Materials and Methods

The growers were provided with plastic mulch and drip tape for up to one acre of production. The University of Kentucky Horticulture Department also provided a bed-shaper/plastic layer, a water-wheel transplanter, and a plastic mulch lifter to remove the mulch at the end of the growing season. All other inputs including fertilizer, pesticides, irrigation pumps, and labor were provided by the growers. They recorded basic information such as yield data, input costs, etc. An extension associate from the Department of Horticulture visited weekly to assist with disease management, harvesting practices, and any other production issues. The extension associate was also involved in planning and preparing field days to display commercial vegetable production techniques to other growers and people interested in producing vegetables.

The four demonstrations utilized conventional production techniques. All sites used raised beds with black, 1 mil, 4-foot-wide plastic mulch sealed on top of the beds. The height of the beds ranged from 3 to 6 inches. The black plastic helps warm the soil in the bed allowing for increased rate of growth by the transplants early in the growing season.

Results and Discussion

The 2015 growing season presented some problems for commercial producers in north-central Kentucky. The greatest challenge was record rainfall amounts in April, June, and July. The first issue occurred at the Trimble County plot, when pepper plants drowned in standing water from the excessive rainfall. Even with the raised beds, the standing water was too high. Fortunately, only one small corner of the demonstration plot was affected. This rainfall also rendered the herbicide used between the beds ineffective, leading to weed pressure. This plot also had an outbreak of southern blight, but the grower was instructed by the extension associate to remove the infected plants from the field, thus limiting disease severity and inoculum for future seasons.

Second, heavy rains in July promoted the development of Septoria leaf blight on tomatoes in the Shelby County and Spencer County plots. The disease spread rapidly in the warm, wet weather, as it spreads by splashing rain. Combined with early blight, Septoria severely damaged tomato foliage, thus limiting yields. The growers tried to slow disease development and dispersal of inoculum using fungicides such as fixed coppers and chlorothalonil.

Powdery mildew became a problem later in the season on summer squash and cucumbers primarily. Most heavily damaged summer squash plantings were removed and replanted, because of rapid plant growth and quick fruit set. As powdery mildew is expected in cucurbits most years in Kentucky, a preventative fungicide program should have been implemented shortly after transplanting.

The garlic and strawberry plots in Jefferson County did not experience any significant disease or weed pressure. This was in part due to the crops already having been harvested prior to the heavy summer rains.

Profitability of the four demonstrations varied greatly. Diminished yields due to disease and excessive precipitation caused the net loss for the Shelby County grower (Table 1). Initial start-up costs for growers greatly reduced profitability as well. These initial costs were for one-time investments such as equipment, which can be amortized over the useable life of the product, thus leading to increased profits in the years to come. The most profitable plots based on size and returns were the Jefferson County plots, most likely due to less loss to disease and direct-marketing the crops, resulting in higher sale prices.

Table 1. Costs and profits for mixed vegetable plots—Trimble, Spencer, Jefferson, and Shelby Counties, 2015

	Trimble (Bell Pepper)	Spencer (Mixed Production)	Jefferson (Garlic)	Jefferson (Strawberry)	Shelby (Mixed Production)
Plot Acreage	3.82	0.34	0.03	0.22	1.04
Inputs					
Plants and Seeds	$2500.00	$464.10	$157.27	$85.00	$1076.00
Fertilizer	800.00	74.20	25.00	85.00	475.00
Plastic Mulch	308.42	36.96	2.80	22.40	181.24
Drip Lines, Irrigation Fittings and Fertilizer Injector	537.00	595.40	2.00 (Drip Lines)	16.00 (Drip Lines)	644.44
Herbicide	325.00	N/A	N/A	N/A	N/A
Insecticide	N/A	242.52	N/A	N/A	25.00
Fungicide	N/A	40.00	N/A	N/A	40.00
Water	160.00	400.00	5.00	95.00	521.00
Manual Labor	2100.00	2400.00	120.00	1500.00	8076.00
Machine Labor (Fuel cost)	270.00	25.00	10.00	50.00	347.00
Marketing	N/A	140.00	N/A	N/A	N/A
Miscellaneous	990.90 (Boxes)	N/A	N/A	354.76 (Row Covers)	1243.00
Total Expenses	7991.32	4418.18	317.07	2607.16	12628.65
Yield	734 Bu.	*	150 Bulbs 190 Scapes	617 Qt.	*
Revenue	9213.00	4000.00	375.00	3085.00	7547.00
Profit	$1221.68	-$418.18	$57.93	$477.84	-$5081.65

*Yields for mixed vegetable production vary based on crops.

Fruit and Vegetable Disease Observations from the Plant Disease Diagnostic Laboratory in 2015

Julie Beale, Brenda Kennedy, Sara Long, Emily Pfeufer, and Nicole Gauthier, Plant Pathology;
Shubin K. Saha and Shawn Wright, Horticulture

Introduction

Diagnosis of plant diseases is an ongoing educational and research activity provided to residents of the commonwealth by the UK Department of Plant Pathology, College of Agriculture, Food and the Environment, and the Agricultural Experiment Station. The Plant Disease Diagnostic Laboratory (PDDL) is made up of two branches: main campus in Lexington and UK Research and Education Center in Princeton. Two full-time diagnosticians and a full-time diagnostic assistant are employed in the PDDL. Plant Pathology and Horticulture extension specialists provide additional diagnostic expertise and formulate general and case-specific management recommendations for samples. County extension agents submit the majority of diagnostic samples on behalf of their local growers and home gardeners (94%), although some samples are submitted directly by growers. Computer-based laboratory records are maintained to provide information used in conducting plant disease surveys, identifying new disease outbreaks, and designing educational programs. All diagnoses of plant diseases are reported to a national repository. Detailed diagnostic records are retained in the PDDL for a period of five years, with disease occurrence data maintained dating to 1983.

Materials and Methods

Visual examination is the initial step in processing plant disease samples. In most cases, microscopy is part of the visual assessment. Following visual and microscopic examination, some specimens require specific tests such as moist chamber incubation, isolation of pathogens onto culture media, enzyme-linked immunosorbent assay (ELISA), polymerase chain reaction (PCR) assay, nematode extraction, or soil pH and soluble salts tests. Once a diagnosis has been made, a report is compiled including a description of the sample condition, tests conducted, findings and recommendations. This report is sent electronically to the grower and county extension agent and copied to any extension specialists involved in the diagnosis.

Results and Discussion

Fruit and vegetable samples comprised roughly one-quarter of approximately 2,300 plant specimens examined in 2015. Forty-five percent of fruit and vegetable samples were from commercial growers (1). Fruit and vegetable disease diagnosis involves a great deal of investigation into the possible causes of disease symptoms. Fruits and vegetables are high value crops for which a large proportion of diagnostic samples require specialized testing and/or consultation with UK extension plant pathology and horticulture specialists.

Abundant rain and cool temperatures during spring with continuing rain through early summer delayed planting and favored development of fungal, oomycete, and bacterial diseases in many crops. Dry conditions prevailed in late summer, particularly west of the Bluegrass; however, intermittent rains provided enough moisture to promote downy mildew on late-season cucurbits and post-harvest fungal fruit rots on apple (2). The following summary includes the predominant diseases submitted as diagnostic samples, as well as a description of several unusual or significant diseases of fruit and vegetable crops.

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

Sclerotinia diseases ("white mold") are favored by cool, wet spring weather and were diagnosed on a number of vegetable crops (cabbage, cucumber, tomato). Sclerotinia stem rot ("timber rot") was a problem in high-tunnel and greenhouse tomatoes, particularly in structures where continuous in-ground tomato production had been practiced. The fruit rot phase of white mold was observed in several of these systems as well, with development of large sclerotia (over-wintering structures) at the stem end of infected fruits. Greenhouse ornamentals such as petunia were also diagnosed with white mold.

Cucurbit downy mildew (*Pseudoperonospora cubensis*) appeared early, i.e., by mid-July, for the third consecutive year in Kentucky, first developing on cucumber. A sentinel plot network aided extension specialists and agents in downy mildew detection across the state. Despite a general drying trend in August, intermittent rainy periods late in the growing season allowed severe downy mildew to develop on squash, muskmelon, and pumpkin. This occurred in sentinel plots as well as in commercial fields, some of which saw at least a 50 percent reduction in yield. Field diagnosis of downy mildew was complicated in some areas by co-infection with powdery mildew (*Sphaerotheca fuliginea*).

Brassica downy mildew (*Hyaloperonospora parasitica*) was diagnosed on kale for the first time in Kentucky (Note: A first report is pending; a previous UK Plant Disease Diagnostic Lab record documented this pathogen on a brassicaceous weed in 2003, but an official first report was not submitted at that time). Heavy sporulation developed on the cotyledons and first true leaves of kale seedlings in greenhouse production. Subsequent field plantings in the same location also became infected, but brassica samples with downy mildew were not submitted from other sites.

Thread blight (*Corticium stevensii*) was diagnosed in seven counties in eastern Kentucky and one county in northern Kentucky on apple, pear, cherry, and gooseberry. Fungal over-wintering structures (sclerotia, rhizomorphs) developed on the surface of branches and on fruit (apple). This disease is limited to extremely wet, shady sites with very poor air circulation and is only seen in very wet growing seasons. Although the number of samples submitted to the PDDL with thread blight was unusual, its high incidence correlates with the wet weather conditions that prevailed in certain areas.

Tree Fruit Diseases

Pome fruits. Fire blight (*Erwinia amylovora*) occurred on certain apple and pear cultivars but was not widespread. Moderate levels of foliar fungal diseases of apple developed, particularly cedar-apple rust (*Gymnosporangium juniperi-virginianae*) and frogeye leaf spot (*Botryosphaeria obtusa*), due to frequent rains in spring. Thread blight was common in eastern Kentucky (see above). Predominant fruit rots were bitter rot (*Colletotrichum* sp.) and black rot (*Botryosphaeria obtusa*).

Stone fruits. Fruit (and ornamental) *Prunus* species were damaged by extremely low winter temperatures, which allowed development of Leucostoma canker (*Leucostoma cincta*) on injured branch tissues. Spring rains favored bacterial canker (*Pseudomonas syringae,* multiple pathovars) on peach and cherry. Peach leaf curl (*Taphrina deformans*) was common on peach in eastern and central Kentucky, while defoliating levels of cherry leaf spot (*Blumeriella jaapii*) and bacterial leaf spot (*Xanthomonas campestris* pv. *pruni*) developed statewide on cherry.

Nut trees. High levels of pecan scab (*Cladosporium caryigenum*) were diagnosed, particularly in western Kentucky.

Small Fruit Diseases

Grapes. Anthracnose (*Elsinoe ampelina*) and black rot (*Guignardia bidwellii*) and downy mildew (*Plasmopara viticola*) were common. Crown gall (*Agrobacterium vitis*) was also diagnosed.

Brambles. Winter injury reduced bramble fruit production. Aside from winter injury, Phytophthora root rot (*Phytophthora* spp.) was the most frequently diagnosed disease on raspberry.

Blueberries. Root and collar rot (*Phytophthora cinnamomi*) was common on blueberry. Various fungal stem canker/blight diseases were also seen (*Botyrosphaeria corticis* and *B. dothidea, Phomopsis* sp.). Bacterial leaf scorch (*Xylella fastidiosa*) was diagnosed on blueberry for the first time in Kentucky.

Strawberries. Common leaf spot (*Mycosphaerella fragariae*) and angular leaf spot (*Xanthomonas fragarieae*), which are both favored by wet conditions and may have similar early symptoms, were common. Spring rains also favored Phomopsis leaf blight and later development of the fruit rot phase (*Phomopsis obscurans*). The black root rot complex (*Pythium* sp., *Rhizoctonia* sp., and *Fusarium* sp.) was diagnosed in mid-autumn in several plantings.

Vegetable Diseases

Beans and peas. Foliar/pod diseases, including angular leaf spot (*Phaeoisariopsis griseola*) and anthracnose (*Colletotrichum lindemuthianum*) were common due to frequent rains. Cercospora leaf spot (*Cercospora* sp.) was commonly diagnosed from home garden plantings in western Kentucky. A few cases of common bacterial blight of bean (*Xanthomonas axonopodis* pv. *phaseoli*) were diagnosed.

Cole crops. In contrast to the previous several years in which few diseases were observed on cole crops, a number of brassica samples were examined this year. Diagnoses included black rot (*Xanothomonas campestris* pv. *campestris*) on collard and kale, Rhizoctonia stem rot and wirestem (*Rhizoctonia solani*) on cabbage and kale, Alternaria head rot (*Alternaria brassicicola*) on broccoli, white mold (*Sclerotinia sclerotiorum*) and white leaf spot (*Pseudomycosphaerella capsellae*) on cabbage and turnip, and downy mildew (*Hyaloperonospora parasitica*) on kale (see above). An unusual diagnosis was bacterial leaf spot (*Pseudomonas syringae* pv. *maculicola*) on Brussels sprouts in late fall.

Cucurbits. Wet conditions throughout spring and early summer enhanced foliar/vine diseases of cucurbits, particularly angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*), anthracnose (*Colletotrichum orbiculare*) and gummy stem blight (*Didymella byroniae*) on cantaloupe, cucumber and watermelon. Bacterial wilt (*Erwinia tracheiphila*) was a problem on cantaloupe and cucumber early in the season in areas where striped cucumber beetle pressure was high. Downy mildew (*Pseudoperonospora cubensis*) began appearing on cucumber as early as mid-July, and both downy mildew and powdery mildew (*Sphaerotheca fuliginea*) became serious problems later in the season on pumpkin. Other diseases diagnosed occasionally on cucurbits included Phytophthora blight (*Phytophthora capsici*) on summer squash and pumpkin and Fusarium wilt (*Fusarium oxysporum* f.sp. *niveum*) on watermelon. Cottony leak (*Pythium* sp.) and bacterial spot (*Xanthomonas campestris* pv. *cucurbitae*) were diagnosed on cucumber and winter squash fruits.

Peppers Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), Phytophthora blight (*Phytophthora capsici*) and stem rots (*Rhizoctonia* sp. and *Pythium* sp.) were seen occasionally on pepper.

Tomatoes. Timber rot (*Sclerotinia sclerotiorum*) was diagnosed in a number of greenhouse/high tunnel systems, with a majority of plants affected in some sites. Fruit rot from Sclerotinia was also observed in certain locations (see above). Leaf mold (*Fulvia fulva*) was prevalent in greenhouse/high tunnel systems with poor air circulation. Occasional cases of bacterial diseases, including bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*), bacterial speck (*Pseudomonas syringae* pv. tomato) and pith necrosis (*Pseudomonas corrugata*), and soilborne diseases including southern blight (*Sclerotium rolfsii*), Rhizoctonia (*Rhizoctonia solani*) and Pythium (*Pythium* spp.) stem rots and root knot nematode (*Meloidogyne* sp.) were also diagnosed in covered cropping systems. Tomato spotted wilt virus was fairly common in indoor and field tomato plantings. A single case of the whitefly-vectored tomato yellow leaf curl virus (*Begomovirus*) was diagnosed from a greenhouse and in surrounding outdoor tomato plantings. The foliar diseases early blight (*Alternaria solani* and *tomatephila*) and Septoria leaf spot (*Septoria lycopersici*) were common in field production and home gardens.

Other vegetables Root knot nematode (*Meloidogyne* spp.) and Fusarium dry rot (*Fusarium* sp.) were seen occasionally on potato.

Fruits and vegetables are high value crops. Because many of them are new or expanding crops in Kentucky and involve production systems unfamiliar to Kentucky growers, disease diagnosis and management is critical. The PDDL is an important resource for extension agents and the growers they assist. The

PDDL encourages county extension agents to include in their programming the importance of accurate disease diagnosis and timely sample submission. The information gained from diagnostic analyses will help improve production practices and reduce disease occurrences and epidemics.

The PDDL relies on funds from the National Plant Diagnostic Network and IPM grants to help defray some of the laboratory operating costs.

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Selected Vegetable Diseases over 32 Years from the Plant Disease Diagnostic Labs

Emily Pfeufer, Julie Beale, Sara Long, Brenda Kennedy, Paul Bachi, Cheryl Kaiser, and Brian Eshenaur, Plant Pathology

Introduction

A great deal of information can be learned about plant diseases in Kentucky by mining historical disease records. The Plant Disease Diagnostic Laboratories (PDDL), based in Lexington and Princeton, KY, have retained a database of records, by Kentucky county, since 1983. In some cases, looking back on plant diseases that have occurred in the past can help growers be better prepared to manage these diseases in the future. In addition, free online resources allow growers to monitor their risk on a site-specific basis, which promotes effective and economical disease management.

Methods

Disease diagnoses were made using the protocols described in *Fruit and Vegetable Disease Observations from the PDDL–2015*. Vegetable diseases of interest were placed into a search algorithm of the PDDL's combined 32-year database. Diagnoses were totaled by year or by month and figures were generated in Microsoft Excel.

Results and Discussion

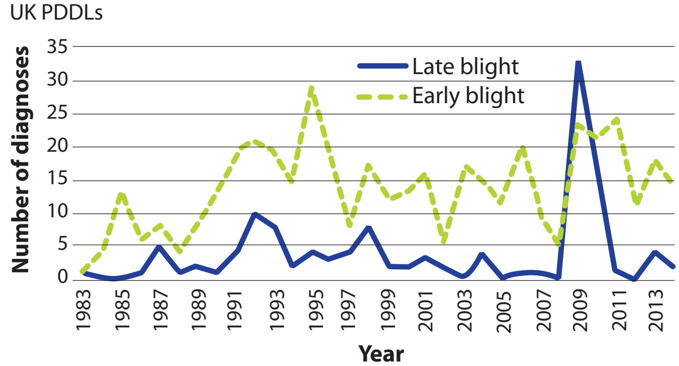
Diagnoses of "blight" diseases on tomato, 1983 to 2015

Early blight, caused by *Alternaria solani* and *A. tomatephila*, was identified much more commonly in Kentucky throughout the last 32 years than late blight, caused by *Phytophthora infestans*. The only exception to this occurred in 2009 (Figure 1), when many home gardens in the eastern U.S. had late blight as a result of infected transplants being marketed through big box stores (Fry et al., 2009). The prevalence of pathogen inoculum, or spores, combined with the wet, disease-conducive weather, resulted in an unusually high incidence in late blight throughout the state. The late blight pathogen does not overwinter in Kentucky, and growers saw reduced incidence of the disease in 2010. No positive samples of late blight were submitted to the diagnostic labs in Kentucky in 2015, although Kentucky locations were under threat for the disease due to conducive conditions during part of the 2015 growing season combined with positive diagnoses of late blight nearby. Growers who are interested can track their own farm-specific risk of developing late blight in their tomato (or potato) crops by using http://usablight.org. Contributors to this monitoring website are a national network of plant pathologists who register confirmed diagnoses of late blight, and growers can use the site to more effectively time specific fungicide applications.

Conversely, early blight is a perennial tomato problem (Figure 1), though the number of reports of the disease fluctuates from year to year and farm to farm. Factors that affect the incidence and/or severity of early blight include variety susceptibility, field rotation status, plant nutrient status, and the previous year's early blight pressure. The pathogen that causes early blight overwinters on-site in soil or plant debris, and its spores are not well dispersed by wind. Tomato plants first become symptomatic in their older leaves, then the pathogen spreads to upper plant parts by rain splashing the spores up to previously uninfected tissue.

Although the early blight disease progresses much more slowly through a planting than late blight does, fungicides are still necessary to keep the overall disease level below economically damaging levels. Early blight is caused by true fungi, while late blight is caused by an oomycete, or water mold pathogen. This is an important distinction to make and emphasizes the importance of a correct diagnosis, since the most effective fungicides against these diseases have specific modes of action and would not have efficacy on the other type of tomato 'blight' disease.

