Spring 2018

Effect of Cultivar and Type on Pepper Yield and Weight

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EFFECT OF CULTIVAR AND TYPE ON PEPPER YIELD AND WEIGHT

A Thesis
Presented to
The Faculty of the Department of Agriculture
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

By
Elizabeth 'Egan' Blessinger

May 2018

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ON PEPPER YIELD AND WEIGHT

Date Recommended April 19, 2018

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4/23/18

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Acknowledgements

First and foremost, I would like to thank God for leading me to WKU and blessing me with this opportunity. My parents and siblings for always pushing me in my educational goals and having faith in my abilities. My husband, Adam, for all of the encouragement and support. Without him, I would have lost my sanity.

I would like to thank Mr. Roger Dennis, for taking me under his wing throughout my tenure at WKU and teaching me everything I know about horticulture. Dr. Elmer Gray, for the many, many hours spent in the field harvesting, collecting data, and all of the advice throughout this journey. Dr. Todd Willian, for his guidance and good sense of humor over the past several years. Dr. Hunter Galloway, for the time spent running and analyzing data. I would not have been able to complete this without each of you.

I would also like to thank Ball Horticulture for supporting this project and making data collection and evaluation possible.

Table of Contents

List of Figures

List of Tables

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Elizabeth 'Egan' Blessinger May 2018 38 Pages

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Peppers (*Capsicum*) are a valuable commodity throughout the world. They provide food, coloring additives, vitamins, and ornamental aesthetics. Peppers can be grown in many different areas of the world and their success is based on variety selection. Breeding cultivars for superior performance is critical to success. Recent consumer desire for less chemical use throughout the growing process has resulted in new cultivar developments.

The objective of this research was to investigate how cultivar and type affect the yield and weight of field grown peppers. This study provides valuable information for growers in determining which cultivars are suitable for production in Kentucky.

The research was conducted at the Western Kentucky University Agriculture Research and Education Complex in Bowling Green, Kentucky in 2016. Plants were provided by Ball Horticultural and Pan American Seed, Elburn, Illinois. The experimental design was a random design, with a 12 plant experimental unit consisting of four three plant rows. Thirty-six cultivars were divided into groups based on the type of pepper produced. Harvest occurred approximately every 7 days and were grouped into 3 periods.

Data were obtained on yield, weight, and mean weight. Individual group selection is determined by the producers and their goals for production. There were wide differences in the types of peppers, including size, shape, and color. When comparing all

groups, two of the thirty six cultivars, Cultivar 23 (Tapered) and Cultivar 34 (Chili) performed best for both yield and mean weight.

I. <u>Introduction</u>

Peppers (*Capsicum*) are a major commodity throughout the world. Their uses include flavoring in food manufacturing, coloring in cosmetics, supplying heat to medicines through capsaicin, and as fresh market foods. Some cultivars are grown as ornamental plants and may be added to fresh bouquets in the floral industry. Dried powders from *Capsicum* have been used to brighten colors of flamingos and koi fish in zoo settings (Bosland and Votava, 2012).

For reasons including adaptability to various climates and versatility in culinary use, peppers have been cultivated throughout the world. After centuries of cultivation for specific traits, the United States National Plant Germplasm System currently lists more than 5,000 species of *Capsicum* (Bosland and Votava, 2012). Several species of peppers are commonly grown in the United States, the largest being *Capsicum annum L*., which includes bell, certain chiles, and jalapeno; *C. chinense L*. which includes habanero; and *C. baccatum L*. which includes chile peppers such as 'Aji' and 'Lemon Drop' (McMahon et al., 2007).

Recent interest in more organic production methods has led to the need for new plant varieties with greater resistance to drought, insects, and diseases. For Kentucky producers, pepper cultivars need to be able to withstand and perform well in its variable climate. The objective of the present study was to determine which types of peppers and specific cultivars are most adapted to South Central, Kentucky growing conditions.

II. Review of Literature

Pepper Production Methods

Peppers are members of the *Solanaceae* family and are primarily grown as summer annuals in the Northern Hemisphere. The warm, moderately wet, and humid summers of South Central Kentucky are ideal for *Capsicum* production. Peppers are grown in various areas across Kentucky both in open fields and in high tunnels. Generally, peppers are started in seeding mixtures in a greenhouse environment and after approximately 7 weeks, when significant root development has occurred, plants are transplanted to the field, high tunnel, or container (Jones et al., 2000).

Peppers are typically grown in a greenhouse, high tunnel, or open field. Contrary to operations in the United States, throughout the world peppers are produced largely in a greenhouse environment. In 2002, greenhouse pepper production in the US were estimated to be 50 hectares (Jovicich et al., 2005).