Figure 1. Diagnoses of "blight" diseases on tomato, by year, from the UK PDDLs

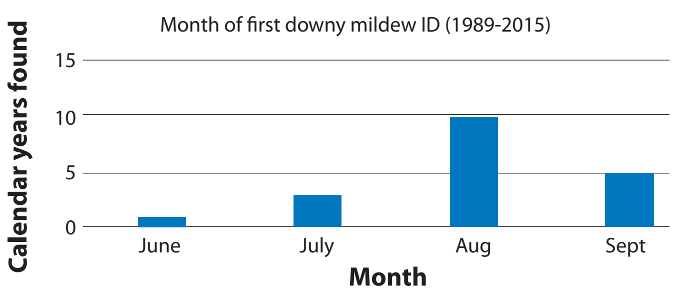


Cucurbit downy mildew diagnoses from 1989 to 2015

Cucurbit downy mildew can affect a wide range of cucurbit crops, including cucumber, watermelon, muskmelon, summer squash, winter squash, and pumpkin. This is another disease that can move very quickly through crops. Prior to 2004, this disease was managed principally through planting resistant cucurbit varieties, however, these resistant varieties have been ineffective for the last ten years (Holmes et al., 2015). Most cultivars currently marketed as resistant might be termed "tolerant" at best. Cucurbit downy mildew has the potential to decimate crop foliage in as little as two weeks, leaving small or unripened fruit and resulting in unseasonably early crop termination. There are five common pathotypes of the downy mildew pathogen in the U.S., and some cucurbits may host only certain pathotypes. For example, watermelon hosts only two out of the five pathotypes, honeydew can host four out of the five, and cucumber is an excellent host for all five pathotypes (Holmes et al., 2015).

The cucurbit downy mildew pathogen does not overwinter in Kentucky but rather is moved northward on weather systems from the southern U.S. and countries to our south (Holmes et al., 2015). In recent years, the first report of cucurbit downy mildew in Kentucky has occurred in July, although in most years the disease is present by August (Figure 2). Once present in the state, the disease is spread quickly by local weather events, particularly those with rain and wind. Fungicide management of the disease is critical, and many of these downy mildew–specific fungicides tend to be expensive.

Figure 2. Month of first cucurbit downy mildew diagnoses from 1989 to 2015 in Kentucky.



Growers can monitor their individual risk level through the cucurbit downy mildew ipmPIPE, which will send them a text or email alert when a positive identification of the disease has been found within 200 or 500 miles of their location. This service is free and may be accessed at http://cdm.ipmpipe.org. Like usablight.org, this site is monitored by a network of plant pathologists in the eastern half of the U.S., many of whom are updating it daily during the height of the season. By utilizing these free online resources, growers may more specifically time their applications of oomycete-specific fungicides to reduce costs while still effectively managing these highly communicable, potentially devastating crop diseases.

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Rootstock Effects on Apple and Peach Tree Growth and Yield

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

Introduction

Although apple and peach are the principal tree fruits grown in Kentucky, the hot and humid summers and heavy clay soils make their production more difficult here than in some neighboring tree fruit–producing regions. The hot, humid summers lead to high disease and insect pressure in Kentucky orchards. Despite these challenges, orchards can 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 help establish baseline 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.

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 in March 2009 on a 16-foot by 20-foot spacing.

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 three 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 dug up, reset, and allowed to resettle through the summer of 2010. The heights of the graft unions above the soil line average 5 inches with a range of from 3 to 7 inches.

Orchard floor management for these trials consists of 6.5 feet of 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 both 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 for peach. Cumulative yield efficiency is the cumulative yield (total of all the annual yields) divided by the current year's trunk cross-sectional area. The TCSA is an indicator of the proportion of nutrient resources a tree is putting into fruit production relative to vegetative growth. Tree height and canopy spread (the average of the within-row and across-row tree widths) are recorded at the end of the fifth and the final (usually the 10th) seasons of each trial. Fruit size is calculated as the average weight (oz) per fruit. All data is statistically analyzed using SAS v.9.43.

Results and Discussion

A crop was produced in both apple and peach rootstock trials in spite of some fruit buds being affected by temperatures dropping to -6°F and -13°F on February 17 and 19, 2015, respectively, and then again on March 6, when temperatures dropped to -10°F.

2009 Peach Rootstock Trial

Mortality, Julian date of 90 percent bloom and 10 percent fruit maturity, cumulative yield, yield, number of root suckers, trunk cross-sectional area (TCSA), and cumulative yield efficiency varied significantly among the fourteen rootstocks in this trial (Table 1). Krymsk1 and Bright's Hybrid have had the highest mortality rates, 62.5 percent and 50 percent, respectively. The date of 90 percent bloom averaged less than a day from first to last with Microbac, Krymsk 86, KV010-123, KV010-127, HOBK 32, Controller 5, and Krymsk 1 being the earliest, and Atlas and Lovell being the latest to bloom. Maturity was the latest for Viking and HBOK 32, and earliest for Bright's Hybrid, P. americana, Krymsk1, and Controller 5. Guardian has produced the largest trees to date, but they are not statistically different in size from Microbac, Viking, Lovell, Krymsk 86, Bright's Hybrid, KV010-127, or Atlas. Krymsk 1 are significantly smaller than all other stocks in this trial. Yield per tree was highest for Guardian and lowest for Krymsk 1. Cumulative yield from 2012 through 2015 was highest for Atlas, but was not significantly different from that of Lovell, Guardian, KV010-123, Viking, or KV010-127. Controller 5 had the highest cumulative yield efficiency. *P. americana* had significantly more root suckers than the other rootstocks. Fruit size was not significantly different among rootstocks.

2010 Apple Rootstock Trial

In 2012, a tree with G.11 as the rootstock was lost due to deer damage; a tree with B.9 broke at the graft union; and two trees with M.9 NAKBT337 were lost possibly from winter injury. Three trees (one M.9 Pajam2 and two B.71-7-22) succumbed to fire blight infections in 2013, and seventeen trees succumbed in 2014 due to the results of fire blight (including two B.64-194, five M.26 EMLA, two Supporter 3, one with PiAu51-11, four with M.9 NAKBT337, and three with M.9 Pajam2). In 2015, a tree with G.935 N broke at the graft union, and three trees succumbed to winter injury (two B.70-20-20 and one M.9 Pajam2).

Mortality, cumulative yield from 2012 through 2015, yield per tree for 2015, average weight per fruit, TCSA, and cumulative yield efficiency varied significantly among the 31 rootstocks (Table 2). M.9 Pajam2 had the highest tree mortality (56%), but this was not significantly different from B.64-194, which had a mortality rate of 29 percent. M.9 NAKBT337, M.26 EMLA, Supporter 3, also had mortalities greater than 29 percent.

B.70-20-20 rootstocks have produced the largest trees, but they were not significantly larger than trees on PiAu 9-90. Similarly, B.71-7-22 produced the smallest trees, but they were not significantly smaller than trees on B.9, B.7-20-21, G.2034, G.41N, or G.4003. Yield in 2015 was greatest for G.4004, but this was not significantly greater than the yield from G.41TC, G.41N, M.26 EMLA, G.4013, G.5087, and B.7-3-150. G.5222 trees have produced the most fruit to date over the life of this trial (total of all harvests from 2012 through 2015), but they were not significantly more than those on G.4004, G.5087, G.935N, G.4814, and G.202N. Fruit size (as measured by average fruit weight) ranged from 7.3 ounces for B.10 down to 4.7 ounces for B.7-20-21. Root sucker number ranged from over 20 suckers for M.9 Pajam2 and G.4814 to none for B.10. B.9 has had the highest cumulative yield efficiency to date, but it was not significantly different from G.4003, G.41N, G.4004, G.5087, G.41TC, B.71-7-22, or G.5222.

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Table 1. 2015 results for the 2009 NC-140 peach rootstock planting, Princeton, KY

Rootstock[1]	Tree Mortality (% lost)	Julian Date of 90% Bloom	Julian Date of 10% Maturity	Cumulative Yield (2011-2015) (lb/tree)	2015 Yield (lb/tree)	Fruit Weight (oz/fruit)	Number of Root Suckers per tree	TCSA (sq. in)	Cumulative Yield Efficiency (2011-2015) (lbs./sq. in. TCSA)
Guardian	0	95.3	181.8	247.3	56.1	6.8	0.0	24.1	10.26
Microbac	0	95.0	181.5	205.5	46.6	6.6	8.0	23.5	8.73
Viking	25.0	95.7	182.2	235.0	50.4	7.1	0.0	22.8	10.29
Lovell	0	96.3	181.6	256.5	53.0	7.1	0.1	22.0	11.64
Krymsk 86	0	95.0	181.8	207.7	52.6	6.7	0.1	21.4	9.71
Bright's Hybrid	50.0	95.5	178.8	182.6	37.0	6.6	0.0	20.8	8.76
KV010-127	0	95.0	181.9	266.9	43.8	7.2	0.0	20.7	12.92
Atlas	0	96.8	181.3	222.0	50.6	6.6	0.0	20.7	10.72
KV010-123	12.5	95.0	181.7	241.6	44.7	7.3	0.4	19.9	12.12
HBOK 32	12.5	95.0	182.0	183.9	25.7	7.2	0.0	17.7	10.39
HBOK 10	0	95.8	180.4	193.6	34.1	7.1	0.0	16.0	12.09
Controller 5	0	95.0	179.1	198.0	54.1	7.2	0.3	13.2	15.01
P. americana	25.0	95.2	178.8	127.8	38.7	7.0	14.0	11.5	11.16
Krymsk 1	62.5	95.0	179.0	64.2	25.3	6.0	1.3	7.4	8.72
Mean	13.4	95.4	180.9	202.3	43.8	6.9	1.7	18.7	10.89
LSD (5%)[2]	28.6	0.7	2.1	51.5	21.3	0.7	4.0	3.6	3.72

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

2 Least significant difference at the 0.05 probability level. Differences between two numbers within a column that are less than the least significant difference are not statistically significant at the 0.05 probability level.

Table 2. 2015 results for the 2010 NC-140 apple rootstock trial, Princeton, KY

Rootstock[1]	Initial Number of Trees	Tree Mortality (% lost)	Cumulative Yield (2012-2015) (lbs./tree)	2015 Yield (lbs./tree)	Fruit Weight (oz./fruit)	Number of Root Suckers Per Tree	TCSA (sq.in.)	Cumulative Yield Efficiency (2012-2015) (lbs./sq. in TCSA)
B.70-20-20	12	17	29.3	10.1	6.3	17.4	16.2	1.81
PiAu 9-90	4	0	27.3	7.5	6.8	14.5	15.6	1.75
B.7-3-150	12	0	54.3	22.4	6.5	3.7	12.8	4.25
PiAu 51-11	11	9	37.0	12.5	6.3	1.5	12.4	2.99
B.70-6-8	12	0	45.8	18.3	6.7	0.3	12.1	3.77
B.64-194	7	29	29.0	11.4	6.8	1.2	11.1	2.61
B.67-5-32	12	0	39.6	15.8	6.7	6.4	10.6	3.73
G.202 N	8	0	55.0	11.0	6.8	12.0	9.8	5.59
M.26 EMLA	11	45	54.1	23.8	7.2	0.8	9.8	5.51
G.5222	8	0	79.6	21.1	6.5	11.0	8.7	9.17
G.935 TC	4	0	41.4	15.0	6.8	14.3	8.2	5.05
G.3001	3	0	44.2	14.1	6.8	3.7	8.2	5.42
G.935 N	10	10	62.3	16.7	6.9	6.2	8.0	7.75
G.4814	4	0	56.5	16.9	6.8	20.5	7.8	7.24
M.9 Pajam2	9	56	53.5	22.0	6.2	21.3	7.7	6.94
G.4004	4	0	77.4	35.6	6.7	9.5	6.9	11.22
G.11	8	13	52.6	12.3	6.7	3.4	6.7	7.81
G.202 TC	12	0	48.8	16.5	6.4	19.5	6.6	7.39
M.9 NAKBT337	12	50	47.3	11.9	6.9	10.8	6.6	7.18
G.5087	4	0	63.8	22.9	6.7	5.0	6.1	10.42
G.4214	2	0	35.0	14.1	6.7	14.8	6.0	5.81
Supp.3	5	40	42.5	4.4	4.9	3.3	5.8	7.26
B.10	1	0	46.9	20.7	7.3	0.0	5.8	9.85
G.4013	2	0	38.1	23.3	6.7	8.5	5.7	6.73
G.41 TC	12	0	52.8	32.1	6.3	8.0	5.1	10.38
G.4003	7	0	50.4	20.9	6.6	2.0	4.1	12.26
G.41 N	3	0	47.7	25.1	7.1	1.0	4.0	11.80
G.2034	2	0	24.0	9.9	5.3	14.0	2.5	9.55
B.7-20-21	12	0	9.7	6.2	4.7	0.4	2.2	4.46
B.9	12	8	27.9	17.6	5.9	4.4	2.1	13.25
B.71-7-22	10	20	12.5	9.0	6.5	3.4	1.3	9.52
Means	NA	8.3	44.7	16.8	6.5	7.8	7.6	7.05
LSD (0.05)[2]	NA	35.7	24.7	13.4	1.3	11.6	3.4	7.29

1 Arranged in descending order of the fall trunk cross-sectional area (TCSA) for each rootstock.
2 Least significant difference at 0.05 probability level. Differences between two numbers within a column that are less than the least significant difference are not statistically significant at the 0.05 probability level.

Consumer Preference for Pawpaw Cultivars and Kentucky State University Advanced Selections

Sheri B. Crabtree, Kirk W. Pomper, and Jeremiah D. Lowe, Plant and Soil Science

Introduction

The pawpaw [*Asimina triloba* (L.) Dunal] is a tree fruit native to Kentucky and much of eastern North America (Pomper and Layne, 2005). Pawpaw is being grown on a small scale in several commercial orchards in Kentucky, in addition to commercial orchards in numerous locations elsewhere in the U.S. and worldwide. There has been increasing interest in pawpaw in recent years from consumers, restaurants, wineries, and other local retailers as a unique locally grown fruit. Over 50 pawpaw cultivars are commercially available, with varying flavor, texture, and quality (Pomper et al, 2009). The Kentucky State University (KSU) Pawpaw Research Program is seeking to enhance and improve the pool of commercially available pawpaw cultivars by conducting germplasm evaluation and breeding to develop superior advanced selections for future release. The objective of this taste trial was to compare consumer preference of available pawpaw cultivars to KSU advanced selections.

Materials and Methods

A tasting panel was conducted at the H.R. Benson Research and Demonstration Farm in Frankfort to determine consumer preference for KSU advanced selections compared to commercial varieties of pawpaw. Varieties evaluated included Susquehanna, Sunflower, Potomac, Taytoo, Mitchell, and KSU-Atwood™, and KSU advanced selections Hi7-1 and Hi4-1. Fruit were harvested from the orchards at the KSU Research Farm two days prior to the event. Ripe fruit were held under refrigeration and less ripe fruit were left at room temperature to ripen fully before the event.

Refrigerated fruit was brought out of refrigeration four hours prior to tasting to allow all fruit to reach room temperature. Fruit was sliced for samples, and a whole example fruit was placed by the sample plates. Fruit samples were labeled with the cultivar name or advanced selection number. Thirty-five panel members tasted and evaluated the fruit on flavor, texture, and appearance on a scale of 1 to 5, with 1 being poor and 5 being excellent. Data were analyzed using CoStat Statistical software (CoHort Software, Monterey, CA), and subjected to analysis of variance and least significant difference (LSD) means separation. Treatment means were separated based on a significance level of $P < 0.05$.

Results and Discussion

KSU advanced selections compared similarly or favorably to the commercial cultivars (Table 1). Advanced selections Hi4-1 and Hi7-1 received an average flavor rating of 4.4 and 4.3, respectively, significantly higher than the cultivars Taytoo (3.8), Sunflower (3.6), and Mitchell (3.3). Hi4-1 and Hi7-1 also compared favorably to the cultivars on fruit texture, scoring 4.2 and 4.1 respectively, outranking the cultivars Sunflower (3.7) and Taytoo (3.6). Appearance ratings did not vary among cultivars and advanced selections. The first KSU cultivar released in 2011, KSU-Atwood™, also ranked highly on both flavor and texture.

Table 1. Consumer rankings of eight pawpaw cultivars and advanced selections on fruit flavor, texture, and appearance

Variety	Flavor	Appearance	Texture
Hi4-1	4.4 a[1]	4.0	4.2 a
Atwood	4.3 ab	4.3	4.2 a
Hi7-1	4.3 ab	3.8	4.1 ab
Potomac	4.1 abc	3.9	4.0 abcd
Susquehanna	4.0 bcd	4.2	4.1 abc
Taytoo	3.8 cd	3.9	3.6 d
Sunflower	3.6 de	3.9	3.7 cd
Mitchell	3.3 e	3.9	3.8 bcd
	***	NS	**

1 Ranking: 1= Poor; 5= Excellent.

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

Following great interest in pawpaw in the early part of the 20th century, the pawpaw industry stagnated and many older cultivars were lost during the period of 1930 to 1960 (Peterson, 2003). Several new cultivars emerged in the 1960s and 1970s, and the pawpaw industry saw a further rejuvenation in the late 1990s through the early 2000s, with new releases from the PawPaw Foundation and Neal Peterson. There appears to be a trend for these recent improved releases to be preferred by consumers, with KSU advanced selections and recent cultivar releases ranking highest in this evaluation, followed by recent Neal Peterson releases (Potomac and Susquehanna). The cultivars selected in the 1960s and 1970s (Taytoo, Sunflower, Mitchell) were less preferred by consumers in this study. Data from consumer preference tasting trials will be taken into consideration along with production data from regional variety trials at KSU and grower sites in determining future cultivar releases from KSU.

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Third and Fourth Year Data from the Advanced Thorny and Thornless Primocane-fruiting Blackberry Selection Trial at Kentucky State University

Jeremiah D. Lowe, Kirk W. Pomper, and Sheri B. Crabtree, Plant and Soil Sciences; and John R. Clark and John G. Strang, Horticulture

Introduction

Kentucky has a climate that is favorable for blackberry production, and the number of farms with blackberry acreage in the state has increased from 271 in 2007 to 368 in 2012 (USDA, 2012). With brambles there are two cane types: primocanes, or first year canes, which are usually vegetative, and floricanes, which are the same canes, flowering and producing fruit the next growing season. 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.

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). With the exception of 'Prime-Ark® Freedom,' 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) and the Arkansas primocane-fruiting (APF) selections of thorny or thornless (T) advanced selections (APF-153 T, APF-190 T, and APF-205 T) from the UARK blackberry breeding program, were planted at the KSU Harold R. Benson Research and Demonstration Farm, in Frankfort, KY. Plants were arranged in a randomized complete block design, with four blocks, and five 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 five plants, with each row 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- to 8-inch deep layer of straw around plants, adding straw when necessary and hand weeding. Plants were irrigated weekly with t-tape laid in the rows. Plants were fertilized with NatureSafe 10-2-8 fertilizer in April at 100 pounds of nitrogen per acre. Fruit were harvested twice weekly and data collected. ANOVA and LSD means separation were performed using CoStat Statistical Software (CoHort Software, Monterey, CA).

Results and Discussion

Two of the advanced selections in the trial have been released as cultivars—APF-153 T as Prime-Ark® Freedom and APF-190 T as Prime-Ark® Traveler, both thornless varieties. Due to severe winter temperatures in 2013 (-8°F) and 2014 (-18°F), floricanes suffered severe winter dieback and the floricane crop was lost in both 2014 and 2015. Primocane fruit production began in early August and continued until frost. Temperatures were mild in 2014 with 42 out of 122 days higher than 85°F from June through September with an average high in July of 81.8°F. Growing conditions in 2015 were hot; there were 56 out of 122 days with a daily high temperature above 85°F from June through September. The average high for July 2015 was 84.6°F. In 2014, Prime-Ark® 45 had the highest yield at 1,650 pounds per acre; APF-205 T was the second highest at 1,446 pounds per acre (Table 1). Prime-Ark® Freedom had the lowest yield at 648 pounds per acre. Prime-Ark® Freedom had the largest berry size at 6.65 grams and Prime-Ark® the smallest at 3.98 grams per berry. In 2015, Prime-Ark® 45 and Prime-Ark® Traveler had the highest yields at 3,139 and 2,588 pounds per acre respectively. Prime-Ark® Freedom had the smallest yield but largest berry size in 2015. While Prime-Ark® Freedom has a large berry size, it continues to be a low yielding variety in this planting. Prime-Ark® Traveler has proven to be significantly more productive than Prime-Ark® Freedom, while still having a large berry size. Prime-Ark® Traveler is also an erect selection allowing cultivation without trellising and should be a promising new selection for Kentucky growers.