Greenhouse production allows the grower to have control over production factors: temperature, humidity, irrigation, fertilization, wind, and day length (Bosland and Votava, 2012). Greenhouse grown crops have lower evapotranspiration rates; therefore they have higher water use efficiency than field produced plants (Fernandez et al., 1998). Production sites are generally located near highly populated areas to lessen the cost of transportation and utilities. The Netherlands is the world leader in greenhouse pepper production, exporting 10% of the country’s 163,293 metric tons of bell peppers to the United States in 1995 (Bosland and Votava, 2012).

High tunnel production allows growers to control certain aspects of production at a significantly lower cost than greenhouse systems. Production in these structures can increase the growing season up to 4 weeks in the spring and 8 weeks in the fall (Wells & Loy, 1993). Research has shown that high tunnel production of peppers resulted in 50% greater yields compared to standard field production (Waterer, 2003).

Peppers are classified into two major groups: bell and chile. These groups can be subdivided, categorizing the peppers into different types. These types are based on size, shape, length, heat, and use.

Growth Requirements

Pepper plants begin growth by producing a terminal stem. After 9 to 11 true leaves are present this stem produces flowers. Several branches are produced from the axils of the highest leaves. Each of these branches forms two leaves and ends in a flower. This process repeats until the mature plant is formed (Dorland and Went, 1947). Plants are ready for installment in the field when 4 to 6 true leaves are present and significant roots are established (UMass, 2013). Transplanting to the field should be delayed until the likelihood of frost has passed, which will usually be about April 15th in South Central, Kentucky.

Peppers thrive when nightly temperatures are between 15˚ and 24˚ C and soil temperatures reach 15˚ C (Orzolek et al., 2010). Higher yields result when daily air temperatures range between 18°C and 32°C during fruit set (Bosland and Votava, 2012). Day time temperature between 18°C and 29°C is ideal for pepper production, while night time temperature should not fall below 15°C. Although peppers require warm temperatures to produce, abortion of buds can result from temperatures above 35°C (Hemphill, 2010).

Deep, well drained, sandy loam soil is ideal for *Capsicum* production (Bosland and Votava, 2012). A pH range from 6.5 and 6.8 produces the highest yields (UMass, 2013). Soil testing for nitrogen and nitrate levels can be beneficial to pepper production. High levels of nitrogen can result in excessive foliage, which can be detrimental to fruit production, because much of the plant energy will go towards the foliage rather than fruit. In the absence of soil test results, pre-plant application of 5-10-10 at the rate of 1.4 kg per 9.3 m^2 should be applied (Dufault and Doubrava, 2003).

Field selection is critical for optimum pepper production. A well-drained upland soil is highly recommended, soils that hold excessive moisture or are near waterways increase the threat of disease (Jones et al., 2000). Peppers should not be planted following a crop of tobacco or other members of the *Solanaceae* family to aid in disease prevention. Consideration should also be given to pesticides that have been used in previous years. Ideal crops to follow or rotate with peppers include: wheat, soybeans, cabbage, sweet corn, cantaloupes, or cucumbers (Jones et al., 2000).

Nutrient requirements vary with plant developmental stage. Starting with transplanting, a recommended nutrient solution consists of (ppm): Nitrogen- 70, Phosphorus- 50, Potassium- 119, Calcium- 110, Magnesium- 40, and Sulfur- 55. When plants reach maturity the recommendations are: Nitrogen- 160, Phosphorus- 50, Potassium- 200, Calcium- 190, Magnesium- 48, and Sulphur- 65. (Jovivich et al., 2003). After significant fruit set, fertilization with a complete fertilizer is recommended. Supplying available nutrients will improve yield, quality, and will benefit growers financially (Dufault and Doubrava, 2003).

Although drought resistant cultivars exist, irrigation is usually essential for optimum yields. Adequate water is crucial at flowering and fruit set; a deficit at either stage can result in aborted flowers and/or fruit. Frequency and amount of water needed depends on the composition of soil, temperature, humidity, wind, and sunlight. Peppers should receive 2.5 - 5.1 cm of water a day during the growing season (Zandstra et al., 1985). The fibrous root system of pepper is relatively shallow, and absorbs water from the top 30 cm of soil. Irrigation rate and frequency can be determined by assessing the moisture level at the root zone, by hand, or with a moisture meter. (Bosland and Votava, 2012).

Utilizing drip irrigation has led to an increase in the yield of peppers (ITRC, 1996). Drip irrigation allows for water and nutrients to be applied directly to the crop at root level, thus increasing quality and yield. Pepper water requirement varies based upon temperature and humidity, lower irrigation amounts with longer frequency resulted in significantly reduced yields (Sezen et al., 2007).

Research has shown that optimum plant spacing varies with plant type. Plants should be spaced 45 - 60 cm apart within rows that are 76 - 101 cm apart (Zandstra et al., 1985). Distances between and within rows have significant influences on yields. It has been determined that plants grown in very narrow spacing produce the highest fruit yields per hectare but the lowest yield per plant. Despite the lower per plant yield, density of plants makes up for the loss of yield per plant (Bosland and Votava, 2012). Fruit weight and yield increased as plant placing increased from 15 - 60 cm (Decoteau and Graham, 1994). Jovivich et al. (2004), reported that as plant population increased, weight and number of pepper fruit increased.