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Table 1. Yield and berry weight in 2014 and 2015 for three cultivars and one advanced selection of primocane-fruiting black berries

	Fruit Weight (g)		Yield (lb/acre)	
Selection	**2014**	**2015**	**2014**	**2015**
Prime-Ark 45	4.68 c	3.90 b	1650 a	3139 a
Prime-Ark Freedom	6.65 a	4.45 a	648 c	654 b
Prime-Ark Traveler	3.98 d	3.46 b	949 bc	2588 a
APF-205 T	5.32 b	3.89 b	1446 ab	1169 b

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

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

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Introduction

In Kentucky, there are over 670 farms growing berry crops, including blackberries, valued at over $2,600,000 annually (Census of Agriculture, 2012). Kentucky's climate is well suited for blackberry production.). With brambles there are two cane types: primocanes, or first year canes, which are usually vegetative, and floricanes, which are the same canes, flowering and producing fruit the next growing season. 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.

'Black MagicTM' is a thorny primocane-fruiting selection suited for home growers and on-farm sales (Clark et al., 2014). 'Black MagicTM' was previously evaluated as an advanced selection in Kentucky but was not compared to 'Prime-Ark®45' (Lowe et al., 2012). 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 'Black MagicTM' in terms of yield and fruit quality under Kentucky growing conditions. Here we report production from the trial in its third year

Materials and Methods

In June 2012, a blackberry trial was planted at the KSU Research and Demonstration Farm on certified organic land. The planting contained three replicate blocks each of the selections 'Black MagicTM' and 'Prime-Ark®45', both primocane-fruiting selections from the University of Arkansas. Plants were arranged in a completely randomized design, with 3 replicate plots each containing 5 plants of each selection (total of 15 plants of each selection) in 10 foot plots. This trial was managed with organic practices following the National Organic Program standards. A combination of cultivation, hand weeding, and straw mulch was used for weed control. Drip irrigation was used as needed. Plots were fertilized with NatureSafe 10-2-8 fertilizer at (100) lbs of N per acre. Floricanes were removed in March so only a primocane crop was produced. Primocanes were tipped on all selections at one meter beginning in early June to promote lateral branching and flowering. Ripe fruit were harvested from the plants twice weekly, from July through October.

Results and Discussion

Primocane fruit were harvested from late-July until frost in late-October (Table 1). The average high for July 2013 was 81.9°F. Growing conditions in 2013 were mild; there were 40 out of 122 days with a daily high temperature above 85°F from June through September. Temperatures were also mild in 2014 with 42 out of 122 days warmer than 85°F from June through September with an average high in July of 81.8°F. Growing conditions in 2015 were hot; there were 56 out of 122 days with a daily high temperature above 85°F from June through September. The average high for July 2015 was 84.6°F. Summer temperatures were hotter in 2015, which can reduce fruit set, size, and quality on primocanes, and may have resulted in smaller fruit size in cultivars in 2015.

Table 1. Yields and berry weights in 2013, 2014, and 2015 for 'Black Magic™' and 'Prime-Ark®45' at the Kentucky State University Research Farm, Frankfort, KY

Selection	2013 Fruit Weight (g)	2014 Fruit Weight (g)	2015 Fruit Weight (g)	2013 Yield (lb/acre)	2014 Yield (lb/acre)	2015 Yield (lb/acre)
Black Magic	5.11 a1	5.36 a	3.33 a	1479 a	1026 a	852 b
Prime-Ark 45	4.9 a	4.31 b	3.99 a	1071 a	1501 a	2307 a

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

In 2013, 'Black Magic™' had a larger berry size and a higher yield, but the differences were not significant. In 2014, 'Prime-Ark® 45' had a trend toward larger yields, but again, the difference was not significant. 'Black Magic™' did have a significantly larger berry size (5.36 g vs. 4.31 g) in 2014 (Table 1). In 2015, 'Prime-Ark® 45' had a significantly larger yield; however, 'Black Magic™' and 'Prime-Ark® 45' had similar berry sizes (Table 1). In Arkansas, 'Black Magic™' had similar primocane yields (1117 lb/acre) observed in our Kentucky trial.

The University of Arkansas Blackberry Breeding Program recommends that commercial producers plant 'Prime-Ark®45' due to the superior shipping quality of the firmer fruit of 'Prime-Ark®45.' Due to softer fruit, 'Black Magic™' is recommended for U-pick and on-farm sale production practices as well as home gardeners. Year to year yield characteristics will need to be further evaluated; however, the data suggest that 'Prime-Ark®45' and 'Black Magic™' have large fruit and yield well in Kentucky. 'Prime-Ark®45' as well as 'Black Magic™' should be considered by commercial growers interested in producing primocane-fruiting blackberries.

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Rabbiteye Blueberry Variety Trial

Chris Smigell, John Strang, and John Snyder, Horticulture

Consumer interest in blueberries has motivated Kentucky farmers to increase blueberry acreage from 200 in 2007 to around 350 acres in 2012, according to USDA statistics. This trial has been continued to evaluate rabbiteye blueberry variety adaptation to Central Kentucky growing conditions. Rabbiteye varieties typically have shorter chilling requirements than highbush varieties. Consequently rabbiteye flower buds may begin developing and opening earlier than those of the highbush varieties, and thus have a greater chance of being damaged or killed by late spring frosts. Rabbiteye blueberries also have the potential to extend blueberry harvesting in Kentucky for about a month later than highbush varieties.

Materials and Methods

The trial was established at the Horticultural Research Farm in Lexington in the spring of 2004. Plants were acquired from Fall Creek Nursery, Lowell, OR; Finch Nursery, Bailey, NC; DeGrandchamp's Farm, South Haven, MI; and Dr. Jim Ballington at North Carolina State University, Raleigh, NC. Originally highbush, southern highbush, and rabbiteye varieties were planted. Two years ago most of the highbush and southern highbush varieties were removed except for a few for comparative purposes.

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 had been adjusted from 5.6 to 4.6 by applying sulfur. Seventy pounds of phosphorus were applied per acre and incorporated into the field prior to bed shaping and planting. Five replications of individual plant plots were set in rows running east to west in a randomized block design. The rabbiteye blueberries were planted with 6 feet between plants and 12 feet between rows. All plants were mulched with a three-foot-wide, six-inch layer of wood chips.

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 ounce per plant in March, April, May, June, and July. In 2015 Captan was applied for disease control and Surflan and glyphosate for weed control.

Fruit were harvested once a week. Twenty-five berries from each plant were weighed to determine average berry size at each harvest, and fruit were rated subjectively by the same evaluator at all harvests for taste and appearance several times during the season.

Results

Precipitation averages for 2015 were above normal for April through July, and below normal for August. All rabbiteye varieties except the selection NC-1827 from Dr. Ballington's breeding program at North Carolina State University and the Lenoir and Star southern highbush varieties exhibited symptoms of winter injury to twigs and buds (Table 1). This is attributed to a low temperature of -13°F on 20 February.

Table 1. Rabbiteye and highbush yields, berry weights, taste and appearance ratings, and harvest dates

Variety (Type)[1]	Yield[2] (lb/A)	Winter injury (1-4)[3]	Berry wt (oz/25 berries)	Berry taste (1-5)[4]	Berry appearance (1-5)[5]	First harvest date	Last harvest date
NC-1827 (R)	8900 a	1	1.1 cd	3.5 b	4.8 a	25 June	19 August
Spartan (HB)	7700 a	1	1.5 ab	3.5 b	4.0 c	17 June	6 July
Star (SH)	5200 ab	2.3	1.7 a	3.6 b	4.1 c	17 June	6 July
Lenoir (SH)	2700 bc	2.5	1.2 bcd	4.3 a	4.3 bc	17 June	6 July
Tifblue (R)	2000 bc	1.8	1.3 bcd	3.3 b	4.3 bc	6 July	25 August
Columbus (R)	820 bc	1.9	1.7 a	3.5 b	4.8 a	6 July	25 August
Climax (R)	720 bc	1.8	1.4 bc	3.5 b	4.5 ab	6 July	21 July
Ira (R)	510 bc	2	1.0 d	3.6 b	4.7 ab	16 July	25 August
Powderblue (R)	350 bc	2.3	1.2 bcd	3.6 b	4.8 a	13 July	25 August
Onslow (R)	30 c	2.7	-	-	-	13 August	13 August

1 Type: HB = highbush; SH = southern highbush; R = rabbiteye.
2 Numbers followed by the same letter are not significantly different (Duncan Multiple Range Test LSD $P \leq 0.05$).
3 Winter injury: 1 = none, 5 = excessive
4 Berry taste: 1 = poor; 5 = excellent
5 Berry appearance: 1=poor, 5=excellent

Harvest and fruit attribute data are shown in Table 1. The selection NC-1827 had a significantly higher yield than any other rabbiteye variety, and a higher yield than it had in any previous year in this study (Table 2). It tended to have the lowest berry weight of any variety, suggesting it may not have been pruned adequately. It was similar in yield to the highbush variety Spartan, which showed no winter injury. NC-1827, Tifblue, Spartan and Star had higher yields than their eight-year average yields (Table 2). The southern highbush Lenoir had a little over half the yield of the other southern highbush, Star. It tended to have more winter injury than all but Onslow. Taste ratings were lower than in previous years for all varieties due to excessive rain, but Lenoir had a significantly better taste than any other variety. It has consistently been one of the best tasting varieties in this study. Spartan, Star and Lenoir had the earliest first- and last harvest dates as would be expected. NC-1827 was the earliest of the rabbiteye types to be harvested and Ira was the latest.

Table 2 shows yields for all trial years, and NC-1827 had the highest average and cumulative yield of all the rabbiteye varieties. Following a spring freeze in 2013 and the February freeze of 2015, NC-1827 also had the highest rabbiteye yields, suggesting it is probably the hardiest rabbiteye of those evaluated in this trial. Powderblue had the second highest average yield. Columbus had the highest berry weight of all rabbiteye varieties in five of the seven evaluation years. The remaining rabbiteye varieties in this trial were pretty similar in average yield. All rabbiteye varieties are very attractive, with uniform shape and a heavy, waxy bloom. Their flavors also tend to be similar. They have a more grainy texture and thicker skin than most of the highbush varieties. The top performing rabbiteye blueberries over the eight harvest years were NC-1827 and Powderblue.

Acknowledgments

The authors would like to thank the following persons for their hard work and assistance in the successful completion of this trial: Dave Lowry and Joseph Tucker. Funding for this project was provided by a grant from the Kentucky Horticulture Council through the Agricultural Development Fund.

Table 2. Rabbiteye and highbush yields (lb/A), 2008–2015 (plants considered mature starting in 2008)

Variety (Type)[1,2]	2015	2014	2013	2012	2011[3]	2010	2009	2008	Cumulative Yield	Avg. Yield
NC-1827 (R)	8880	2840	861	1050	0	2940	4150	2750	23,470	3350
Powderblue (R)	350	8030	0	3180	0	40	2420	2860	16,870	2410
Columbus (R)	820	5760	0	350	0	1990	1290	840	11,050	1580
Onslow (R)	30	3450	0	2930	0	310	1600	1930	10,250	1460
Climax (R)	720	2160	0	740	0	430	2360	2150	8570	1220
Tifblue (R)	1970	3010	0	1190	0	80	1070	1150	8500	1210
Ira (R)	500	5360	0	250	0	150	590	50	6900	990
Spartan (HB)	7710	2980	1530	2970	-	7050	2200	7660	32,100	4590
Star (SH)	5210	2840	-4	-	-	7510	2000	6710	24,300	4860
Lenoir (SH)	2700	2450	1230	-	-	7250	3950	5590	23,100	3850

1 Type: HB = highbush; SH = southern highbush; R = rabbiteye.
2 Listed in decreasing order of rabbiteye variety average yield.
3 Sinbar application in 2010 reduced or eliminated bud development in rabbiteyes in 2011; this year was not included in the average yield calculations.
4 A dash indicates no data was taken.

Erect Thornless Blackberry Cultivar Trial

Dwight Wolfe, June Johnston, and Ginny Travis, Horticulture

Introduction

Blackberries are an important small fruit crop in Kentucky. Demand for this fruit at farmers' markets is strong and generally exceeds supply. Producers are looking for better cultivars that are thornless, productive and have berries with good size and flavor. Resistance to orange rust and rosette are also a consideration among growers. Three thornless erect cultivars (Natchez, Osage, and Ouachita) and two selections (A-2434T and A-2491T), all from John Clark's breeding program at the University of Arkansas, are being evaluated at the UKREC, Princeton, KY.

Materials and Methods

Twenty plants each of five cultivars, Natchez, Osage, Ouachita, and two numbered selections, A-2491T and A-2434T, were planted in the spring of 2013. Plants were spaced 2.5 feet apart within 12.5-foot-long plots in rows spaced 18 feet between rows. One cultivar was allocated to each plot and each of the four rows in this trial contained five plots per row. Cultivars were randomized in a block design with each row being one block. Trickle irrigation was installed, and plants were maintained according to local recommendations (1, 2). Fruit in 2015 was harvested one to three times per week as needed from June 18 through July 20. Yield and number of fruit picked were recorded. Fruit size was calculated as the average weight (yield divided by the number of berries picked) for each plot. At the UKREC Horticulture Open House, June 25, 2015, volunteers rated berries for flavor, color, seed size, number of seeds, and taste on a five-point scale with one being undesirable and five being excellent.

Results and Discussion

A good crop was produced in spite of temperatures dropping to -13°F in February. Canes typically do not survive below -10°F, but the floricanes of all the cultivars/selections in this trial survived well even above the snow line. The -13°F temperature probably did affect yield for some cultivars/selections, but yields in 2015 still more than doubled those obtained during the first cropping season in 2014 (3). Yields varied from an average of 20.0 pounds per plot for A-2434-T to 15.9 pounds per plot for Ouachita (Table 1). Berries ripened over about a four to five week period from about June 18 through about July 20, with Natchez ripening first and Ouachita and A-2491-T ripening last (Figure 1). Note that the yield per acre would obviously be higher if rows were spaced closer together as would typically be the case in a commercial operation. Ouachita and A-2491-T started ripening a week later than Natchez but continued to ripen a week after Natchez was finished.

Average berry size for the season varied from 9 grams for Natchez down to 4 grams for A-2491-T. Berry size for Natchez decreased from more than 9 grams per berry for the first two weeks of the season to about 7 grams or less for the last two weeks that this cultivar was harvested (Figure 2). Berry size remained fairly constant throughout the season for the other cultivars/selections in the trial.

Table 1. Summary of 2015 results from the blackberry cultivar trial at UKREC, Princeton, KY[1]

Cultivar	Harvest period	Yield (lb/ plot)	Size (grams/ berry)[2]	Flavor	Color	Seed Size	Number of seeds	Taste
A-2434-T	6/22–7/20	20.0	6.6	2.5	3.2	2.0	1.5	2.0
Natchez	6/18–7/10	19.9	9.0	2.7	2.8	3.0	4.0	3.0
Osage	6/22–7/20	18.7	5.1	3.3	4.3	3.0	3.0	2.7
A-2491-T	6/22–7/16	16.2	4.4	3.7	4.2	3.3	3.5	4.7
Ouachita	6/24–7/20	15.9	5.0	4.5	4.0	4.7	4.5	4.0
LSD(0.05)[3]	NA	(NS)[4]	0.5	(NS)	(NS)	(NS)	(NS)	(NS)

1 Rating scale for flavor, color, seed size, number of seeds, and taste is from 1 to 5 with 5 being the best. Sample size was 6 for flavor and color, 3 for seed size and taste, and two for number of seeds.
2 Fruit size (grams per berry) was calculated as the average weight (yield divided by the number of berries picked) for each plot.
3 Least significant difference at 0.05 probability level. Differences between two numbers within a column that are less than the least significant difference are not statistically significant at the 0.05 probability level.
4 NS denotes that values within a column were not significantly different from one another at 0.05 probability level.

Figure 1. Erect thornless blackberry cultivar trial at Princeton, KY

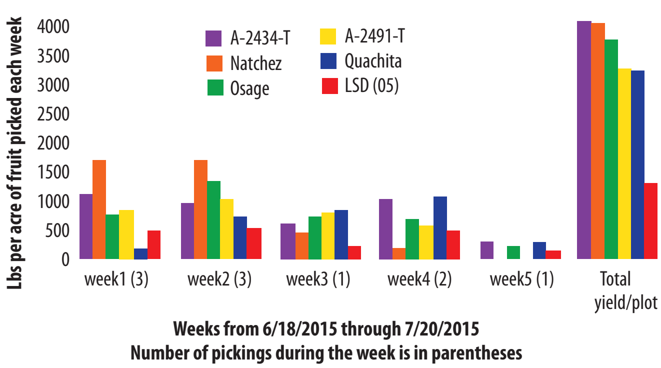
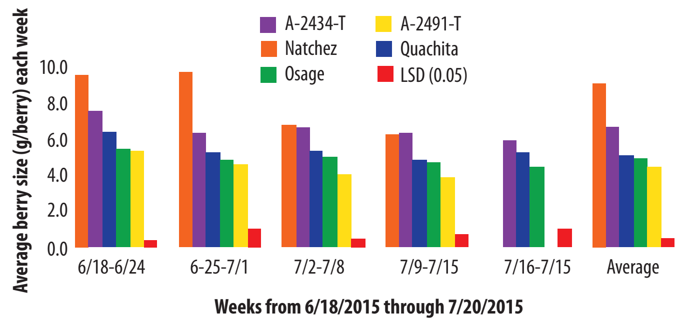


Figure 2. Erect thornless blackberry cultivar trial at Princeton, KY



Seven volunteers contributed to the ratings, but only three rated all five components. Two volunteers rated only flavor and color; one rated only flavor, color, and seed size; one rated only flavor, color, and taste; and one was discarded because A-2491-T was rated for all five components but no rating as given for either flavor or taste or both for the other cultivars/selections. Consequently, sample sizes varied from six for flavor and color, to three for seed size and taste, to only two for number of seeds. Ouachita and A-2491-T were rated the highest for taste (4.0 and 4.7, respectively), and A-2434-T was rated the lowest (2.00). However, due to the small number of evaluators and the amount of variability among them, no statistically significant differences among the cultivars/selections were observed. Further, the winter freeze on the mornings of Feb 19 and Feb 20, 2015, injured some canes as evidenced by lack of leaves on some cultivars/selections and/or their canes. This lack of leaves and sub-lethal injury to the canes could have affected flavor this season. This data is preliminary, and the trial will be carried on for a few more years.

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Evaluation of Strawberry Varieties as Matted Rows

John Strang, Chris Smigell, and John Snyder, Horticulture

Strawberries continue to be popular with Kentucky consumers and most growers find that high-quality strawberries are readily marketable. Based on the 2012 Census of Agriculture there are about 207 acres of strawberries grown in Kentucky and of these roughly 80 percent are grown using the matted row cultural system as opposed to about 15 percent in the plasticulture system. This study evaluated newer strawberry varieties planted in the matted row system at the University of Kentucky Horticultural Research Farm in Lexington. This is the second year, or first fruiting year, of this study.

Materials and Methods

Sixteen dormant, bare-rooted strawberry varieties were planted on 24 April 2014. Allstar, Chandler, Earliglow, and Jewel were included as standards. Each plot was a 10-foot-long single row and consisted of six plants set 2 feet apart in the row with 4 feet between rows. Plots were replicated four times in a randomized block design.

Insect, disease and weed control were conducted in accordance with the Midwest Commercial Small Fruit and Grape Spray Guide (ID-94). No fungicides were applied in 2014, while Captan was applied four times during bloom in 2015. Brigade insecticide was applied 20 May 2015 for spittlebug control.

Chateau pre-emergence herbicide was applied over the top of the dormant plants following transplanting, two sprays of Select Max were applied 9 July and 10 August during the 2014 season for post-emergence grass control and Devrinol was applied in early September 2014. Chateau was not applied until mid-March of 2015 due to excessive snow in February.

Rows were narrowed to a width of 14 inches on 25 October 2014 because runner plants were crossing the row middles into adjoining plots. The field was mulched with miscanthus straw on 11 December 2014.

Fifty-seven pounds of N per acre as ammonium nitrate and 104 pounds of K as 0-0-60 per acre were tilled into the soil prior to planting. Beginning on 11 July 2014, 5.2 pounds of N as calcium nitrate was applied weekly for a total of 31 pounds of N per acre. The plot was drip-irrigated as needed.

The 2014 season was relatively cool with slightly more rainfall than normal, while the 2015 season was extremely rainy and cool. Ten-foot sections in each plot were harvested in the spring of 2015. Yield, fruit size, flavor, and appearance data were collected.

Data are shown for the 2015 harvest season. Twenty berries were weighed at each harvest to determine average berry weight. Berry flavor was assessed twice for each variety, and firmness and appearance were assessed on 23 and 27 May and 2, 5, and 9 June.

Results and Discussion

This was a rainy season, so both yield and berry size were generally good, but berry flavor was reduced. A frost on the morning of 24 April reduced flower numbers particularly on early maturing varieties. Sonata, Darselect, Allstar, AC Valley Sunset, Clancy, and Flavorfest had the best yields and fruit quality (Table 1). Record and Sonata had the highest yields, with 24,700 and 23,000 pounds per acre, respectively. Record also had the largest fruit size, but scored very low in flavor and had soft fruit. Earliglow, Rubicon, AC Valley Sunset, Flavorfest, Darselect and Sonata were rated as having the best tasting fruit. Clancy, Allstar and Flavorfest tended to have firmer fruit and Flavorfest, Galetta, AC Valley Sunset, and Daroyal were rated to have the most attractive fruit.

Earliglow, Galetta, and Daroyal were the earliest varieties to be harvested, while Malwina was by far the latest, beginning production as the other later varieties had just about finished producing.

The continuous wet weather also promoted leaf disease development. Thus the percentage of leaves showing any disease lesions was high for all varieties (Table 2). Flavorfest, Allstar, Sonata, Daroyal, and Earliglow were the five varieties with the fewest leaves showing any disease symptoms – in this case lesions. Varieties having a high percentage of leaves with lesions also tended to have a higher number of lesions counted per leaf. The number of lesions per leaf also tended to be similar to the percentage of leaf area affected by the lesions. Nearly all varieties had a statistically similar percentage of leaf area affected by the lesions.

The incidence of leaf spot caused by the fungus *Mycosphaerella fragariae* was low, ranging from 1 to 5 percent, except for Malwina (Table 3). Phomopsis leaf spot was the primary disease noted and the captan fungicide that was applied will not con-

Table 1. Strawberry yield, fruit characteristics, and harvest mid-point

Variety	Yield (lb/A)[1]	Avg. berry wt.[2] (g/berry)	Attractiveness[3] (1-5)	Firmness (1-5)[4]	Flavor (1-5)[5]	Harvest mid-point[6] (date)
Record	24775 a	18.6	4.1	1.4	3.3	09 Jun
Sonata	23019 a	11.3	4.1	1.3	4.3	02 Jun
Jewel	18159 b	10.9	4.0	2.3	3.3	02 Jun
Mayflower	17642 bc	11.3	4.1	2.0	3.3	04 Jun
Darselect	16131 bcd	12.5	4.1	1.4	4.3	31 May
Daroyal	16036 bcd	10.7	4.3	1.1	3.8	29 May
Allstar	15695 b-e	10.4	4.1	3.3	4.2	01 Jun
AC Valley Sunset	14361 b-f	15.0	4.5	2.0	4.5	06 Jun
Clancy	13966 b-f	11.1	3.9	3.8	4.1	02 Jun
Flavorfest	13517 c-f	11.1	4.4	3.1	4.4	30 May
Rubicon	12074 def	10.4	3.9	1.3	4.5	30 May
Chandler	11802 def	9.3	4.1	2.9	3.5	03 Jun
Galetta	11530 ef	12.7	4.6	2.1	4.0	29 May
Malwina	10699 fg	13.8	4.0	3.0	4.1	17 Jun
Earliglow	9978 fg	6.4	3.8	2.0	4.6	27 May
Donna	7351 g	9.5	4.2	1.4	3.7	31 May

1 Numbers followed by the same letter are not significantly different (Duncan Multiple Range Test LSD P≤0.05).
2 Based on 20 berries at each harvest.
3 Attractiveness: 1 = poor; 5 = excellent.
4 Firmness: 1 = soft; 5 = very firm.
5 Flavor based on two evaluations: 1 = poor; 5 = excellent.
6 Date on which half of the berries were harvested, based on total yield weight.

Table 2. Disease lesion incidence and severity based on ten-leaf samples

Variety	Percent leaves out of 10 showing lesions[1]	Lesions per leaf[3] (No.)	SSe Area affected by lesion[4] (%)
Flavorfest	38 a[2]	4 f	3 b
Allstar	38 a	5 ef	6 b
Sonata	38 a	3 f	9 ab
Daroyal	43 ab	4 f	3 b
Earliglow	48 ab	6 cdef	8 ab
Chandler	53 abc	4 ef	3 b
Record	60 abcd	6 cdef	9 ab
Rubicon	65 abcd	6 def	8 ab
Galetta	68 abcd	8 cde	4 b
Donna	68 abcd	4 f	12 ab
Mayflower	73 bcd	7 cdef	7 b
AC Valley Sunset	73 bcd	9 cd	9 ab
Clancy	83 cd	10 bc	18 a
Malwina	85 d	13 b	11 ab
Darselect	90 d	20 a	10 ab

1 Ten leaves were randomly picked from the canopy top and inside of each replicate.
2 Means within same column followed by the same letter are not significantly different (Duncan's Multiple Range Test LSD P≤0.05).
3 Sum of all lesions on the ten leaves that appeared to be caused by disease, divided by ten. If the ten leaves had small numbers of lesions (< 50), they were individually counted; where lesion numbers were very high, numbers were estimated.
4 Percent area of the ten leaves aggregated.

Table 3. Estimated incidence of three common strawberry leaf diseases

Variety	Leaf spot Incidence[1,2]	Phomopsis Incidence[4]	Leaf scorch Incidence[5]
Flavorfest	3 b[3]	8 f	0 c
Allstar	1 b	11 f	5 bc
Sonata	1 b	25 de	2 c
Daroyal	1 b	13 ef	6 bc
Earliglow	1 b	15 def	14 b
Chandler	2 b	19 def	0 c
Record	3 b	45 b	5 bc
Rubicon	2 b	8 f	3 c
Galetta	5 b	18 def	4 bc
Donna	1 b	39 bc	1 c
Mayflower	1 b	50 b	3 c
AC Valley Sunset	1 b	28 cd	3 c
Clancy	1 b	69 a	2 c
Malwina	13 a	21 def	38 a
Darselect	3 b	8 f	31 a

1 Visual estimate of percent of entire canopy showing lesions.
2 Leaf spot caused by *Mycosphaerella fragariae*.
3 Means within same column followed by the same letter are not significantly different (Duncan's Multiple Range Test LSD P≤0.05).
4 Leaf spot caused by *Phomopsis obscurans*.
5 Leaf scorch caused by *Diplocarpon earliana*.

trol this disease. Flavorfest, Darselect, Rubicon Allstar, Daroyal, Chandler, Earliglow, and Galeta showed the lowest incidence of phomopsis. Clancy, Mayflower, Record, and Donna had highest levels of this disease. Incidence of leaf scorch, caused by the fungus *Diplocarpon earliana,* also tended to be relatively low. Chandler, Flavorfest, Donna, Sonata, and Clancy had 2 percent or less incidence of leaf scorch, although most varieties had statistically similar levels.

Examination of the yield, berry quality and disease susceptibility results shows that overall Sonata, Allstar, and Flavorfest were the best performing varieties in this year's trial.

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Evaluation of Cherry-Based Baits for Trapping and Management of Spotted Wing Drosophila for Organic Growers of Primocane-fruiting Blackberries

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Introduction

Spotted wing drosophila (SWD), ***Drosophila suzukii,*** is a new pest of economically valuable small fruit and tree fruit crops in Kentucky. The U.S. Department of Agriculture confirmed that the spotted wing Drosophila fly was present in south central Kentucky in 2012. The SWD has already spread across Kentucky in 2013. This fruit fly is originally from Asia where it is a pest of cherries and can be very destructive to softer-skinned fruits such as blueberries, blackberries, and raspberries. However, later-ripening small fruit crops, such as primocane-fruiting raspberries and blackberries, are at the highest risk (Cole et al, 2014a; 2014b).

SWD traps have not been good predictors of population sizes nor do trap captures necessarily occur before fruit infestation. Traps are placed in the canopy of the crop as the female SWD prefer to rest during the day in dark, dense locations. Traps can be made out of a one-quart, clear deli container with about one inch of bait solution to which one drop of dish soap has been added. Initially traps were baited with apple cider vinegar, but yeast and sugar baits and other baits have been shown to catch flies one to two weeks earlier than just apple cider vinegar (Cole et al., 2014a). The objective of this study was to determine the attractiveness of natural and artificial cherry baits compared to a control without fruit juice, for monitoring SWD presence and numbers.

Materials and Methods

Traps were created by cutting a roughly 1.5 by 5 inch hole in one side of a quart deli container and gluing red screening with 2 mm x 2 mm openings over the hole (Burrows, 2013). All traps were baited with a 150 ml solution of either yeast, sugar, and water (control); one part tart cherry juice to one part yeast, sugar, and water; one part sweet cherry juice to one part yeast, sugar, and water; one part cherry Kool-Aid to one part yeast, sugar, and water; or one part black cherry Kool-Aid to one part yeast, sugar, and water. Traps were placed in a primocane-fruiting blackberry variety trial at the KSU Harold R. Benson Research and Demonstration Farm in Frankfort, KY. There were a total of 15 traps, three reps of five treatments. The traps were randomly placed among cultivars 'Prime-Ark 45®' and the Arkansas primocane-fruiting (APF) selections APF-153 T, APF-156 T, APF-158, APF-172, APF-185 T, APF-190 T, and APF-205 T) from the UARK blackberry breeding program. Plants were arranged in a randomized complete block design, with four blocks, including five 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 five plants; with each row 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. The SWD traps were placed in the field on August 24th and September 4th. Traps were collected after three days, brought back to the lab, and transferred to containers with 70 percent ethanol. SWD males and females were identified and enumerated. ANOVA and LSD means separation were performed using CoStat Statistical Software (CoHort Software, Monterey, CA).

Results and Discussion

All baits successfully captured both SWD and other drosophila species. While there were no significant differences, there was a trend for yeast and tart cherry juice to capture more flies than the other baits (Table 1). The Kool Aid-based baits tended to be less attractive to all fruit flies examined. Based on this limited study, although SWD are a pest of cherries in Asia, where they are native, yeast-based baits without fruit extract were as effective as fruit-based baits and should continue to be used in a management program for developing a SWD spray schedule. Additional trapping periods and baits should be evaluated to determine which baits are optimal for preferentially capturing SWD.

Table 1. Numbers of male spotted wing Drosophila (SWD), female SWD, total SWD and other Drosophila captured using the three different baits

Bait	MSWD	FSWD	Total SWD	Other Drosophila
Yeast	30	54	84	31
Tart Cherry	28	56	84	15
Sweet Cherry	17	40	57	13
Black Cherry Kool-Aid	16	35	51	8
Cherry Kool-Aid	7	24	31	9

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Wine and Seedless Table Grape Cultivar Evaluation Trial in Kentucky

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Introduction

Spring frosts, cold winter temperature fluctuations and long, warm, humid summers pose challenges to growing wine and table grapes in Kentucky. Despite these challenges, grape production in Kentucky can be profitable when the proper management practices are implemented. Successful production is achieved by the use of proper cultural practices (canopy management, weed control, pest control) and matching cultivar and rootstock to a specific site. The primary types of grapes grown in Kentucky are *Vitis vinifera* (European), and interspecific hybrids. Although interspecific hybrids 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. Because *V. vinifera* cultivars are more susceptible to winter injury and diseases, this results in lower yields and increased pesticide and 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 and rootstock and clone selection. The following research update is intended to provide the 2015 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 (UKHRF) in Lexington, KY. Vineyard one consists of five table grape and 20 interspecific hybrid cultivars. Each cultivar in vineyard one has four replications with three vines per replication (12 vines total). 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 own-rooted with the exception of Chambourcin, Chardonel, Vidal Blanc, and Traminette, which were additionally planted on the rootstocks 101-14, 3309, and 5C respectively. Additional own-rooted hybrid cultivars 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 a cultivar has four replications with four vines per replication (16 vines total). 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. Standard commercial cultural management practices were implemented in both vineyards (CCD Grape Crop Profile, 2014). In March 2015 vines were spur pruned to retain approximately six 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 June, followed by an application of contact herbicide (paraquat) in early July. Most vines expressed moderate vine vigor. Immediately following bloom, 40 pounds of actual N/acre was applied. Fertilizer was evenly distributed within a 3-foot-wide band directly under the vine row. Disease and pest controls 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 to 6 shoots per foot of cordon (hybrid) in mid-May and by cluster thinning to appropriate crop loads, post fruit set according to the balanced cropping principles established by Howell (2001). Bird netting was applied in late July due to extremely high bird pressure. Fruit maturity and harvest dates were determined by taking a 100-berry sample per cultivar, starting at veraison, and tested weekly to monitor the progression of total soluble solids (TSS) using a digital refractometer (Atago USA Inc., Bellevue, WA), pH using a Hannah 222 pH meter (Hannah Instruments, Ann Arbor, MI) and titratable acidity (TA) (end point titration of pH 8.2 using 0.100 N sodium hydroxide) until harvest. Each vine was harvested separately to determine the total number of clusters and yield per vine. Table grape clusters were selectively harvested at two to three harvest dates per cultivar dependent upon evenness of ripening and fruit chemistry. A final 100-berry sample was taken at harvest to determine fruit chemistry (TSS, pH and TA) and berry weight. Cluster rot and cluster damage (rachis and pedicel collapse, bird damage) was calculated by visually assessing damage. Any cluster that presented more than 30 percent damage was considered a culled cluster and was not included in the marketable weight. All yield component data were analyzed using general linear model and means were separated using Duncan-Waller K-ratio t Test using SAS statistical programs (SAS Institute, Cary, NC).

Results and Discussion

Freezing temperatures during the past two winters resulted in extensive damage to most *V. vinifera* cultivars at the UKHRF (vineyard two). Mid-winter temperatures reached as low as -5.8°F in January 2014, and -7.0°F (Kentucky Mesonet) in January 2015, resulting in nearly 100 percent primary bud mortality in all *V. vinifera* vines except Riesling, Rkatsiteli, Pinot Gris, and Chardonnay. Substantial primary bud mortality led to extremely low shoot densities, with less than three shoots per linear foot of vineyard row expressed by most *V. vinifera* vines. Although many *V. vinifera* vines were not killed, shoots were predominantly derived from secondary, tertiary, and latent bud positions, with most vines producing commercially unacceptable yields and weaker than average shoot vigor. Most *V. vinifera* cultivars suffered substantial damage to perennial vine structures (trunks and cordons) and failed to produce quality renewal shoots at or near the graft union. The severity of damage warranted removal of all *V. vinifera* vines.

Subfreezing temperatures during December (2014) and January (2015) did not affect primary bud mortality rates for any American or interspecific hybrid wine grape cultivars, with average shoot fruitfulness and vine croploads being within range of historical yields. A wetter than average start to the season made it difficult to control fungal pathogens during the 2015 growing season. Timely fungicide applications resulted in low incidence of foliar infections. Frequent rainfall during the months of May, June, and July led to cluster rachis infections, which resulted in some rachis and pedicel collapse during ripening. Rachis and pedicel collapse of Seyval, Traminette, Vignoles, and Chardonel led to substantial berry cracking located near the pedicels, thus warranting slightly earlier than normal harvest in order to prevent large yield losses associated with berry cracking. For most cultivars cluster rot was limited to only rot of single berries or patches of two to three berries that were mostly inconsequential to overall cluster integrity (Tables 1 and 2). Sunny days and lower than average relative humidity during August likely prevented the spread of cluster rot and resulted in ideal ripening conditions for most hybrid and table grape cultivars.

Because cluster rot incidence and severity was low in 2015, the dominant factor affecting the percentage of culled clusters (Tables 1 and 2) was damage associated with bird predation. Bird pressure was intense and early this year, with significant bird damage observed on most of the early ripening, dark pigmented, small-berried cultivars including Foch, Marquette, Frontenac,

Table 1. Yield components for the 2015 interspecific hybrid wine 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)
White						
Aromella	Aug 10	4.6	2.2	4.6	1	156
Cayuga White	Aug 10	4.3	2.1	4.4	0	242
Chardonel/C-3309	Sep 28	5.9	2.9	4.6	4	337
Chardonel/OR	Sep 28	2.2	1.3	3.8	3	256
Frontenac Gris	Aug 11	1.5	0.8	4.6	52	149
LaCrosse	Aug 11	7.7	3.8	4.9	4	223
Seyval	Sep 1	2.7	1.4	5.1	4	221
Traminette/5C	Aug 24	6.4	3.2	5.0	2	189
Traminette/OR	Aug 24	4.2	2.1	4.9	2	127
Vidal Blanc/5C	Aug 27	7.1	3.7	4.9	2	288
Vidal Blanc/OR	Aug 27	5.9	3.1	4.8	0	246
Vignoles	Sep 1	2.7	1.4	5.4	9	99
Villard Blanc	Aug 25	4.8	2.5	5.5	0	218
Mean		**4.6**	**2.4**	**4.8**	**7**	**213**
LSD (0.05)		**1.2**	**.53**	**.56**	**8.1**	**34.5**
Red						
Chambourcin/101-14	Sep 24	6.3	3.1	4.3	1	354
Chambourcin/OR	Sep 24	1.5	1.0	4.8	0	129
Chancellor	Sep 10	3.7	1.4	5.3	17	182
Corot Noir	Aug 24	3.7	1.9	4.5	0	150
Foch	Aug 11	0.1	0.1	4.2	93	73
Frontenac	Aug 17	0.4	0.2	5.1	86	99
GR7	Aug 25	1.1	0.6	4.9	65	118
Marquette	Aug 11	0.8	0.4	4.1	71	101
Noiret	Sep 1	2.4	1.6	4.6	10	173
Norton	Sep 28	5.2	2.6	4.6	0	123
St. Vincent	Sep 15	7.5	3.7	4.9	0	367
Mean		**3.1**	**1.6**	**4.7**	**29**	**186**
LSD (0.05)5		**1.0**	**.50**	**.47**	**11.2**	**39.0**

1 Yield per acre calculated using 8ft x 10ft 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
5 LSD = Least significant difference using a 95% confidence interval

Table 2. Yield components for the 2015 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)
Jupiter	Aug 11	3.2	1.6	4.1	18	192
Marquis	Aug 14	4.5	2.2	3.9	4	326
Reliance	Aug 2	3.7	1.9	3.8	21	284
Mean		3.8	1.9	4.0	17	266
LSD (0.05)5		1.2	.56	.55	17.9	43.9

1 Yield per acre calculated using 8ft x 10ft 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
5 LSD = Least Significant Difference using a 95% confidence interval

Frontenac Gris, and GR7. Bird damage was also more severe on the seedless table grapes Jupiter and Reliance as compared to the large and lightly pigmented grapes of Marquis (Table 2). Grape berry moth damage was observed primarily in the earlier ripening and larger-berried cultivars like Concord and Jupiter. Damage caused by grape berry moth has steadily increased over the past five years from nearly non-existent to an average of one to two berries per cluster on earlier-ripening and larger-berried cultivars.

Vines that expressed lower than ideal vigor and yield included own-rooted Chardonel, Seyval, Corot Noir, Noiret, own-rooted Chambourcin, and Chancellor (Table 1). The majority of hybrid and table grape cultivars maintained moderate to high vine vigor and therefore produced yields greater than 4.0 tons per acre (Tables 1 and 2). During the past five years wine grape cultivars that have consistently produced moderate to high yields of quality fruit include Aromella, Cayuga White, Chardonel/3309, Traminette, Vidal Blanc, Villard Blanc, Chambourcin/101-14, Norton, and St. Vincent.