Cultivar Selection

Cultivar selection is a major decision for pepper growers. With so many varieties available, knowing the intended market and characteristics desired by consumers is vital. Growers prefer varieties that produce high yields, have resistance to diseases, have a uniform harvest maturity, and longevity of production. Fruit size, shape, color, flavor, and capsaicin levels are all critical characteristics (Kaiser and Ernst, 2014).

Pest Problems

Kentucky pepper production often encounters insect pest problems with aphids (*Aphid spp.)*, beet armyworms (*Spodoptera exigua)*, and European corn borers (*Ostrinia nubilalis)* being the most common. Beet armyworm is the most prominent of these pests due to its wide host range and resistance to most insecticides. A mature female moth can lay over 600 eggs in a 7-day period. Eggs take only 2-3 days to hatch into larvae which immediately begin feeding on both foliage and fruits. The entire life cycle is completed in about one month and the results can be devastating (Bessin, 2003). Although beet armyworms are resistant to many insecticides, when treated at a juvenile stage, control is possible. Treating before larvae reach 1.3 cm in length is highly recommended. Lambda-cyhalothrin, chlorpyrifos, and malathion are a few of the most effective chemical controls for beet armyworms. *Hyposoter exiguae*, a parasitic wasp, is an important biological control. One female wasp can eliminate 100 host caterpillars per day (Capinera, 2017).

The European corn borer not only leaves fruit that it has directly injured unmarketable, but also can cause fruit to ripen prematurely or quickly rot on the vine. The mature female moth will lay 15 to 30 eggs at a time on the underside of leaves.

Depending upon conditions, 3 to 7 days after these eggs are laid the larvae hatch and tunnel into the plant to overwinter.

Common insecticides used to control European corn borers are acephate, zeta-cypermethrin, and methoxyfenozide. Chemical control with these products does not kill the eggs or larvae once they have tunneled in to the plant. (Youngman and Day, 2009). Biological controls for this pest control eggs and larvae. *Trichogramma ostrinia*, is a wasp that parasitizes eggs. Using this biological control at a release rate of 220,395/hectare when moths were first noticed resulted in 0% European corn borer damage to a Connecticut crop (Hazzard et al., 2012).

Aphids are very common pests in greenhouse pepper production. They reside on the underside of leaves and feed on plant juices. Adult females have the ability to give birth to live offspring, as many as 12 per day, which results in rapid reproduction. Small populations of aphids do not cause harm but because of their reproductive capacity these populations increase rapidly. Large populations cause chlorosis and stunted shoot growth. Aphids excrete a sugary material, called honeydew, allowing sooty mold to grow (Boucher, 2012).

Management of aphids is most successful with biological controls. The most commonly utilized natural predator of aphid is *Hippodamia convergens* or lady beetle. Release rates vary depending on the infestation. A significant infestation should exist before lady beetles are used, as one lady beetle will eat 50+ aphids a day. When adequate food is not available the beetles will leave (Flint, 2014). Crops should be scouted weekly to detect signs of pest activity. Proper dose and application method are very important when treating for all pests.

Disease Problems

Several plant pathogens also infect Kentucky pepper crops. Bacterial leaf spot (*Xanthomonas)*, pepper virus complex, and anthracnose *(Colletotrichum)* are the most common pathogens affecting Kentucky pepper production. Bacterial leaf spot is considered the most serious of these pathogens, costing producers thousands of dollars annually. This pathogen prefers wet, warm conditions and is spread through the soil by water splashing, wind, and mechanical movement. Selecting resistant cultivars and implementing crop rotations are the most effective forms of prevention (Jones et al., 2000).

Pepper virus complex includes several viral diseases affecting peppers in Kentucky including; tobacco mosaic, tobacco etch, and cucumber mosaic. These diseases, when transmitted early in the growing period will severely stunt the plant, deform leaves and produce irregular fruits. Prevention is key with pepper virus complex; utilizing resistant cultivars, controlling weeds- especially of those in the *Solanaceae* family, and crop rotation can help with prevention (Jones et al., 2000).

Anthracnose is caused by the fungus *Colletotrichum*, and can affect all parts of the pepper plant during any stage of growth. Damaged fruit are the biggest problem resulting from infection because they are unmarketable. Wet, sunken lesions cover the fruit and rotting proceeds. Symptoms worsen when conditions are wet, transmitting spores through rain splash and mechanical movement, i.e. people, tools, and pests. Pathogen free seeds, weed control, and removal of infected plant debris are recommended control procedures. Resistant varieties exist for chili peppers but not for bell peppers (Roberts et al., 2015).

Market Trends

China continues to be the largest producer of bell and chili peppers worldwide, followed by Mexico and Indonesia. The United States ranked sixth in the world in 2007, producing 855,870 metric tons (Fereira, 2008).

Currently, seed companies distribute several hundred varieties of both sweet and hot peppers (Orzolek et al., 2010). In 2015, the United States produced 17,725 hectares of bell peppers with a value of $732,699,000 and 7,325 hectares of chili peppers with a value of $135,743,000 (USDA, 2016). Most peppers harvested in the United States are sold as fresh produce, resulting in several market outlets. These include wholesale markets, cooperatives, local retailers, roadside stands, farmers markets, or pick your own operations.

In 2013, bell peppers ranked as the eighth largest fresh market vegetable in terms of production area in Kentucky with 66 hectares being grown. The majority of Kentucky peppers are grown by smaller local operators. There are two large wholesale operators in the state, located in Pulaski County and Scott County. (Saha and Hanks, 2014).

This research was directed toward an evaluation of a number of diverse pepper cultivars in Southern Kentucky. Date of harvest, total yields, weights, and numbers of harvests were examined to determine which cultivars are most suitable.

III. Materials and Methods

Thirty-six cultivars of peppers from *C. annum*, *C. chinense*, *and C. baccatum* were provided by Ball Horticultural and Pan American Seed, Elburn, Illinois. Basic information including type (hot, bell, snack) color (green, red, yellow, striped), and size (mini, snack) was provided (Table 9). Cultivars were classified into 7 groups (a, b, c, d, e, f, & g) based on the type of fruit. Numbers of cultivar within types were: (a) bell pepper (9), (b) snack peppers (5), (c) mini bell (4), (d) tapered (6), (e) jalapeno (4), (f) chili (6), and (g) habanero (2).

Research was conducted at Western Kentucky University Agriculture Research and Education Complex (AREC) in Bowling Green, Kentucky. Seedlings were sown March 22, 2016, by Ball Horticultural and Pan American Seed, Elburn, Illinois. Plants were received in plug trays from Ball Horticultural and Pan American Seed, Elburn, Illinois on April 20th, 2016(Fig. 1). Plugs were transplanted to 1020 tray cell pack inserts and grown in a temperature and humidity controlled greenhouse for 41 days (Fig. 2). The average temperature of the greenhouse ranged from 21° - 24° C during the day and 15° - 18° C at night. Data were collected at four intervals (-42, -35, -23 and -7 d) to determine plant count, height, and vigor score over the 41 day period. On days -7 and -6 (May 25th and 26th), a liquid fertilizer (20-20-20) was applied at 1:200 ppm to all plants while in the greenhouse. Study day 0 was defined as the day in which plants were transplanted to the field.

Plot Preparation

The field plot area was prepared by applying a 1% v/v glyphosate and glufosinate mixture with a backpack sprayer to burn down all present vegetation. Subsequently the plot area was tilled two separate times to a depth of 12.7 centimeters. Final plot preparation was performed by manually removing all remaining plant material and raking the soil to remove tillage ridges. Plot spacing was measured and marked by flags for each cultivar.

Twelve plants from each of the thirty-six cultivars were transplanted to the field on day 0 (May 31st). Two of the thirty-six varieties did not have twelve plants, other varieties were used as fillers to complete the block of twelve and thus equalize plant spacing. Yields or other data were not recorded for any of the filler plants. On day 0, a side dress fertilizer application of 19-19-19 was applied near the base of each plant at a rate of 5.7g per 140 cm 3 - plant row. Plants were individually hand watered until the soil appeared saturated every other day for a two-week period following transplanting. Black plastic mulch was laid around each plant and covered with organic leaf mulch to help with weed control (Fig. 3).

Harvest

Fruit harvest began on day 59 of the trial. Mature fruit was harvested approximately every seven days (study days 59, 66, 73, 80, 87, 94, 101, 108, 115, 129, 143, and 145). As the season progressed the ripening process slowed, therefore periods between harvests became longer. At the last harvest (study day 145), all fruits that had the potential of ripening were harvested. Fruit maturity was determined based on color (red, gold, and green) and size; these parameters varied for each pepper cultivar. Data were collected on total number and weight of pepper fruits produced for each cultivar row. Mean pepper weight was calculated by dividing the total weight produced for each row by the number of pepper produced in the row. Weights were taken using a AND scale, model number 7G-15KA with a precision of .000; recorded originally in pounds and later converted to grams.

Study Design and Statistical Analysis

Due to the limited numbers of available pepper plants, a one-way random design was followed. The experimental unit included 12 plants consisting of four three plant rows. Cultivars 1-30 were spaced 46 cm apart, while 31-36 were spaced 61 cm apart as recommended by Ball Seed. Rows were spaced 60 cm apart. Each row served as a sampling unit resulting in four within replications. Cultivars were grouped by pepper type. (Table 1).