Table 3. Fruit composition for the 2015 interspecific hybrid wine grape cultivar trial, UK Horticulture Research Farm[1]

Cultivar/Rootstock	100 Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
White				
Aromella	176	15.9	3.0	9.7
Cayuga White	313	17.6	3.1	8.8
Chardonel/C-3309	276	22.1	3.3	6.8
Chardonel/OR	244	24.1	3.4	5.8
Frontenac Gris	127	20.1	3.3	12.4
LaCrosse	210	17.4	3.1	8.0
Seyval	214	21.9	3.3	5.6
Traminette	195	20.0	3.0	7.1
Traminette/5C	200	18.7	3.1	8.2
Vidal Blanc/5C	217	18.0	3.4	6.5
Vidal Blanc/OR	215	18.5	3.3	7.7
Vignoles	186	23.2	3.2	9.6
Villard Blanc	292	16.2	3.1	11.6
Red				
Chambourcin/101-14	279	21.8	3.3	7.8
Chambourcin/OR	237	22.6	3.4	7.9
Corot Noir	258	16.9	3.3	6.1
Chancellor	198	20.8	3.5	6.9
Foch	131	19.4	3.3	10.8
Frontenac	138	21.1	3.2	19.9
GR7	167	21.3	3.3	8.2
Marquette	139	22.0	3.3	11.1
Noiret	232	19.7	3.2	6.1
Norton	130	22.5	3.5	8.8
St. Vincent	359	19.3	3.2	8.2

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

Table 4. Fruit composition for the 2015 table grape cultivar trial, UK Horticulture Research Farm[1]

Cultivar/Rootstock	Berry Wt. (g)	TSS[2] (%)	Juice pH	TA[3] (g/L)
Jupiter	450	18.3	3.6	5.9
Marquis	417	16.2	3.4	4.2
Reliance	268	17.4	3.1	7.0

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

Most fruit chemistry profiles (TA, pH, TSS) were in commercially acceptable ranges (Tables 3 and 4). However, the abnormally high TA levels in Frontenac Gris, Frontenac, Foch, and Marquette (Table 3) can be attributed to earlier than normal harvest necessitated by excessive bird pressure. Similarly, high TA levels in Aromella and Vignoles were also due to early harvest, related to deteriorated fruit integrity in the face of impending rain. Both Vidal blanc and Villard blanc were harvested at lower TSS and higher TA in order to produce wines made in the traditional method of Champagne production that require lower pH and TSS and higher TA. Due to diligent disease and pest control as well as the optimal ripening conditions in August and September wines produced at the UKHRF during the 2015 season have the potential to be of exceptional quality.

The vineyards at the UKRF are planted in an excellent site with good elevation and proper water and air drainage. Vines are carefully managed in a research setting. All sites in Kentucky will not be able to sustain economically viable crops of all varieties. It is imperative to evaluate each grape-growing site and match variety and rootstock to that specific site.

Acknowledgment

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Winter Squash Variety Evaluation

John Strang, Chris Smigell, and John Snyder, Horticulture; Pam Sigler, Program and Staff Development

Twenty winter squash varieties were evaluated in a replicated trial to determine their performance under Central Kentucky conditions. These included hubbard, spaghetti, kabocha, delicata, butternut, and several other types. Culinary evaluations were conducted to assess consumer varietal preferences. Winter squash are valued for their decorative aspects as well as their eating quality and are often purchased as seasonal decorations.

Materials and Methods

Varieties were seeded on 27 May 2015 into 72-cell plastic plug trays filled with ProMix BX multipurpose media (Premier Horticulture, Inc.) at the University of Kentucky Horticulture Research Farm in Lexington. Plants were set into black plastic–mulched, raised beds using a waterwheel setter on 11 June. Plots were 20 feet long, with six plants set 4 feet apart within the row and 10 feet between rows. Each treatment was replicated four times in a randomized complete block design. Drip irrigation provided water and fertilizer as needed.

Forty pounds of N/A as calcium nitrate was incorporated into the field prior to bed shaping and planting. The plot was fertigated with a total of 10 pounds N/A as calcium nitrate divided into eight applications over the season. The systemic insecticide Montana 2F (imidacloprid) was applied with a hand sprayer as a drench at the base of each plant after transplanting using the maximum rate of 8 fl oz/A. Brigade insecticide was applied for insect control as needed. Weekly foliar fungicide applications included Champ, Previcure-Flex and Cabrio. No preemergent herbicides were applied due to excessive rainfall. One fruit from each replication was measured for dimensions and evaluated for skin and interior color. At harvest, one sample of each squash type was microwaved and evaluated for taste.

Three consumer panels also evaluated the winter squash. Each panel sampled a different type of squash but the procedures for each consumer panel were the same. Consumers were presented with a whole squash and a cross section that included seeds. They were asked to rank the visual appeal as if they were purchasing at a farmer's market. They were asked then to evaluate squash that had been cut, had seeds removed, was brushed with vegetable oil and roasted for 30 minutes at 400°F. These were evaluated for appearance, texture and flavor. These data were not analyzed statistically because of the low number of taste panelists but are presented to provide growers some indication of varietal consumer acceptance. The Hoss butternut was not evaluated in the consumer taste panels.

Table 1. Winter squash variety trial yield and fruit characteristics, Lexington, KY 2015

								Outside measurements		Cavity measurements	
Variety[1]	Squash type[2]	Seed source	Days to harvest	Yield (cwt/A)[3]	Avg. no fruit/A	Avg. wt./fruit (lb)	Culls (%)	Length (in.)	Width (in)	Length (in)	Width (in)
Goldetti	Sp	BU	100	340 a	7260	4.7	4	11.1	4.9	8.4	2.9
Small Wonder	Sp	RU	90	300 a	14670	2.0	11	5.6	4.8	3.5	2.6
Pinnacle	Sp	ST	85	200 bc	6610	3.0	8	7.5	5.3	5.5	3.1
Hai	Ka	CL	85-95	230 b	3010	7.5	11	6.6	8.3	3.8	5.7
Delica	Ka	CL	85	160 bcd	3340	4.9	23	4.7	7.9	2.6	5.9
Sweet Mama	Ka	SW	85	160 bcd	2940	5.2	28	5.1	8.1	2.7	5.5
Winter Sweet	Ka	JO	95	140 cde	3270	4.4	8	4.1	7.5	2.2	5.4
Thunder	Ka	RU	85	130 cde	3270	3.8	14	4.2	7.2	2.6	5
Shokichi Green	Ka	JO	100	120 de	13140	0.9	5	2.8	4.4	1.7	2.9
Space Station	Ka	RU	90	120 de	2830	4.1	32	4.6	7.6	2.4	5.1
Eclipse	Ka	RU	85	110 de	2610	4.3	31	4.3	7.7	2.5	5.1
Shokichi Shiro	Ka	JO	100	110 de	12670	0.9	4	2.8	4.1	1.6	2.7
Super Delight	Ka	ST	90	110 de	3120	3.6	24	5.4	6.7	3.1	4.7
N. GA Candy Roaster	Ba	JO	100	320 a	4180	7.6	0.2	22.3	4.4	17.3	1.6
Hoss Butternut	Bn	CL	90-95	300 a	6970	4.2	0.6	8.7	5.3	3.1	3.1
Red October	Hu	SW	90	290 a	3740	7.8	5	11.0	8.5	7.2	6.3
Red Kuri	Hu	JO	92	160 bcd	3630	4.4	16	7.0	7.1	3.9	5.2
Hooligan	Mp	JO	90	140 cde	18330	0.8	0.9	2.3	4.2	1.4	2.8
Jester	Dl/Ac	JO	95	120 de	9550	1.3	2	4.7	3.8	3.2	2.3
Delicata JS	Dl	JO	100	70 e	7730	0.9	13	6.3	2.6	5.4	1.3

1 Listed in decreasing order of yields of each type.
2 Sp = spaghetti, Ka = kabocha, Ba = banana, Bn = butternut, Hu = hubbard, Mp = mini-pumpkin, Dl = delicate, Ac = acorn
3 Numbers followed by the same letter are not significantly different (Duncan Multiple Range Test P=0.05).

Results and Discussion

The spring season was cool and wet. Yield and variety characteristics data are shown in Tables 1 and 2. Varieties are grouped by squash type and then ranked on total marketable yield by weight. The top varieties based on Horticultural Research Farm and consumer evaluations were Goldetti and Small Wonder Spaghetti squash; Delica and Sweet Mama kabocha squash; Delicata JS delicata-type squash; and Red Kuri hubbard squash.

Table 2. Winter squash fruit characteristics, Lexington KY, 2015

Variety	Flavor (1-5)[1]	Skin color[2]	Interior color[2]	Comments
Goldetti	4	gold	lt gr	Moist, crunchy, slightly sweet; pale speckles on skin
Small Wonder	3	or-y	cr-y	Moist, bland taste; smooth and attractive
Pinnacle	3.7	lt y	wh-y	Very moist, crunchy, sl sweet; canary yellow
Hai	3.8	grey-gr	brn-or	Moist, not as fine-grained as other kabochas; deep sutures
Delica	4.2	ol-gr	or	Dry, fine-grain, slightly sweet; attractive int & ext; lighter gr sutures & speckles
Sweet Mama	4.4	dk ol	dk y	Dry, smooth flesh
Winter Sweet	4	grey	dk y	Very dry flesh; attractive int. & ext.; darker blotches on skin
Thunder	4.4	dk ol	brn-or	Very dry, fine-grain, sweet; paler, sunken spots and streaks
Shokichi Green	3.8	ol	dk y	Dry, fine-grain flesh; slightly streaked skin, fine speckles
Space Station	4.2	dk ol	y-or	Lt grey sutures and small dimples around top
Eclipse	4.4	dk ol	lt or	Fine-grain, slightly sweet, moist; pale, thin suture streaks
Shokichi Shiro	4.3	grey-gr	dk y	Dry, fine-grain flesh; no streaks or speckles
Super Delight	4.3	dk ol	or-y	Very dry, fine-grain flesh; not flat like other kabochas
N. GA Candy Roaster	3.7	pink-or	dk y	Very fine, smooth, moist flesh
Hoss Butternut	3.3	flesh	y-or	Very dense; attractive int., coarser-grain flesh than other varieties in trial
Red October	3.8	red-or	dk y	Moist, fine-grain flesh
Red Kuri	3.5	red-or	brn-or	Smooth, fine-grain flesh, not sweet; attractive inside & out; lt orange sutures
Hooligan	4.5	cr-y	lt y	Coarse-grain flesh, dry, sweet; very attractive; variable color & size, orange sutures
Jester	4.5	cr-wh	y-or	Very sweet, medium grain flesh, not stringy
Delicata JS	4.7	cr-wh	cr-y	Very sweet, moist; edible skin

[1] Flavor: 1 = poor, 5 = excellent. Based on 2 samples microwaved under plastic wrap and tasted without any seasonings.

[2] Interior and skin color: or = orange, cr = cream, y = yellow, brn = brown, gr = green, ol = olive, wh = white, lt = light, dk = dark, br = bright, ; e.g., red-or = "reddish orange".

Horticultural Research Farm Evaluations

Goldetti spaghetti squash was the top yielding variety in this trial with 340 cwt per acre and few cull fruit. It has an attractive gold skin color and microwaved flavor was very good. However a consumer familiar with growing summer squash might think that it resembles an over-mature zucchini, thus additional marketing information may be needed. Small Wonder spaghetti squash also produced an excellent yield, was attractive and could be considered a one-serving squash.

Delica and Sweet Mama kabocha squash had good yields and eating quality as in our previous trials. Kabocha squash are noted for their smooth, fine-grained, dry flesh. Both had high levels of cull fruit despite their high yields. Culling was due to sunburn and fruit cracking in the field, indicating that these should be harvested promptly once they have matured. Hai had the top kabocha yield but did not reach the flavor of some of the other varieties. Thunder, Eclipse, Shokichi Shiro, and Super Delight were notable for their microwaved eating quality. Shokichi Shirro and Shokichi Green were both small and considered to be single serving kobocha squash.

The Red October hubbard squash variety yielded considerably better than Red Kuri. Both had a reddish orange skin that was very attractive with smooth, fine-grained flesh.

The heirloom North Georgia Candy Roaster banana squash was notable for its yield, large size, and looks. Although it did not score high in taste ratings, this type of squash is rarely eaten without spices and processing. It was easily processed and made very smooth, outstanding pies for which it is noted in Georgia.

Delicata JS was the least productive squash in the trial, but rated as one of the sweetest and best tasting. Delicata squash have a thin skin that is edible.

Hooligan is classified as a mini-pumpkin with outstanding ornamental characteristics. The flesh is a little coarser than most of the other varieties in this trial, but microwaved flavor was very good.

Jester is an attractive multicolored cream, green, and orange variety. It is shaped like an acorn squash, but we felt has a better eating quality in that it is less fibrous and has a finer textured flesh.

The Hoss butternut is a larger-fruited, heavy yielding butternut that should be good for processing.

Consumer Panel Evaluations

Kabocha (Table 3)

This panel was conducted at the grand opening of an indoor farmers' market in a rural county. Of the 12 panel participants, two ate winter squash regularly (monthly or more often) and six did when in-season. Those who ate winter squash ate acorn, butternut, cushaw, pumpkin, and spaghetti squash. None of the participants had tried a kabocha squash.

Participants rated visual appeal of the whole squash and a cross-cut that included the seeds. Mean scores ranged from 2.3 to 2.8 (Somewhat appealing to appealing) for uncooked squash.

Super Delight (3.4), Hai (3.8) and Sweet Mama (3.4) received the highest ratings for visual appeal of the cooked squash. Each retained a bright yellow color after being roasted in their skin.

Table 3. Mean ratings[1] by panelists that evaluated kabocha squash

Variety	Visual Appeal Raw	Visual Appeal Roasted	Texture Roasted	Flavor, Roasted
Delica	2.3	2.6	2.9	3.4
Sweet Mama	2.5	3.4	3.0	3.3
Shokichi Green	2.8	1.6	2.3	2.1
Shokichi Shiro	2.8	2.5	2.9	2.8
Thunder	2.4	2.8	2.5	2.0
Winter Sweet	2.3	1.6	2.2	2.1
Space Station	2.3	2.4	2.9	2.8
Eclipse	2.4	2.3	2.6	2.5
Hai	2.8	3.8	2.9	2.5
Super Delight	2.7	3.4	3.3	3.5

[1] Range: 1 = Not appealing to 4 = Very appealing

Some varieties took on a green color from the skin after being roasted.

Those consumers who did not eat squash were reluctant to try them and eight of the 12 consumers participated in the taste panel. Super Delight (3.3) and Sweet Mama (3.0) received the highest ratings for texture. Super Delight (3.5), Delica (3.4), and Sweet Mama (3.3) received the highest ratings for flavor. One consumer mentioned that Sweet Mama was stringier than the other varieties while another consumer commented that Sweet Mama and Hai had the best texture and flavor.

Shokichi Green and Shokichi Shiro are small, individual serving size squashes. Being roasted at the same temperature and length of time as the larger kabocha squash dried out the smaller ones, and may have lowered their ratings.

When asked how likely they would be to purchase kabocha squash, 57 percent of consumers who tasted the kabocha squash were likely or very likely to purchase. Two who responded "not likely" were farmers who grow kabocha squash, and therefore would typically not need to purchase them.

Delicata, Hubbard and Banana Squash

The hubbard, delicata and banana squash consumer panel consisted of seven Master Gardener students of which 71 percent purchase winter squash for consumption, and 29 percent for decoration. A little over half (57%) reported eating winter squash (acorn, butternut, cushaw, pumpkin and spaghetti squash) five to eight times per year. Consumers reported being more likely to purchase the Delicata JS and Hooligan varieties based on visual appeal (Table 4).

All of the cooked delicata squash were considered visually appealing (Range= 3.3 to 3.9) but Delicata JS ranked highest for texture (Mean=3.5) and flavor (Mean = 3.7) compared to the others. Two-thirds (67%) reported being likely or very likely to purchase delicata squash in the future.

Red Kuri, the smallest of the three hubbard and banana squash, ranked highest for visual appeal, flavor, and texture (Table 5). Consumers commented that Red October and North Georgia Candy Roaster were not as appealing due to the large size and inability to utilize the squash in a timely manner.

Spaghetti Squash (Table 6)

The consumer panel for spaghetti squash was conducted at a Healthy Community meeting in a rural county where participants purchased winter squash for decoration (67%) and as a food source (83%). Two-thirds of the panel rarely or never ate winter squash. Those who normally ate squash consumed acorn, butternut, cushaw, pumpkin, and other types.

All varieties were rated similarly for appearance, texture, and flavor, with a slight preference for Small Wonder. Three-fourths (77%) shared that they were likely or very likely to purchase spaghetti squash after sampling. One person planned to try it as a substitute for pasta since her husband was diabetic.

Table 4. Mean ratings[1] by panelists that evaluated delicata squash

Variety	Visual Appeal Raw	Visual Appeal Roasted	Texture Roasted	Flavor Roasted
Delicata JS	3.3	3.7	3.5	3.7
Jester	2.9	3.3	1.6	2.2
Hooligan	3.3	3.9	2.2	2.3

[1] Range: 1 = Not appealing to 4 = Very appealing

Table 5. Mean ratings[1] by panelists that evaluated banana and hubbard squash

Variety	Visual Appeal Raw	Visual Appeal Roasted	Texture Roasted	Flavor Roasted
Red October	2.4	3.0	2.9	2.7
North Georgia Candy Roaster	2.6	3.1	2.9	3.0
Red Kuri	3.1	3.4	3.4	3.3

[1] Range: 1 = Not appealing to 4 = Very appealing

Table 6. Mean ratings[1] by panelists that evaluated spaghetti squash

Variety	Visual Appeal Raw	Visual Appeal Roasted	Texture Roasted	Flavor Roasted
Small Wonder	2.8	3.7	3.2	2.6
Goldetti	2.6	3.2	3.0	2.6
Pinnacle	2.6	3.1	2.8	2.3

[1] Range: 1 = Not appealing to 4 = Very appealing

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Seedless Watermelon Variety Trial for Kentucky, 2015

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Introduction

Watermelon continues to be a major vegetable crop produced for fresh market in Kentucky. Watermelon is only second in acreage to sweet corn in the state and while sweet corn acreage has been diminishing, watermelon acreage has been increasing. From 2007 to 2012, there was a greater than 40 percent increase in acres planted to watermelon in Kentucky (USDA, 2013). There has been a sustained trend toward expansion of vegetable crops, particularly for major crops in the state (Snell et al., 2013). Watermelon production is not concentrated in one region of the state but rather distributed throughout. However most of it is in Daviess, Lincoln, Casey, Hart, Allen, and Christian Counties.

Farmers need to select varieties that suit their buyers and have good yields and quality. Kentucky markets are diverse, thus watermelon varietal characteristics appropriate for wholesale producers are not necessarily the same as those for farmers selling via retail channels. The objective of the experiment was to evaluate twenty seedless watermelon varieties produced under local conditions in Kentucky.

Materials and Methods

The experiment was established 19 April when twenty varieties were sown in 50-cell black seedling flats (Landmark Plastic, Akron, OH). Jiffy-Mix #17 (Jiffy Products of America, Lorain, Ohio) was the seedling media used. All varieties, as well as the non-harvested pollinizer variety Accomplice, were transplanted on 22 May with a Rain-Flo waterwheel setter into a Maury silt loam. The experimental design was a randomized complete block, replicated three times. Rows were spaced on 8 foot centers with 4 feet in-row spacing. Experimental plots were 40 feet in length with 10 seedless plants per plot. Pollenizers were interplanted within the row at a ratio of one pollenizer for every two trial plants. Pre-plant fertilizers were 110 pounds of urea (46-0-0) and 100 pounds of muriate of potash (0-0-60) per acre. Plastic mulch–covered (4 ft x 1 mil, Filmtech Plastics of the Sigma Plastics Group, Lyndhurst, NJ) raised beds were formed using a Rain-Flo plastic layer. Simultaneously, irrigation drip tape was installed (12-inch emitter spacing, 30 gph/100 ft, Aqua Traxx, The Toro Company, Bloomington, MN) under the plastic. Fertigating began 3 June and ended 31 July applying 5 pounds N per acre using calcium nitrate each time. In 2015, fertigations were fewer than in typical seasons due to excessive rain fall, which led to frequent soil saturation and reduced irrigation frequency. Between 12 June and 2 July vines were turned back onto the plastic weekly to keep varieties separated and to allow for cultivation of row middles for weed management. The ID-36 Vegetable Production Guide for Commercial Growers (Bessin et al, 2014) was followed to select fungicides and insecticides selection and to properly rotate between pesticide modes of action. The timing of preventative fungicide sprays was determined using MELCAST (Egel, 2014). It has been shown that in some seasons, the proper timing of preventative sprays can result in reduced fungicide usage (Egel and Latin, 2012). Insecticide applications were based on insect counts gathered by weekly scouting for arthropod pests. Plots were harvested weekly from 31 July through 27 August (five harvests). Each fruit was individually weighed; fruit less than 9 pounds was not included. Three fruit from every replication of all varieties were evaluated for internal quality including percent soluble solids, size, and firmness. Soluble solids were measured using a refractometer (RF-12, Extech Instruments, Nashua, New Hampshire). An analog penetrometer (FT, Wagner Instruments, Greenwich, Connecticut) was used for measuring fruit firmness. Yield data were analyzed by general linear model and means were separated by Fisher's least significant difference test using SAS statistical programs (SAS Institute, Cary, NC.)