Gravel Road

Cultivar 36 Group F	Cultivar 30 Group C	Cultivar 24 Group D	Cultivar 18 Group E	Cultivar 12 Group A	Cultivar 6 Group A
Cultivar 35 Group F	Cultivar 29 Group C	Cultivar 23 Group D	Cultivar 17 Group E	Cultivar 11 Group A	Cultivar 5 Group A
Cultivar 34 Group F	Cultivar 28 Group G	Cultivar 22 Group D	Cultivar 16 Group E	Cultivar 10 Group A	Cultivar 4 Group A
Cultivar 33 Group F	Cultivar 27 Group G	Cultivar 21 Group D	Cultivar 15 Group C	Cultivar 9 Group A	Cultivar 3 Group A
Cultivar 32 Group F	Cultivar 26 Group D	Cultivar 20 Group C	Cultivar 14 Group C	Cultivar 8 Group B	Cultivar 2 Group B
Cultivar 31 Group F	Cultivar 25 Group E	Cultivar 19 Group B	Cultivar 13 Group C	Cultivar 7 Group A	Cultivar 1 Group B

Table 1. Plot Diagram of Experiment

Harvest data were combined into three harvest periods (harvest period 1 included harvest at days 57, 64, 71, and 78; harvest period 2 included harvest at days 85, 92, 99, and 106; and harvest period 3 included harvest at days 113, 127, 134, and 141) for analysis. Additionally, all harvest periods were combined into total harvest. The effects of cultivar on weight of peppers produced, mean pepper weight, and number of peppers produced were evaluated in a one-way ANOVA design using the GLIMIXXED procedure in SAS (9.4). To satisfy assumptions of ANOVA and meet normality a square root transformation of the data was conducted. The fixed effect of cultivar and random effect of replication were included in the model. Treatment means were calculated using the LSMEANS option and separated with the PDIFF option using a Tukey adjustment. Significance was considered at alpha < 0.05.

IV. Results & Discussion

Pepper yields by counts and weights are presented by cultivar groups (A through G) and harvests periods (1 through 3) in Tables 2 through 8.

Group A (Bell Type, Table 2)

Data for pepper Type A is reported in Table 2. Cultivars 6 and 10 only produced peppers in 1 of the 4 replications. Harvest period 1, Cultivar 11 had a greater pepper count and more total weight as compared with cultivars 6, 7, and 10. Cultivar 3 and 4 had mean weights almost 20 times greater than cultivar 6. The reduced individual pepper weight for cultivar 6 is due to only one replication producing peppers.

Harvest period 2, cultivar 11 produced the greatest count (67 peppers) among all cultivars followed by cultivar 12 (28 peppers) with no other cultivars differing from one another (cultivar 3 = 9 peppers, cultivar 4 = 9 peppers, cultivar 5 = 12 peppers, cultivar 6 = 9 peppers, cultivar 7 = 9 peppers, cultivar 9 = 6 peppers, and cultivar 10 = 7 peppers). Cultivar 5 had a greater total weight as compared with cultivars 7, 9, 10, 11, and 12 but did not differ from cultivars 3, 4, and 6. Cultivars 3, 4, 5, 6, and 9 had a mean weight approximately 10 times greater than cultivar 11.

Harvest period 3, Cultivar 11 produced the greatest count of peppers among all cultivars; however, cultivar 11 produced the smallest individual weight per pepper compared with all other cultivars. Total weights did not differ among cultivars. The lack of differences in total weight for the harvest period indicated that cultivar 11 produced a great enough count to offset the reduced individual pepper weight.

When all harvests were totaled, cultivar 11 produced the greatest count among all cultivars. Cultivar 5 produced a total weight of almost 3 times as much as cultivar 10 (4787.4 g and 1603 g, respectively). Cultivar 5 had a greater individual pepper weight (145.2 g/pepper) as compared with cultivar 11 (22.9 g/pepper) and cultivar 12 (47.0 g/pepper), but did not differ from cultivar 3 (133.5 g/pepper), cultivar 4 (138.4 g/pepper), cultivar 6 (124.3 g/pepper), or cultivar 9 (129.3 g/pepper). Cultivars 11 and 12 were not classified as a mini bell type; however, the individual pepper weights of cultivar 11 and 12 more closely resemble the individual pepper weights of pepper type C.

Romero et al., (2001) reported a mean weight of 159 g/pepper over a two week period in Jackson Springs, North Carolina. The reported mean weight is similar to all harvest individual pepper weights of cultivars 3, 4, 5, 6, and 9; however the reported mean weight is less than the individual pepper weights for cultivars 3, 4, and 5 in harvest periods 1 and 2.

Table 2. Least Square Means for Pepper Group A[1] (Bell)

Harvest Period	Cultivar									SEM	P - value
	3	4	5	6	7	9	10	11	12		
Harvest Period 1											
Weeks 1 to 4											
Count	3^{c}	3^{c}	4^{c}	1^{c}	3^{c}	2^{c}	0^{c}	34^{a}	13^{b}	1.74	<0.01
Weight (g)	657^{ab}	560^{ab}	821^{ab}	106^{c}	382^{bc}	423^{abc}	0^{c}	926^{a}	677^{ab}	100	<0.01
LSMean Weight (g/pepper)	212.3^{a}	200.7^{a}	196.8^{a}	10.9^{cd}	144.5^{ab}	172.0^{a}	0^{d}	22.9^{cd}	50.1^{bc}	18.67	<0.01
Harvest Period 2											
Weeks 5 to 8											
Count	9^{c}	9^{c}	12^{c}	9^{c}	9^{c}	6^{c}	7^{c}	67^{a}	28^{b}	2.53	<0.01
Weight (g)	1986^{ab}	2135^{ab}	2858^{a}	2076^{ab}	1259^{b}	1168^{b}	1003^{b}	1534.1^{b}	1550.1^{b}	227	<0.01
LSMean Weight (g/pepper)	220.7^{a}	239.5^{a}	237.2^{a}	225.5^{a}	141.4^{b}	206.4^{a}	149.4^{b}	22.9^{d}	55.6^{c}	10.21	<0.01
Harvest Period 3											
Weeks 9 to 12											
Count	16^{bc}	15^{c}	16^{bc}	16^{bc}	11^{c}	11^{c}	11^{c}	51^{a}	30^{b}	4.44	<0.01
Weight (g)	1411	1352	1353	1364	943	1144	695	919	1095	328	0.43
LSMean Weight (g/pepper)	82.4^{ab}	82.3^{ab}	79.7^{ab}	79.0^{ab}	83.0^{a}	93.8^{a}	61.3^{b}	20.6^{d}	38.6^{c}	4.16	<0.01
Total of all Harvest											
Count	27^{c}	26^{c}	31^{c}	26^{c}	22^{c}	19^{c}	18^{c}	150^{a}	70^{b}	6.31	<0.01
Weight (g)	3846^{ab}	3854^{ab}	4787.4^{a}	3392^{ab}	2418^{bc}	2599^{bc}	1603^{c}	3175^{abc}	3132^{abc}	468	<0.01
LSMean Weight (g/pepper)	133.5^{a}	138.4^{a}	145.2^{a}	124.3^{ab}	105.9^{bc}	129.3^{ab}	88.1^{c}	22.9^{e}	47.0^{d}	5.65	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abcde]Least means within a row with different superscripts differ (P < 0.05).

Group B (Snack Type, Table 3)

Data for pepper Type B are reported in Table 3. Harvest period 1, no differences existed among cultivars for either count or total weight. Cultivar 1 had 15.3 g/pepper greater mean weight as compared with cultivar 19.

Harvest period 2, cultivar 2 produced at least 30 more peppers than any other cultivar. Total weight did not differ among cultivars. Cultivar 1 had a greater weight as compared with cultivar 2 but was not different than cultivar 8 or 19. The data indicates that for harvest period 2, cultivar 2 produced more peppers but had lower mean weight as compared with all other cultivars.

Harvest period 3, there was no difference in pepper count among cultivars. Cultivar 1 produced almost 900 g more total weight as compared with all the other cultivars, cultivar 1 (2050 g), cultivar 2 (869 g), cultivar 8 (1163 g), and cultivar 19 (1097 g). Cultivar 1 produced greatest mean pepper weight as compared with all other cultivars for harvest period 3.

Total pepper counts did not differ among cultivars for all harvest periods. Cultivar 1 had greater mean weight as compared with cultivar 2. Cultivar 1 produced 1777 g more weight as compared with cultivar 2. The greater total weight of cultivar 1 compared to cultivar 2 is due to the increased mean pepper weight since no differences existed for total pepper count.

Table 3. Least Square Means for Pepper Type B[1] (Snack Type)

Harvest Period	Cultivar 1	Cultivar 2	Cultivar 8	Cultivar 19	SEM	*P* - value
Harvest Period 1						
Weeks 1 to 4						
Count	20	26	34	22	5.11	0.26
Weight (g)	1433	815	1182	1236	272	0.49
LSMean Weight (g/pepper)	77.3^{a}	34.7^{c}	40.3^{bc}	62.0^{ab}	8.61	<0.01
Harvest Period 2						
Weeks 5 to 8						
Count	24^{b}	57^{a}	27^{ab}	25^{b}	7.04	0.03
Weight (g)	1635	1763	1272	1437	298	0.51
LSMean Weight (g/pepper)	56.7^{a}	27.1^{b}	42.0^{ab}	49.1^{ab}	6.07	0.03
Harvest Period 3						
Weeks 9 to 12						
Count	44	29	35	62	7.05	0.05
Weight (g)	2050^{a}	869^{b}	1163^{b}	1097^{b}	215	<0.01
LSMean Weight (g/pepper)	43.0^{a}	26.5^{b}	29.0^{b}	31.1^{b}	2.02	<0.01
Total of all Harvest						
Count	88	113	96	109	8.85	0.27
Weight (g)	5348^{a}	3571^{b}	3797^{ab}	4963^{ab}	525	0.02
LSMean Weight (g/pepper)	56.2^{a}	29.5^{c}	36.3^{bc}	42.7^{b}	3.68	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abc]Least means within a row with different superscripts differ ($P < 0.05$).