Results and Discussion

In 2015, yields were greatly reduced to a range of 20,700 to 40,500 pounds per acre as compared to 43,300 to 85,200 pounds per acre in 2014 (Table 1) (Saha and Hanks, 2014). Reduced yield was likely due to excessive rain in July, which promoted anthracnose and gummy stem blight diseases. The average precipitation for July in Fayette County is 4.65 inches, while in 2015 9.66 inches fell (Weather Underground, 2015). In addition to promoting disease development, the rainy weather often prevented timely fungicide applications, and as the ground was saturated, it was impractical to fertigate.

The top 13 yielding varieties had statistically similar yields. Numerically, SV0258WA had the highest yield (297 lbs/plot) (Table 1). Fruit count of SV0258WA was not significantly different from fourteen varieties (Table 1). A similar trend was observed with regard to total bins of SV0258WA per acre (58.2 bins/A) (Table 2). Other comparable varieties included Lucille, SV7018WA, as well as commonly used varieties in Kentucky such as Fascination and Tri-X 313. More than half of the SV0258WA melons were the 45-count size (Table 2). WDL0409, KB12106, Traveler, and USAW90020 produced the most watermelons in the 60-count

Table 1. Yield of seedless watermelon varieties, 2015

Variety	Seed Company	Total Fruit Weight (lb) per plot[z]	Total Fruit Number per plot	Fruit Weight (lb) per acre	Fruit Number per acre
SV0258WA	SM	297 a[y]	19 abc	40,500 a	2630 abc
Lucille	OG	284 ab	20 a	38,600 ab	2760 a
Fascination	SY	277 ab	19 abc	37,700 ab	2550 abc
SV7018WA	SM	276 abc	20 ab	37,500 abc	2680 ab
USAW 90020	UA	273 abc	21 a	37,200 abc	2820 a
SV8298WA	SM	270 abcd	18 abc	36,700 abcd	2490 abc
Razorback	HI	268 abcd	17 abcd	36,400 abcd	2310 abcd
Sweet Dawn	SY	263 abcd	18 abc	35,800 abcd	2410 abc
Captivation	SY	254 abcd	16 abcd	34,600 abcd	2180 abcd
Savannah	SY	249 abcd	18 abc	33,800 abcd	2410 abc
SV0241WA	SM	241 abcd	17 abcd	32,800 abcd	2310 abcd
TRI-X 313	SY	240 abcd	17 abcd	32,700 abcd	2270 abcd
Traveler F1	HM	236 abcd	18 abc	32,000 abcd	2490 abc
Talca	OG	229 abcde	15 bcde	31,100 abcde	2000 bcde
Unbridled	SK	219 bcdef	16 bcde	29,800 bcdef	2150 bcde
Exclamation	SY	215 bcdef	14 bcde	29,200 bcdef	1950 bcde
KB12106	KB	204 cdef	16 bcde	27,800 cdef	2140 bcde
Kingman	SK	195 def	14 cde	26,500 def	1900 cde
Maxima	OG	155 ef	10 e	21,000 ef	1360 e
WDL0409	SY	152 f	12 de	20,700 f	1590 de

[z] Plot size: 320 ft2 .
[y] Means within columns separated by Fisher's least significant test (P ≤ 0.05), means with same letter are not significantly different.

size (Table 2). Talca, Maxima, Lucille, Fascination, and SV0258WA were the top five varieties numerically for producing the most watermelons in the 45-count class (Table 2).

The average brix of SV7018WA (10.9%) was greater as compared to the other nineteen varieties (Table 3). Average brix for SV0258WA was 9.9 percent and was comparable to the other varieties evaluated (Table 3). Fruit firmness varied from 2.98 pounds-force to 3.93 pounds-force (Table 3). Overall there was not a great amount of variation amongst varieties this season with regard to fruit quality. As in many wet seasons, excessive rainfall in the 2015 season diluted the sugar content of the fruit.

In summary, choosing an appropriate variety to fit your marketing style is important. For instance, if wholesale is your primary method, what aspects of the production are most important? Total yield and brix are typically considered; however choosing a variety that produces most of its fruit in the 45-count size could also be a consideration. This is one of the more typically preferred sizes. Given multiple considerations, based on these results, appropriate varieties would include: Lucille, SV7018WA, Fascination, and SV0258WA. Fascination is widely planted in the southeast U.S., and SV0258WA is newer but increasing in usage. Lucille and SV7018WA are more recent releases and it would be beneficial to evaluate these varieties in a season with more favorable conditions. Excessive precipitation and the ensuing water-logged soil and foliar disease certainly impacted the production season.

Table 3. Fruit quality of seedless watermelon varieties, 2015. Three fruit from every replication for each variety

Variety	°Brix[z]	Firmness (lbs-force)	Fruit Length (in)	Fruit Width (in)	Degree of Seedlessness[x]	Hollow Heart[y]	Color
SV7018WA	10.9 a[w]	3.4 defg	11.2 a	8.1 cdefg	0.0	0.2 bc	red
USAW 90020	10.3 b	3.2 fg	10.2 bcd	8.1 cdefg	0.3	0.0 c	pink
TRI-X 313	10.2 bc	3.4 bcdef	10.7 abc	8.0 defg	0.1	0.8 ab	pink
SV8298WA	10.2 bc	3.7 abcde	10.7 ab	7.8 efg	0.1	0.4 bc	pink
Unbridled	10.1 bcd	3.0 g	9.6 d	8.6 bc	0.4	0.4 bc	pink
Lucille	10.0 bcde	3.2 fg	10.7 abc	8.0 defg	0.1	0.7 bc	pink
Captivation	10.0 bcde	3.8 abc	11.2 a	8.3 cde	0.0	0.8 ab	light pink
Exclamation	10.0 bcde	3.4 bcdefg	9.8 d	9.2 a	0.2	0.4 bc	pink
Kingman	9.9 bcde	3.6 abcdef	10.0 cd	7.6 g	0.1	0.4 bc	pink
WDL0409	9.9 bcde	3.7 abcde	10.1 bcd	7.7 fg	0.1	0.7 bc	pink
SV0258WA	9.9 bcde	3.6 abcdef	11.2 a	8.3 cde	0.0	0.9 ab	pink
Savannah	9.9 bcde	3.3 efg	10.6 abc	8.3 cde	0.1	0.2 bc	pink
KB12106	9.9 bcde	3.8 abcd	11.1 a	7.6 g	0.0	1.4 a	pink
Traveler	9.8 bcde	3.8 abc	10.0 bcd	8.4 cd	0.0	0.4 bc	pink
Maxima	9.8 bcde	3.7 abcde	10.0 d	9.0 ab	0.2	0.3 bc	pink
Talca	9.7 cde	3.2 fg	10.7 abc	9.0 ab	0.1	0.3 bc	pink
Sweet Dawn	9.7 cde	3.9 a	11.4 a	8.3cde	0.0	0.0 c	pink
SV0241WA	9.6 cde	3.4 cdefg	10.7 abc	7.9 defg	0.0	0.7 bc	red
Razorback	9.4 de	3.8 ab	9.7 d	8.4 cd	0.1	0.2 bc	pink
Fascination	9.4 e	3.4 defg	10.9 a	8.2 cdef	0.1	0.9 ab	pink

[z] °Brix: the percent of soluble solids
[x] Degree of Seedlessness: 1 = 0 seeds, 2 = 1 - 5 seeds, 3 = >5 seeds
[y] Hollow Heart: 0 = none, 1 = minor cracking, 2 = severe cracks or cavities
[w] Means within columns separated by Fisher's least significant difference test ($P \leq 0.05$), means with same letter are not significantly different.

Table 2. Seedless watermelon varieties by average fruit weight, 2015

		Percent of Fruit in Each Size Class			
	Total	60-count	45-count	36-count	30-count
Variety	Bins per acre	9-13.5 lbs	13.6-17.5 lbs	17.6-21.4 lbs	>21.4 lbs
SV0258WA	58.2 a[z]	24.5	50.2	25.2	0
Lucille	57.0 ab	37.1	54.8	8.0	0
SV7018WA	54.7 ab	47.9	38.3	12.3	1.5
Fascination	54.2 abc	30.1	54.6	12.8	2.6
USAW 90020	53.9 abc	61.6	31.9	6.5	0
SV8298WA	52.7 abc	37.0	46.9	16.2	0
Razorback	52.7 abc	23.3	47.3	23.3	6.1
Sweet Dawn	51.2 abcd	39.2	40.5	18.5	1.9
Savannah	50.2 abcd	41.2	37.6	19.8	1.4
Captivation	48.9 abcd	24.4	47.8	25.6	2.2
TRI-X 313	47.6 abcd	43.7	39.4	13.0	3.9
SV0241WA	47.4 abcd	43.5	44.4	9.8	2.2
Traveler F1	46.6 abcd	66.5	32.1	1.4	0
Talca	44.9 abcd	21.4	58.4	13.2	7.0
Unbridled	43.6 abcde	41.1	46.3	11.1	1.5
Exclamation	42.6 bcde	33.4	46.2	16.0	4.5
KB12106	39.8 cde	66.5	33.5	0	0
Kingman	37.6 de	58.3	30.0	10.3	1.4
Maxima	30.0 e	23.9	58.3	14.4	3.3
WDL0409	29.5 e	68.9	28.9	2.2	0

[z] Means within columns separated by Fisher's least significant difference test ($P \leq 0.05$), means with same letter are not significantly different.

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Sugar-enhanced and Synergistic Sweet Corn Evaluations in Central Kentucky

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Introduction

Locally produced sweet corn is a high-demand item at Kentucky retail markets. This trial was designed to evaluate some of the newest sugar-enhanced and synergistic sweet corn varieties.

Materials and Methods

Twenty-two sugar-enhanced and synergistic sweet corn varieties were planted by hand on 22 May. Plots consisted of a 20-foot-long row of each cultivar and were replicated four times. Rows were spaced 33 inches apart, and roughly 200 seeds were hand-planted in each 20-foot row to assure a good stand. Seedlings were thinned to a distance of nine inches apart.

Prior to planting, 100 pounds of actual N as ammonium nitrate and 18 pounds of K as 0-0-60 per acre were applied to the soil and tilled in. Plants were side-dressed with 50 pounds of actual N per acre as calcium nitrate on 1 July.

Weeds were hand-cultivated 10 days after planting, followed by application of Dual II Magnum herbicide on 1 July. Brigade and Coragen were used for insect control. A low, three-wire electric fence was set up around the plot at the beginning of harvest to keep out raccoons and coyotes.

Results and Discussion

This growing season was very rainy. Variety evaluation results can be found in Tables 1 through 3. Yields for most of the varieties were not significantly different from each other. Essence, Profit, and Ka-Ching, were judged to be the best bicolor varieties in the trial. Profit, a 70 day maturity variety, was the best early maturing variety in the trial and ears were very easily removed from the plant. All other varieties in this study that matured from 62 to 69 days from planting had very poor husk coverage.

Mattapoiset, Silver King, Mirage, and Whiteout were the best white varieties. All of these had good yields, husk coverage, tip fill, and excellent eating quality. In fact, eating quality of just about all of the varieties evaluated was excellent. Aspire, the only yellow variety in the trial, had excellent husk coverage, very good tip fill, and was exceptionally sweet.

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Table 1. Plant characteristics and yields of sweet corn varieties, Lexington, KY, 2015

Variety	Type[1]	Seed source[2]	Kernel color[3]	Days to maturity[4]	Yield (dozen ears per acre)[5]	SSe Seedling vigor[6] (1-5)	Height to first harvested ear (in.)	Ease of ear harvest[7] (1-5)
Allure	se	SW	bc	75	2130 a	4.5	18	4.1
Essence	syn	RU	bc	78	2110 a	3	22	3.3
Mattapoiset	se	SW	w	80	2080 a	3.9	22	3.1
Silver King	se	HR	w	82	2030 a	3.5	23	2.8
Mirage	syn	HR	w	78	1950 ab	2.9	23	3.5
WH 0809	tsw	SY	w	80	1950 ab	3.6	25	3.6
Cameo	syn	RU	bc	84	1900 abc	3.1	24	3.6
Profit	se	SW	bc	70	1900 abc	5	11	4.3
Ka-Ching	se	SI	bc	73-77	1900 abc	4.3	13	3.9
Primus	tsw	SY	bc	81	1880 abc	2.8	17	3
Whiteout	se	SW	w	73	1880 abc	3	23	3.8
Alto	se	SI	bc	62-72	1820 abc	5	12	3.8
Aspire	tsw	SY	y	80	1800 abc	3.5	22	3.1
Cuppa Joe	se	RU	bc	73	1750 abcd	3.5	19	3.9
Revelation	syn	HR	bc	66	1730 abcd	4	11	3.8
Brocade	se	HR	bc	82	1630 abcde	4.1	21	3.9
Luscious	se+	JO	bc	75	1500 bcdef	1.4	16	4
BC 0822	tsw	SY	bc	77	1450 bcdef	3.5	19	3.3
Trinity	se	SI	bc	66-72	1400 cdef	3.4	8	3.6
Sweetness	se	SW	bc	68	1290 def	4.4	9	3.8
Pay Dirt	se	SI	bc	62-72	1200 ef	2.5	9	3.8
Sugar Pearl	se+	JO	w	73	1120 f	2	16	3.8

1 Corn type: se = sugar-enhanced, se+ = sugar-enhanced-plus, syn = synergistic, tsw = Tablesweet® se/supersweet.
2 See appendix for seed company addresses.
3 Days to harvest from seed catalogues.
4 Numbers followed by the same letter are not significantly different (Duncan Multiple Range Test LSD P=0.05).
5 Kernel color: y = yellow; w = white; bc= bicolor.
6 Seedling vigor: 1 = poor growth, 5 = excellent growth.
7 Harvest ease: 1 = difficult to pull ear from stalk; 5 = easy to pull off.

Table 2. Ear characteristics of sweet corn varieties, Lexington, KY, 2015

Cultivar	Husk coverage[1] (1-10)	Ear length (in)	Tip fill[2] (1-10)	Row straightness[3]
Allure	4.8	8.4	8	3.5
Essence	10	7.5	9.3	5
Mattapoiset	9.5	8	9	4
Silver King	9	7.6	8.8	6
Mirage	10	7.9	10	4.8
WH 0809	9.8	7.9	6	7
Cameo	8.5	8.1	4	5.3
Profit	8.5	7.4	9.5	7.5
Ka-Ching	8.8	8.4	9	7
Primus	10	7.7	6.5	6
Whiteout	7.5	7.5	8.3	7.5
Alto	5.5	7.3	9.8	6.3
Aspire	9.8	8.1	7.3	6.8
Cuppa Joe	3.5	8.2	7.8	6.8
Revelation	5.5	7.3	9.5	5.8
Brocade	9	7.6	5.8	5.8
Luscious	7.8	7.2	5.3	6.3
BC 0822	7.8	7.4	0	6
Trinity	7	7.3	7.5	6.8
Sweetness	1.3	7.2	7.3	5
Pay Dirt	6.8	7.1	6.5	5.3
Sugar Pearl	9	6.7	8	5.8

1 Husk coverage: 1 = corn ear protrudes from all husks, 10 = husks completely cover all ten ears.
2 Tip fill: 1 = kernels not filled out on ear tips, 10 = all ears filled to the tip with plump kernels.
3 Row straightness down length of ears: 1 = poor, 5 = very straight.

Table 3. Ear quality characteristics of sweet corn, Lexington, KY, 2015

Cultivar	Pericarp tenderness[1] (1-4)	Kernel tenderness[2] (1-4)	Sweetness[3] (1-4)	Comments
Allure	3.1	3	3.5	Husk not as attractive; some with bacterial rot
Essence	3.6	3.5	3.6	Short flags, attractive husk
Mattapoiset	3.1	3.3	3.8	Attractive husk; long flags
Silver King	2.9	2.9	3.1	Long flags; attractive husk and ear; husk snaps off ear easily
Mirage	3.1	3.3	3.5	Attractive husk and ear; shucks easily
WH 0809	3.5	3.5	3.7	Some dark specks on husks; short flags; attractive husk and ear; snaps off husk easily
Cameo	3	3.3	3.5	Short flags; deep kernels
Profit	3.1	2.8	3.6	Attractive husk and ear
Ka Ching	3.5	3.5	3.6	Large ears, long flags; some with bacterial rot
Primus	3.1	3.3	3.8	Short flags
Whiteout	3.4	3.3	3.4	Husk snaps off ear easily; some with bacterial rots; variable length flags
Alto	3	2.9	3.5	Variable ear length; hard to shuck; med. to long flags
Aspire	3.3	2.9	3.8	Pale, attractive husk; snaps off ear easily; some with spots on husks
Cuppa Joe	3.4	3.3	3.5	Short flags; husk not attractive
Revelation	3.3	3.1	3.4	Fairly attractive, some with bacterial rot
Brocade	2.3	3.1	3.3	Med to long flags, attractive husk
Luscious	2.8	2.6	3.4	Deep kernels; medium to long flags
BC 0822	3.4	3.4	3.6	Attractive husk; short flags
Trinity	3.4	3	2.9	Considerable raccoon feeding; attractive ear; glossy kernels
Sweetness	4	3.4	2.9	Very tender, easy to shuck
Pay Dirt	2.8	2.9	3.4	Several with bacterial rot
Sugar Pearl	2.6	3.4	3.6	Medium to short flags; short ear

1 Pericarp Tenderness: 1= tough; 4 = tender. Taste evaluations were performed on one ear fromeach replication that was microwaved on high for 2 minutes prior to tasting.
2 Kernel tenderness: 1 = crisp; 4 = creamy and tender.
3 Sweetness: 1 = starchy; 4 = very sweet.

Cantaloupe Variety Trial for Kentucky, 2015

Shubin K. Saha, John Snyder, Chris Smigell, and John Walsh, Horticulture

Introduction

Cantaloupe continues to be one of the major vegetable crops produced in Kentucky. Production from 2007 to 2012 has been stable at over 600 acres of production on a total of 550 farms (USDA, 2013). Christian, Casey, Lincoln, Hart, and Allen counties are the main production areas for Kentucky. Cantaloupe is the fifth largest vegetable crop produced in the state based on acreage and accounts for nearly 10 percent of the total vegetable acreage (USDA, 2013). Farmers select varieties mostly based on market, yield, fruit quality, and disease resistance. Farmers primarily utilizing direct sales have greater flexibility in variety selection compared to those producing for wholesale markets. However, earliness is often another consideration as the market value is usually higher early in the production season. The objective of the experiment was to evaluate yield, fruit quality, and maturity for ten different cantaloupe varieties.