Group C (Mini Bell Type, Table 4)

Data for pepper Type C are presented in Table 4. Harvest period 1, Cultivar 13 produced the greatest pepper count as compared with all cultivars. Cultivar 20 did not produce during harvest period 1. Total weight did not differ among the cultivar that produced peppers during harvest period 1 (cultivars 13, 14, 15, 29, and 30). Cultivars 29 and 30 had a mean weight over 2 times greater than cultivar 13.

Harvest period 2, cultivar 20 produced at least 16 more peppers as compared with cultivar 15 and cultivar 14, but was not different than cultivars 13, 29, or 30. Total weight did not differ among cultivars for harvest period 2. Cultivar 13 and cultivar 20 had smaller mean pepper weights as compared with cultivar 14.

Harvest period 3, cultivar 20 produced more peppers as compared with cultivar 14, 29, and 30, but was not different from cultivar 13 and 15. Cultivar 15 produced approximately 3 times more total weight as compared with cultivar 14, but was not different from cultivars 13, 20, and 29. Cultivar 20 had a reduced mean weight as compared with cultivars 14, 15, and 29 but did not differ from cultivars 13 and 30.

Total harvest period, cultivar 20 produced approximately 4 times more peppers than cultivar 14 (86 and 22 peppers, respectively). Total weight produced did not differ among cultivars for total of all harvest. Cultivars 14, 15, and 29 had the greater mean weights as compared with cultivars 13 and 20. The consistently reduced mean pepper weight of cultivar 20 is possibly due to the cultivar being sterile (Figure 4), not producing seeds could possibly lower the weight of individual peppers.

Table 4. Least Square Means for Pepper Group C[1] (Mini Bell Type)

Harvest Period	Cultivar						SEM	P - value
	13	14	15	20	29	30		
Harvest Period 1								
Weeks 1 to 4								
Count	11^{a}	3^{b}	3^{b}	0^{c}	3^{b}	2^{bc}	0.98	<0.01
Weight (g)	800^{a}	441^{ab}	286^{ab}	0^{b}	493^{a}	436^{ab}	120	<0.01
LSMean Weight (g/pepper)	71.6^{b}	123.1^{ab}	110^{ab}	0^{c}	164.6^{a}	188.3^{a}	21.40	<0.01
Harvest Period 2								
Weeks 5 to 8								
Count	16^{ab}	6^{b}	10^{b}	26^{a}	12^{ab}	13^{ab}	2.92	<0.01
Weight (g)	1415	1096	1549	1769	1743	1935	327	0.56
LSMean Weight (g/pepper)	84.3^{c}	177.0^{a}	151.4^{ab}	69.1^{c}	141.9^{b}	153.3^{ab}	6.29	<0.01
Harvest Period 3								
Weeks 9 to 12								
Count	38^{ab}	12^{c}	33^{ab}	59^{a}	22^{bc}	28^{bc}	6.65	<0.01
Weight (g)	1415^{ab}	774^{b}	2347^{a}	1716^{ab}	1481^{ab}	1209^{b}	270	<0.01
LSMean Weight (g/pepper)	36.4^{b}	69.0^{a}	68.7^{a}	27.1^{b}	67.9^{a}	43.9^{b}	6.59	<0.01
Total of all Harvest								
Count	67^{ab}	22^{d}	46^{bc}	86^{a}	38^{cd}	43^{bcd}	6.91	<0.01
Weight (g)	3450	2146	3986	3319	3547	3381	513	0.08
LSMean Weight (g/pepper)	57.2^{bc}	109.9^{a}	93.8^{a}	43.1^{c}	103.1^{a}	86.9^{ab}	8.08	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abcd]Least means within a row with different superscripts differ ($P < 0.05$).

Group D (Tapered Type, Table 5)

Data for pepper Type D are presented in Table 5. Cultivar 26 produced at least 9 fewer peppers for harvest period 1 than all other cultivars. However, cultivars 23 and 26 did not differ in total weight. Cultivar 21 produced 17 more peppers than 26, but cultivars 21 and 26 did not differ in mean weight (43.1 g/pepper and 51.5 g/pepper, respectively). This was not expected since 21 produced the greatest number of peppers and 26 produced the least.