Materials and Methods

Seeding of ten cantaloupe varieties began on 22 April using 50-cell black seedling flats (Landmark Plastic, Akron, OH). A common peat-based substrate, Jiffy-Mix #17 (Jiffy Products of America, Lorain, Ohio), was the seedling media used. Each of ten varieties was transplanted in the designated plots on 20 May at the Horticulture Research Facility into a Maury silt loam soil. Transplanting was done using a Rain-Flo waterwheel setter with 6 feet between rows and 2.5 feet in-row spacing. Plots were 50 feet in length with twenty plants per plot. A plasticulture production system was utilized using plastic mulch–covered (4 ft. x 1 mil, Filmtech Plastics of the Sigma Plastics Group, Lyndhurst, NJ) raised beds with drip tape (12-inch emitter spacing, 30 gph/100 ft., Aqua Traxx, The Toro Company, Bloomington, MN). Plastic and drip tape was installed using a Rain-Flo plastic layer/bed shaper. Pre-plant fertilizer included 110 pounds of urea (46-0-0) and 100 pounds of muriate of potash (0-0-60) per acre. Weekly fertigation was planned, but due to the excessive rain fall, only five applications were made from 3 June to 31 July. At each fertigation event, 9 pounds of actual nitrogen per acre were applied using calcium nitrate, falling 25 pounds per acre short of the recommended rate of actual nitrogen for the season. Fertilization, diseases, and arthropod pests were managed using recommendations in the ID-36 *Vegetable Production Guide for Commercial Growers* (Bessin et al, 2014). The timing of preventative fungicide sprays was determined using MELCAST (Egel and Latin, 2012). Weekly scouting reports dictated insecticide applications through the production season.

Fruit was harvested three times per week beginning on 16 July and terminating 5 August for a total of nine harvests. Each fruit was weighted and three fruit from each variety and each replication were sampled for fruit quality including brix, firmness, and other internal parameters. An analog penetrometer (FT, Wagner Instruments, Greenwich, Connecticut) was used for measuring fruit firmness. Soluble solids were measured using a refractometer (RF-12, Extech Instruments, Nashua, New Hampshire). Yield data were analyzed by general linear model and means were separated by Fisher's least significant difference test using SAS statistical programs (SAS Institute, Cary, NC).

Results and Discussion

Yields in 2015 were significantly reduced, ranging from 1,600 to 6,490 fruits per acre as compared with 4,000 to 12,440 in 2014 (Table 1) (Saha and Hanks, 2014). Reduced yield was likely due to excessive rain in July, which promoted anthracnose, gummy stem blight diseases, and Fusarium crown rot. The average precipitation for July in Fayette County is 4.65 inches; in 2015 9.66 inches fell (Weather Underground, 2015). In addition to promoting disease development, the rainy weather often prevented timely fungicide applications, and as the ground was saturated, it was impractical to fertigate, leading to a deficit of 25 pounds of nitrogen per acre, compared to recommendations.

Average individual fruit weights ranged from 3.2 to 7.1 pounds (Table 1). Nun26367MEM, Maxi East, and Samoa all had greater average fruit weights as compared to the other varieties including the industry standards Aphrodite and Athena (Table 1). Other varieties that were comparable to Athena and Aphrodite for average fruit weight were Sweet East, Orange Sherbet, and Durawest (Table 1). Athena, Wrangler, and Fantasista all had greater total fruit number per plot as compared to the other seven varieties evaluated (Table 1). Athena had the greatest yield by weight as compared to all other varieties with the exception of Aphrodite (Table 1). Other varieties that were comparable to Aphrodite were Fantasista, Sweet East, Nun26367MEM, and Wrangler.

Maxi East had the highest numerical soluble solids (12.4 Brix) as compared to all other varieties (Table 2). It had statistically

Table 1. Yield of cantaloupe varieties, 2015

Variety	Seed Company	Average Fruit Weight (lb)	Number of Fruit per plot[z]	Total Fruit Weight (lb) per plot	Number of Fruit per acre	Total Fruit Weight (lb) per acre
Wrangler	HL	3.2 g	45 a[y]	142 bcd	6490 a	20,500 bcd
Athena	SY	4.7 e	44 a	205 a	6340 a	29,800 a
Fantasista	AT	4.0 f	41 a	163 bc	5950 a	23,700 bc
Aphrodite	SY	5.5 cd	31 b	173 ab	4550 b	25,100 ab
Sweet East	NH	5.8 c	28 bc	161 bc	4070 bc	23,400 bc
Maxi East	NH	6.3 b	21 cd	133 cde	3050 cd	19,300 cde
NUN 26367 MEM	NH	7.1 a	20 d	142 bcd	2900 d	20,700 bcd
Orange Sherbet	SM	5.6 cd	17 de	97 e	2520 de	14,100 e
Samoa	HM	6.3 b	17 de	105 de	2420 de	15,300 de
Durawest	NH	5.4 d	11 e	59 f	1600 e	8,500 f

z Plot size: 300 ft^2

y Means in columns separated by Fisher's least significant test ($P \leq 0.05$), means with same letter are not significantly different.

Table 2. Fruit quality of cantaloupe varieties, 2015

Variety	Seed Company	Brix (% Soluble Solids)	Seed Cavity Length (in)	Seed Cavity Width (in)	Firmness (lbs-force)	Overall Length (in)	Overall Width (in)
Maxi East	NH	12.4 a[z]	4.9 bc	3.0 cd	3.1 cde	8.3 abc	6.7 abc
Orange Sherbet	SM	11.8 ab	5.9 a	3.1 ab	3.8 bcd	8.3 a	6.2 d
Wrangler	HL	11.7 ab	4.5 c	2.2 e	2.9 de	6.8 d	5.3 e
Aphrodite	SY	11.7 ab	4.7 bc	3.4 a	2.4 e	7.3 cd	6.8 a
Sweet East	NH	11.4 abc	5.2 b	2.6 d	3.5 bcde	8.1 ab	6.6 abcd
Fantasista	AT	11.3 abc	4.8 bc	2.5 de	3.2 cde	7.0 d	5.6 e
Durawest	NH	11.1 bc	5.0 bc	2.8 cd	4.5 ab	7.6 bc	6.4 bcd
Athena	SY	11.0 bc	4.4 c	2.7 cd	3.1 cde	7.2 cd	6.3 cd
NUN 26367 MEM	NH	10.7 bc	4.8 bc	2.2 e	5.4 a	8.1 ab	6.9 a
Samoa	HM	10.3 c	5.8 a	3.0 bc	4.3 abc	8.3 a	6.7 ab

[z] Means in columns separated by Fisher's least significant test ($P \leq 0.05$), means with same letter are not significantly different.

Table 3. Early cantaloupe harvest per plot[z], 2015 – Early (July 16 – July 22), 3 harvests

Variety	Seed Company	Number of Fruit	Total Fruit Weight (lb)	Average Fruit Weight (lb)
Athena	SY	7.0 a[y]	29.5 a	4.2 b
Aphrodite	SY	3.3 b	18.8 ab	5.6 ab
Maxi East	NH	2.0 bc	9.2 bcd	4.7 b
NUN 26367 MEM	NH	1.7 bc	13.3 bc	7.8 a
Durawest	NH	1.0 bc	4.3 cd	4.4 b
Fantasista	AT	1.0 bc	4.4 cd	4.2 b
Orange Sherbet	SM	0.3 c	1.5 cd	4.6.b
Samoa	HM	0.3 c	1.8 cd	5.5 b
Sweet East	NH	0.0 c	0.0 d	0.0 c
Wrangler	HL	0.0 c	0.0 d	0.0 c

[z] Plot size: 300 ft2

[y] Means in columns separated by Fisher's least significant test ($P \leq 0.05$), means with same letter are not significantly different.

Table 4. Middle cantaloupe harvest per plot[z], 2015 – Middle (July 24 – July 29), 3 harvests

Variety	Seed Company	Number of Fruit	Total Fruit Weight (lb)	Average Fruit Weight (lb)
Wrangler	HL	32.0 a[y]	103.5 ab	3.2 f
Fantasista	AT	27.7 ab	113.6 a	4.2 e
Athena	SY	22.7 bc	111.8 a	5.0 d
Aphrodite	SY	22.0 bc	121.9 a	5.5 bcd
Sweet East	NH	16.3 cd	93.2 abc	5.8 abc
Orange Sherbet	SM	11.7 de	65.1 cd	5.5 cd
Samoa	HM	11.0 def	69.8 bcd	6.3 ab
Maxi East	NH	6.0 efg	39.7 de	6.3 a
NUN 26367 MEM	NH	4.0 fg	23.9 e	6.1 abc
Durawest	NH	3.0 g	14.4 e	4.8 de

[z] Plot size: 300 ft2

[y] Means in columns separated by Fisher's least significant test ($P \leq 0.05$), means with same letter are not significantly different.

greater soluble solids, however, compared to only four of the nine other varieties evaluated. Excessive July rains likely reduced levels of soluble solids in all varieties. The fruit firmness of all varieties but three were comparable to Athena (Table 2). Nun26367MEM had greater flesh firmness than all varieties with the exception of Durawest and Samoa (Table 2). During the early harvest window (July 16–22), Athena had greater fruit number and greater total fruit weight as compared to all varieties except Aphrodite (Table 3). During the middle harvest window (July 24–29) Wrangler had the greatest fruit number and had comparable or greater total fruit weight as compared to the other varieties (Table 4). Other varieties comparable to industry standards during the middle harvest window included Fantasista and Sweet East. During the late harvest window (July 31–August 5) Nun26367MEM had greater or comparable total fruit per plot and fruit weight per plot relative to other varieties (Table 5). Aside from Athena and Aphrodite, Maxi East and NUN26367MEM combined earliness with high soluble solids.

In a season difficult for producing many vegetable crops, yields from the industry standards Athena and Aphrodite exemplify why they have come to be standards. However, variety selection can largely be dictated by market. Based on this season's results, wholesalers should likely continue with Athena and Aphrodite; however, last year AC9000 performed well (Saha and Hanks, 2014). For direct marketers such as those selling at farm markets, other varieties might be considered. Many of the Tuscan types are of excellent quality and have been comparable in terms of yield, including Wrangler and Orange Sherbet. Wrangler is smaller than many varieties, but customers might overlook the size after tasting it.

Table 5. Late cantaloupe harvest per plot[z], 2015 – Late (July 31 – August 5), 3 harvests

Variety	Seed Company	Number of Fruit	Total Fruit Weight (lb)	Average Fruit Weight (lb)
NUN 26367 MEM	NH	14.3 a[y]	105.3 a	7.4 a
Athena	SY	14.0 a	64.0 bc	4.6 e
Maxi East	NH	13.0 a	84.1 ab	6.5 b
Wrangler	HL	12.7 ab	38.0 cd	3.0 g
Fantasista	AT	12.3 ab	45.1 cd	3.7 f
Sweet East	NH	11.7 abc	68.2 bc	5.8 bcd
Durawest	NH	7.0 bcd	40.1 cd	5.7 cd
Aphrodite	SY	6.0 cd	32.3 d	5.3 d
Orange Sherbet	SM	5.3 d	30.7 d	5.8 bcd
Samoa	HM	5.3 d	33.4 d	6.3 bc

[z] Plot size: 300 ft^2

[y] Means in columns separated by Fisher's least significant test ($P \leq 0.05$), means with same letter are not significantly different.

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Heavy Metals in Pepper Grown in Soil Amended with Recycled Waste

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Introduction

As plants acquire necessary nutrients like N, P, and K, they also accumulate hazardous heavy metals such as Pb, Ni, and Cd. Heavy metals are commonly defined as those having a specific density of more than 5 g cm-3 (Jarup, 2003). Recycling waste for use in crop production is an affordable way for limited-resource farmers to improve crop yield and quality. Farmers are continually searching for alternatives to synthetic fertilizers to alleviate the escalating production costs associated with increasing costs of energy and fertilizers and the problems of soil deterioration and erosion associated with intensive farming systems. Recycling wastes such as sewage sludge (SS), chicken manure (CM), and yard waste (YW) would reduce dependence on synthetic fertilizers and provides amendments useful for improving soil structure and nutrient status (Antonious, 2003). Addition of SS to soil usually increases the growth and yield of a wide variety of crops and promotes the functions of soils.

Peppers (*Capsicum* spp.) are grown for their food value, health-promoting properties and also as a source of capsaicinoids, which have a variety of medicinal uses. However, accumulation of heavy metals by plants grown in SS amended soil can be a serious problem that requires continuous monitoring. Risks of soil contamination when waste materials are used as fertilizer have been a matter of frequent concern. There is a concern that heavy metals in the composted product may transfer from soil and accumulate in edible plant parts. Some of these heavy metals can be detrimental to humans, plants, or animals, if they are present above certain limits. Although soil microorganisms require metals for growth and activity, heavy metals are toxic to soil microorganisms when present in excessive concentrations (Chakrabarti et al., 2005). Increased concentrations of heavy metals in soil have shown negative impact on beneficial soil microorganisms as indicated by the activities of the enzymes they produce (Antonious, 2009). The rate of release of heavy metals from recycled waste used as soil amendments into soil solution and subsequent uptake by plants could also result in phytotoxicity and/or bioaccumulation. There is limited information on heavy-metal absorption and accumulation by edible plants grown in recycled waste. The impact of soil amendments on the heavy metals contents such as Cd, Pb, and Ni of hot pepper (*Capsicum* spp.) plants grown in recycled waste has not been completely investigated. Fruits of *Capsicum annuum* L. (PI 438649 variety Xcatic) have a good marketable shape and attractive red color, and they mature early and contain high concentrations of antioxidant compounds such as capsaicin, dihydrocapsaicin, and ascorbic acid.

The objectives of this investigation were to monitor concentrations of Cd, Pb, and Ni in the fruits of *Capsicum annuum* L. (PI 438649 variety Xcatic) grown under four soil management practices (soil mixed with YW, SS, and CM compared to NM native soil).

Materials and Methods

Field experiment

A field study was conducted at the Kentucky State University Harold Benson Research and Demonstration Farm in Franklin County, KY, on a Lowell silty-loam soil (2.2% organic matter, pH 7). The soil has an average of 12 percent clay, 75 percent silt, and 13 percent sand. Plots (n = 20) of 2 × 10 m each were separated using grass strips. The soil in five plots was mixed with municipal SS obtained from Metropolitan Sewer District, Louisville, KY, at 15 t acre^{-1} (on dry weight basis). Soil from five plots was mixed with YW compost made from lawn trimmings and vegetable remains (obtained from Con Robinson Co., Lexington, KY) at 15 t acre^{-1} (on dry weight basis), and soil in five plots was mixed with caged laying CM obtained from University of Kentucky Poultry Research Facility, Lexington, KY, at 15 t acre^{-1}. Native soil from 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 pepper (*C. annuum* L., PI 438649 variety Xcatic) were obtained from the USDA/ARS National Germplasm Collection

(Griffin, GA) and planted in the greenhouse. Seedlings of 120 days old were transplanted into the field containing the four soil management practices (SS, YW, CM, and NM soil) in a randomized complete block design (RCBD) with five replicates for each soil treatment.

Heavy Metal Analyses in Pepper Tissues

Pepper fruits were washed with tap- and deionized-water and dried in oven at 65°C for 48 hrs. The dried samples were manually ground with ceramic mortar and pestle to pass through 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 was added in volumetric flasks and the mixture was allowed to stand overnight, and then 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. Concentrations of Cd, Pb, and Ni were determined using inductively coupled plasma (ICP) spectrometry following the U.S. EPA method 6020a (1998)

Heavy Metal Analyses in Soil Amended with Recycled Waste

Native soil and soil incorporated with SS, YW, and CM were collected to a depth of 15 cm from field plots using a soil core sampler equipped with a plastic liner tube (Clements Associates, Newton, IA) 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. Elemental concentrations of soil and plants grown under four soil management practices were statistically analyzed using SAS procedure. Means were compared using Duncan's multiple range test.

Results and Discussion

Pb and Cd concentrations in soil amended with YW, SS and CM were not significantly different ($P < 0.05$) compared to NM native soil, while Ni concentrations in NM soil were significantly greater compared to YW, SS, and CM treatments (Figure 1). According to the Codex Alimentarius Commission of the Joint FAO/WHO Food Standards (2006), the maximum Pb level in most vegetables is 0.1 μg g^{-1} on fresh weight basis. These findings indicated that Ni in NM native soil was the source of this high Ni concentration as shown in Figure 1. Ni concentrations in food are usually below 0.5 μg g^{-1}on fresh weight basis.

Concentrations of Cd and Ni in pepper fruits grown under the four soil management practices were not significantly different (Figure 2), whereas, Pb was greater (0.41 and 0.39 μg g^{-1} fruit) in pepper fruits of plants grown in SS and CM treatments, compared to YW and NM treatments (0.18 and 0.13 μg g^{-1} fruit), respectively. These data are expressed on dry weight basis. That the water content of pepper fruits was 91 percent, therefore Cd and Pb concentrations were below the established Codex maximum limits (Codex Alimentarius Commission 2006) of 0.1 μg g^{-1} plant tissue as regulated by the world health organization (WHO) of food standards on fresh weight basis. Table 1 shows the bioaccumulation factor (BAF) of three heavy metals (Cd, Pb, and Ni) from soil into pepper fruits grown under the four soil management practices investigated in this study. BAF is defined as the plant metal content in μg g^{-1} dry plant tissue divided by total metal content in the soil in μg g^{-1} dry soil. Regardless of soil treatment, BAF values in the fruits were in the range: Cd (0.7-1.0); Pb (0.2-0.8); and Ni (0.1-0.4). BAF values below 1 are desirable and represent levels that do not pose human health hazards (Antonious et al., 2010). Whereas, BAF values >1 indicates metal bioaccumulation and potential hazard. Monitoring heavy metal uptake by edible plants grown in recycled waste would facilitate the selection of soil amendments that might be useful for use as organic fertilizer and for studies on the mechanisms of heavy metal uptake and/or translocation. Soil amendments that increase metal accumulation in edible plants should be avoided to prevent potential human exposure to heavy metals through the food chain.

Figure 1. Concentrations of three heavy metals in soil amended with yard waste (YW), sewage sludge (SS), and chicken manure (CM), compared to no-mulch bare soil. Statistical comparisons were carried out among four soil management practices for each metal. Bars accompanied by different letter for each metal are significantly different ($P < 0.05$) using Duncan's multiple range test.

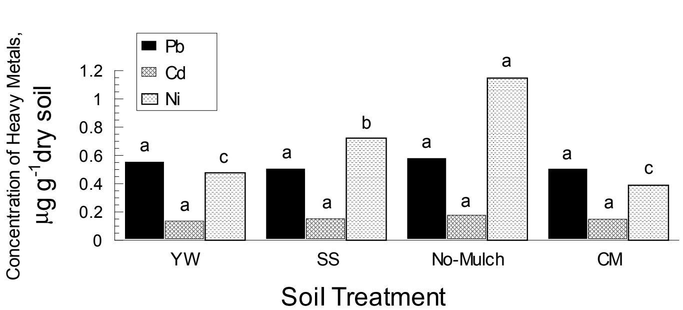

Figure 2. Concentrations of Pb, Cd, and Ni in *Capsicum annuum* L. (cv. Xcatic) fruits of plants grown under four soil management practices. Statistical comparisons were carried out among four soil management practices for each metal. Bars accompanied by different letter(s) for each plant part are significantly different ($P < 0.05$) using Duncan's multiple range test.

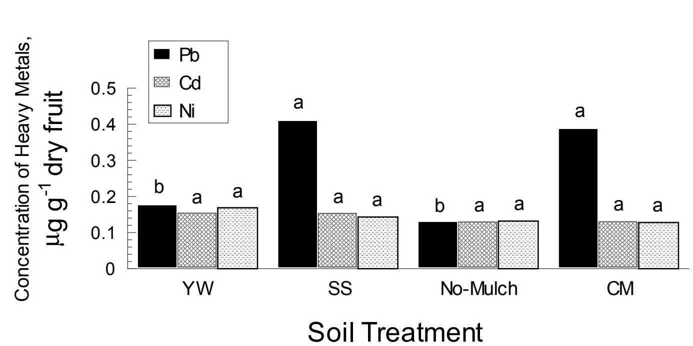

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Table 1 Concentrations and bioaccumulation factor (BAF) of seven heavy metals in pepper (*Capsicum annuum* L. cv. Xcatic) fruits of plants grown under four soil management practices

Heavy Metal	Treatment	µg g^{-1} dry fruit	µg g^{-1} fresh fruit	BAF
Ni	YW	0.169 ± 0.036	0.015 ± 0.010	0.35
	SS	0.143 ± 0.025	0.013 ± 0.001	0.20
	NM	0.132 ± 0.065	0.012 ± 0.003	0.12
	CM	0.128 ± 0.052	0.012 ± 0.008	0.33
Cd	YW	0.154 ± 0.013	0.014 ± 0.001	1.13
	SS	0.153 ± 0.020	0.014 ± 0.007	1.01
	NM	0.129 ± 0.028	0.012 ± 0.004	0.73
	CM	0.130 ± 0.013	0.012 ± 0.006	0.88
Pb	YW	0.175 ± 0.041	0.016 ± 0.009	0.32
	SS	0.408 ± 0.097	0.037 ± 0.001	0.81
	NM	0.129 ± 0.018	0.012 ± 0.005	0.22
	CM	0.385 ± 0.025	0.035 ± 0.012	0.76

Each BAF value is an average of three replicates.

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Enhancing Biomass Production in Arugula and Mustard Greens

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Introduction

Attempts to improve the efficiency of biofumugation have focused on selection of biofumigant crops with high glucosinolate (GSL) content (Kirkegaard and Sarwar, 1998). The use of soil amendments might reduce the biomass needed to produce significant concentrations of isothiocyanate (ITC) generating GSLs in Brassica plants for greater biofumigant potential. Soil borne organisms are becoming more difficult to control due to pathogen resistance and restricted use of some pesticides. Brassica species produce a significant amount of GSLs in their tissue. When GSLs are hydrolyzed by the enzyme myrosinase, which is also present in the Brassica tissues, a range of products are produced including the volatile biocidal ITCs similar to the active ingredient in the nematicide metam sodium (Vapam). New soil management practices are needed to develop and expand our knowledge and technical means of agricultural production systems related to GSLs and plant protection. The escalating production costs associated with the increasing costs of energy and fertilizers to U.S. farmers and the problems of soil deterioration and erosion associated with intensive farming systems have generated considerable interest in less expensive and more environmentally compatible production alternatives such as recycling wastes from processing operations for use as fertilizers in land farming to provide high quality organic amendments (Antonious, 2014; Antonious et al., 2014). Approximately 41,511 water body impairments across the U.S. are attributed to synthetic pesticides, and of that total, 1,300 impairments are located in Kentucky (USEPA, 2013). Brassica plants (such as mustard and arugula) have been shown to release biotoxic compounds (GSLs) or metabolic byproducts active against bacteria, fungi, insects, nematodes, and weeds. When plants containing GSLs are physically disrupted, the hydrolytic enzyme myrosinase is released from ruptured cells, hydrolyzing GSLs primarily to ITCs, glucose, and nitrile products. Incorporation of Brassica tissues such as mustard and arugula into soil can suppress soil-borne pests due to the biofumigant properties of the highly toxic ITCs, and moderately toxic non-glucosinolate S-containing compounds (Bending and Lincoln, 1999). Accordingly, the main objective of this investigation was to assess the impact of recycled waste—sewage sludge (SS), horse manure (HM), and chicken manure (CM) —on arugula and mustard biomass of roots, stem, and leaves at harvest for potential use as natural soil biofumigants.

Materials and Methods

The field trial area was conducted at the University of Kentucky Horticulture Research Farm. Arugula (*Eruca sativa*) and mustard (*Brassica juncea*) were grown in 30-foot by 144-foot beds of freshly tilled soil at 8-inch row spacing in mid-April 2015. Each bed was divided into 12 plots, measuring 12 feet by 30 feet. Each bed was divided into three replicates in a randomized complete block design (RCBD) with the following four treatments: 1) control (no mulch, untreated soil); 2) SS, applied at 15 tons per acre; 3) HM applied at 15 tons per acre; and 4) CM applied at 15 tons per acre on dry weight basis. The entire study area contained 24 plots (2 crops × 3 replicates × 4 treatments).

Results and Discussion

Most agricultural benefits from organic product applications are derived from improved physical properties related to the increased soil organic matter content in addition to their value as fertilizer. Organic amendments improve the physical properties of soils by increasing nutrient and water holding capacity, total pore space, aggregate stability, erosion resistance, temperature insulation, and decreasing apparent soil density (Shiralipour et al., 1992).

Table 1 revealed that soil amended with SS increased plant biomass production in arugula and mustard by 26 and 21 percent, respectively, compared to NM bare soil. Unsurprisingly, total biomass of mustard plants was significantly greater than arugula. Application of organic amendments to agricultural soils makes good use of natural resources and reduces the need of synthetic fertilizers (Antonious, 2013). While preparing field operations, farmers could incorporate arugula and mustard plant debris into the soil for use as soil management practices to control soil-borne diseases. Further studies to quantify GSLs and ITC release are currently under way.

Table 1. Mean weights of arugula and mustard plants grown under four soil management practices. Statistical comparisons were carried out among soil amendments for each crop

Soil Amendment	Root Weight, g	Shoot Weight, g	Plant Weight, g
Arugula			
SS	74.24 a	290.95 a	365.20 a
HM	54.00 b	247.21 b	301.21 b
CM	41.64 c	235.60 c	277.23 c
NM	30.08 c	240.45 c	270.54 c
Mustard			
SS	61.43 b	426.60 a	488.00 a
HM	67.21 b	393.10 b	460.30 b
CM	75.87 a	307.40 d	383.30 c
NM	44.24 c	341.90 c	386.20 c

Each value is an average of three replicates.

Acknowledgments

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On-Farm Sweet Corn Plasticulture Trial

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Introduction

The effect of plasticulture on early production of sweet corn has been well demonstrated. The use of plastic helps to maintain adequate moisture while conserving water use. It also serves to raise the soil temperature, promoting plant growth early in the season. The plastic barrier prevents weed growth, and raising the bed increases drainage from the roots. Growers who are first in the season to market receive a higher price, which can offset the additional cost of plastic used in this production system. In addition, sweet corn growers pursuing organic or "naturally" grown produce can obtain great benefits from the weed control that plastic provides. However, there are currently very limited options for recycling plastic mulches after they are used in the field. For those wishing to reduce their amount of agricultural waste products, biodegradable mulch provides an attractive option. The purpose of this demonstration plot was to compare system costs, germination, yield, and time to harvest in the Ohio River Valley of sweet corn grown on bare ground, common black plastic mulch, or biodegradable mulch. Other measurements included assessment of laying qualities, how each barrier controls weeds throughout the season, and the amount of residue left at the end of the season.

Materials and Methods

Prior to planting, 9 pounds of nitrogen in the form of urea (46-0-0) was applied to this 0.10 acre plot by broadcasting across the planting area (45 lb). After tillage, a Rainflo plasticulture layer was used to raise the planting bed to a height of 6 to 8 inches, install drip tape (8-inch emitter spacing, Aqua Traxx), and to install the two plastic mulches, black plastic (embossed, 1.0 mil) or biodegradable plastic (Bio 360, 0.6 mil); for the bare ground treatment, drip tape but no mulch was installed. On 24 May 2015, corn seeds ('Silver King' variety–82 days) were sown in double rows 18 inches apart at an in-row spacing of 10 inches for a total of 182 plants per replication. Beds were separated by 6 feet on center. Each replication consisted of three 75-foot-long beds. Three replications were performed, with order being assigned randomly. Ease of mulch installation was evaluated during installation. The number of sprouted seedlings in each plot was counted on May 31, and plots were harvested 75 days after seeding. Time spent weeding and removing mulches from the field were recorded for each plot. A cost analysis of the treatments was performed accounting for the cost difference between the two plastics, the labor cost for weeding the bare ground treatment, lifting plastic from the black mulch row, and the yield results per treatment.

Results and Discussion

There was a noticeable difference between the thicknesses of the black (1.0 mil) vs. biodegradable (0.6 mil) plastics. The thinner biodegradable plastic required special care during the laying process to avoid rips. Subsequent to installation both plastics seemed to perform similarly. There was no statistical difference among treatments with regard to seed germination (Table 1). Approximately one month after planting 3.5 man hours was spent hand weeding the three bare ground rows. A minimal amount of weed pressure was present in the standard black plastic and biodegradable treatments but no weeding was necessary. Throughout the season, the standard black and biodegradable mulches provided the same level of weed control.

When harvested 75 days after sowing, significantly more marketable ears were harvested from the biodegradable and black plastic mulch treatments compared to the bare ground treatment. A greater number of ears were harvested from the black than from the biodegradable plastic, but the difference was not statistically significant.

For plastic removal, 2 man-hours were spent to lift the black plastic and remove it from the three rows. However, much of this time was associated with switching tractor implements, and the overall cost may be greatly reduced on a larger scale. Biodegradable mulch still covered most of the rows in which it was used and was able to be tilled in following removal of the drip tape. The market price for corn was set at $5 per dozen ears. The cost analysis for the three treatments is provided in Table 2.

Accounting for these variables, the profit margin for the black plastic over the biodegradable mulch was nominally greater. However, black plastic and biodegradable mulch treatments compared with bare ground resulted in a 47 percent and 46 percent greater profit, respectively. The proper use of herbicides on bare ground, however, could mitigate much of the cost associated with labor in the bare ground. The use of mulch certainly is an attractive option to those trying to limit the use of these products though. Furthermore, from this study it could be reasonably inferred that producers seeking to use biodegradable plastic versus standard black plastic will have a slightly elevated input cost with potentially less labor costs, resulting in a similar profit margin. However, the Bio360 mulch has recently been approved by the USDA National Organic Program for incorporation into the soil, which may be very appealing to those seeking to produce organically and reduce waste output.

Table 1. Average number of ears per plot harvested 75 days after sowing and percent germination seven days after sowing for sweet corn grown with embossed or biodegradable black plastic mulch or with no mulch (bare ground)

Treatment	Average No. of harvested Ears (Day 75)	Average germination % (Day 7)
Black Plastic	129 a[1]	58
Biodegradable	118 a	67
Bare Ground	102 b	52

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

Table 2. Cost Analysis based on a 75-foot row, for sweet corn production using normal embossed black or biodegradable mulch, compared with production without mulch (bare ground)*

	Input cost associated with various treatments			Returns		
Treatment	Plastic cost per plot (75 feet)	Weeding (@ $10/hr)	Lifting plastic (@ $10/hr)	Ears Harvested	Revenue at $5 per dozen	Net Income
Bare Ground	$0.00	$12.00	$0.00	102	$42.50	$30.50
Black Plastic	$2.33	$0.00	$6.67	129	$53.75	$44.75
Biodegradable	$4.56	$0.00	$0.00	118	$49.16	$44.60

*This does not account for other costs (fertilizer, labor, fuel, seed, drip tape) which would be similar among treatments Mulch costs per 48"x4000'roll: Black– $124 (1.0 mil); Biodegradable (Bio360) - $243 (0.6 mil).
Pricing obtained from BerryHilldrip.com.

Ear Damage in Sweet Corn Bordered by Native Perennial Plants and Pasture

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Introduction

Among many other services, native perennial plants provide habitat for beneficial insects (Fiedler and Landis, 2007; Isaacs et al., 2009). Flowering plants can provide beneficial insects with nectar and pollen, which are food sources when there are few prey in the crop itself (Isaacs et al., 2009). The attraction of beneficial insects is fundamental when trying to establish sustainable methods of insect pest management in vegetable and fruit crops. Some researchers have suggested that planting non-crop vegetation such as grasses and flowering plants in close proximity to crop field margins can enhance populations of predaceous arthropods and parasitoids.

Sweet corn pest insects include corn earworm, European corn borer, and fall armyworm. The most serious is corn earworm. Small larvae feed on the silk, then move into the ear. European corn borer larvae tunnel into leaf midribs, stalks, and corn ears. Fall armyworm larvae feed on the leaves, whorl, and ear (Bessin). Beneficial insects include lady beetles, big-eyed bugs, minute pirate bugs, syrphid flies, lacewings, and ground beetles. The objective of this research was to assess and compare the insect damage to corn ears in plantings bordered by native perennial plants and pasture. This was a two-year study.

Materials and Methods

This research was conducted at the Kentucky State University Harold R. Benson Research and Demonstration Farm in Franklin County, KY. Each border row was 75 feet long by 6 feet wide. Corn plots between the border rows were 40 feet wide. This was a randomized complete block design replicated four times. Prevailing winds are west-northwest.

Native perennial border rows contained 16 plant species, including five grasses. Species used were big bluestem (*Andropogon gerardii*), thimbleweed (*Anemone virginiana*), New England aster (*Aster novae-anglica*), side-oats grama (*Bouteloua curtipendula*), purple coneflower (*Echinacea purpurea*), gray-headed coneflower (*Ratibida pinnata*), rattlesnake master (*Erygium yuccifolium*), common boneset (*Eupatorium perfoliatum*), blue lobelia (*Lobelia siphilitica*), bee balm (*Monarda fistulosa*), switchgrass (*Panicum virgatum*), foxglove beardtongue (*Penstemon digitalis*), hairy beardtongue (*Penstemon hirsutus*), slender mountain mint (*Pycantheum tennuifolium*), little bluestem (*Schizacharium scoparium*), and prairie dropseed (*Sporobolus heterolepis*). Pasture border rows, which were the control, were a mixture of grasses, fescue, orchard grass, red clover, Johnsongrass, and broad leaf weeds.

Four yellow sticky traps 15 cm x 15 cm were placed equidistant from each end and each trap in both border rows and in two corn rows of each plot. Sticky traps were used to catch flying beneficial insects. Sticky traps were collected beginning August 7 and ended September 9 in 2014. Traps were collected weekly. In 2015, weekly traps were collected June 10 and ended August 13. Two pitfall traps set with 59 ml of propylene glycol and 59 ml of water were placed equidistant from each end and each trap in both border rows and in two rows of corn in each plot. Pitfall traps were used to catch ground-dwelling insects. Pitfall traps were collected beginning August 6 and ending September 4 in 2014. Traps were collected weekly. In 2015, weekly collections of pitfall traps began on July 15 and ended August 12.

In 2014, corn plots were planted and fertilized on June 18, and herbicide was sprayed June 19. Corn was harvested September 25. In 2015, corn plots were sprayed with herbicide on June 11 and fertilized and corn was planted on June 12. Corn was harvested August 31. "Providence" hybrid corn seed was planted in both years, provided by Syngenta. For both years, Trizmet II herbicide was sprayed at a rate of 1.6 quarts per acre and the fertilizer was a mix of 400 pounds 34-0-0, 100 pounds 18-46-0, 200 pounds 0-0-60 and 20 pounds zinc sulfate. Corn was not sprayed with any insecticides in either year.

Corn plots were not irrigated, as rainfall was adequate for both years. In 2014, total precipitation for April, May, June, July, August, and September was 5.5 inches, 4.59 inches, 4.19 inches, 3.83 inches, 7.12 inches, and 4.11 inches, respectively. Total precipitation in 2015 for April, May, June, July, and August were 11.15 inches, 1.83 inches, 5.22 inches, 10.83 inches, and 1.86 inches, respectively.

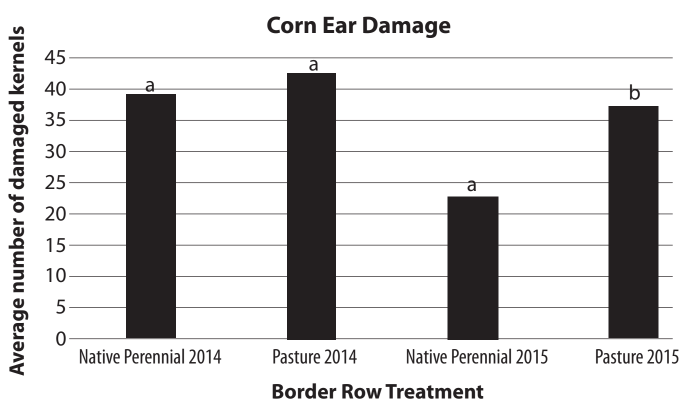
Five ears of corn from the second row on each side of each corn plot for a total of 10 ears were harvested per treatment. Each bag was labeled and taken to the laboratory for assessment of insect damage. Data were analyzed using CoStat Statistical software (CoHort Software, Monterey, CA), and subjected to analysis of variance and least significant difference (LSD) means separation. Treatment means were separated based on a significance level of $P < 0.05$.

Results and Discussion

In 2014, the average number of damaged kernels in the corn bordered by the native perennial plants was 39 and in the corn bordered by pasture was 43 (Figure 1), but this was not a significant difference. In 2015, the average number of damaged kernels in the corn bordered by the native perennial plants was 23, significantly lower than in the corn bordered by pasture, at 37 kernels. (Figure 1).

The most abundant beneficial insects found on sticky traps were spotless lady beetles, minute pirate bugs, syrphid flies, pink lady beetles, and seven-spotted lady beetles, respectively. The most abundant ground beetle species found in pitfall traps were *Harpalus pensylvanicus*, *Cyclotrachelus sodalis, Poecilus lucublandus, Harpalus caliginosus, Stenolophus* spp., and *Scarites subterraneus*, respectively.

Figure 1. Average number of damaged kernels, 2014 and 2015



[1]Bars labled by the same letter for each year are not significantly different (Least Significant Difference p=0.05)1

The reduction in corn ear damage is possibly due to the presence of these ground beetles. There were no differences between the numbers of beneficial insects on sticky traps in the native perennial border rows or corn bordered by native perennial plants in 2014, but there were more beneficial insects in pasture border rows and corn bordered by pasture in 2015. However, there were more ground beetles in the native perennial border rows and corn bordered by native perennial plants in 2015.

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Yield Characteristics of Indigo Purple Tomato Varieties in Kentucky

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Introduction

Tomatoes are one of the most popular and profitable crops in Kentucky (Rowell et al., 2014). Consumers, farmers, and gardeners appear interested in new and heirloom tomato varieties (Saha et al., 2013). Oregon State University has recently released the Indigo series of tomatoes. 'Indigo Rose' was released in 2012 as the first "really" purple variety to come from the Oregon State University vegetable breeding program, which is seeking to breed tomatoes with high levels of antioxidants (Scott, 2012). Indigo series tomatoes may provide additional health benefits over other tomatoes. The objective of this study was to evaluate the yields of Indigo tomato varieties in Kentucky field conditions.

Materials and Methods

The seeds of Indigo Apple, Indigo Blue Beauty, Indigo Blueberries, Indigo Kumquat, Indigo Rose, Indigo Ruby, and Indigo Cherry Drops tomatoes as well as Brandywine, Koralik, and Striped German as control varieties were started on 10 April 2015 in greenhouses at the Kentucky State University (KSU) Harold R. Benson Research and Demonstration Farm in Frankfort, KY. Seedlings were planted on 11 June at the KSU farm on raised beds covered in black plastic mulch with t-tape installed underneath for irrigation. Plants were irrigated as needed. Potato beetles were controlled with Sevin dust applied as needed. Tomatoes were staked using wooden tobacco stakes and twine. The experiment consisted of a randomized complete block design with three blocks. There were four plants of each variety in each plot, with an in-row spacing of 2 feet between plants, 4 feet between blocks of varieties, and between row spacing of 8 feet. Fruit were harvested once per week, beginning on 31 July and ending on 8 October. The number of fruit, weight, and average fruit weight were collected for all plots. Data were analyzed using CoStat Statistical software (CoHort Software, Monterey, CA), and subjected to analysis of variance and least significant difference (LSD) means separation. Treatment means were separated based on a significance level of $P < 0.05$.

Results and Discussion

There was great variation in the total yield of the varieties examined. Indigo Ruby had the highest yield at 9,692 pounds per acre; Indigo Rose had the lowest yield at 3,061 pounds per acre (Table 1). Striped German and Brandywine both had significantly larger fruit than the purple beefsteak variety Indigo Blue Beauty. Koralik had smaller fruit than the other cherry/plum-type Indigo tomatoes; however, the differences were not significant. With yields equal to or greater than the standard heirloom varieties in the trial and their unique appearance and anthocyanin content, growers should perhaps consider the Indigo series for trial plantings.

Table 1. Average fruit weight and yield for Indigo series and heirloom tomato selections

Variety	Average Fruit Weight (g)	Average Yield (lbs/acre)
Indigo Apple	84.8 d[1]	6161 abcd
Indigo Blue Beauty	185.4 c	6865 abc
Indigo Blueberries	7.2 e	8181 ab
Indigo Kumquat	12.5 e	7672 abc
Indigo Rose	35.6 e	3061 d
Indigo Ruby	23.0 e	9692 a
Indigo Cherry Drops	18.0 e	5039 bcd
Brandywine	238.1 b	5286 bcd
Koralik	5.6 e	6110 abcd
Striped German	300.2 a	4515 cd

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

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Appendix A
Sources of Vegetable Seeds

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

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