Harvest period 2, cultivar 23 yielded at least 50 more peppers than all other cultivars. Cultivar 23 produced approximately 2.4 times more total weight than cultivar 22, but cultivar 23 was not different than any other cultivar. Cultivar 21 and 26 had the greatest mean weight as compared with all others.

Count and total weight did not differ among cultivars for harvest period 3; however, cultivar 21 and 26 had a greater mean weight than all other cultivars. Cultivars 21 and 26 constantly, did not differ but had greater mean peppers weights than all other cultivars at all harvest periods.

Cultivar 22 and 23 produced more peppers than cultivar 26; however, cultivars 22 and 23 produced smaller peppers than any other cultivar for total harvest periods. Total weight did not differ among cultivars. Cultivars 21 and 26 had at least 8.8 g/pepper mean weight greater than all other cultivars.

Table 5. Least Square Means for Pepper Group D[1] (Tapered Type)

Harvest Period	Cultivar 21	22	23	24	26	SEM	P - value
Harvest Period 1							
Weeks 1 to 4							
Count	18^{a}	18^{a}	10^{a}	11^{a}	1^{b}	2.77	<0.01
Weight (g)	821^{a}	472^{b}	201^{cd}	378^{bc}	44^{d}	72.00	<0.01
LSMean Weight (g/pepper)	$43.1b^{a}$	25.7^{c}	20.5^{c}	34.1^{b}	51.5^{a}	1.78	<0.01
Harvest Period 2							
Weeks 5 to 8							
Count	15^{b}	25^{b}	79^{a}	29^{b}	23^{b}	8.47	<0.01
Weight (g)	690^{ab}	622^{b}	1520^{a}	907^{ab}	977^{ab}	195.00	0.04
LSMean Weight (g/pepper)	43.6^{a}	25.0^{bc}	19.6^{c}	29.8^{b}	42.0^{a}	2.07	<0.01
Harvest Period 3							
Weeks 9 to 12							
Count	62	73	74	39	39	12.21	0.05
Weight (g)	1436	1044	1041	608	892	274.00	0.15
LSMean Weight (g/pepper)	23.0^{a}	13.8^{b}	14.2^{b}	16.1^{b}	23.5^{a}	1.30	<0.01
Total of all Harvest							
Count	97^{bc}	116^{ab}	163^{a}	79^{bc}	61^{c}	17.32	<0.01
Weight (g)	3084	2258	2858	2002	2029	346	0.08
LSMean Weight (g/pepper)	31.4^{a}	19.0^{c}	17.4^{c}	24.6^{b}	32.0^{a}	1.15	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abcd]Least means within a row with different superscripts differ ($P < 0.05$).

Group E (Jalapeno Type, Table 6)

Data for pepper Type E are presented in Table 6. Harvest period 1, cultivar 17 and 18 yielded at least 31 more peppers than cultivar 25. Cultivar 18 produced 1,000g more total weight than cultivars 16 and 25. However, cultivar 18 and 25 did not differ in mean pepper weight (28.9 g/pepper and 27.1 g/pepper, respectively).

Counts did not differ among cultivars for harvest period 2. Cultivar 18 yielded 637g more total weight and had a mean pepper weight of 3.3 g/pepper greater than cultivar 17.

Harvest period 3, there were no differences for total weight yielded among cultivars. Cultivar 18 had a mean pepper weight at least 2.5 g/pepper greater than all other cultivars. Cultivar 25 produced 50 more peppers than cultivar 17; however, cultivar 17 had a greater mean weight as compared with cultivar 25.

There were no differences among pepper counts for total harvest period. Cultivar 18 yielded at least 1,804g more total weight than either cultivar 17 or 25. Cultivar 18 had the greatest total weight due to the mean weight being at least 3.3 g/pepper greater than all other cultivars.

Table 6. Least Square Means for Pepper Type E[1] (Jalapeno Type)

Harvest Period	Cultivar 16	Cultivar 17	Cultivar 18	Cultivar 25	SEM	*P* - value
Harvest Period 1						
Weeks 1 to 4						
Count	74^{ab}	93^{a}	100^{a}	62^{b}	7.09	<0.01
Weight (g)	1866^{b}	2314^{ab}	2892^{a}	1679^{b}	174	<0.01
LSMean Weight (g/pep	25.3^{bc}	24.8^{c}	28.9^{a}	27.1^{ab}	0.66	<0.01
Harvest Period 2						
Weeks 5 to 8						
Count	44	41	60	56	5.99	0.12
Weight (g)	989^{ab}	925^{b}	1562^{a}	1092^{ab}	144	0.04
LSMean Weight (g/pep	22.3^{b}	22.5^{b}	25.8^{a}	19.5^{c}	0.5	<0.01
Harvest Period 3						
Weeks 9 to 12						
Count	134^{ab}	99^{b}	115^{ab}	149^{a}	9.42	0.02
Weight (g)	2467	1829	2401	2223	198	0.15
LSMean Weight (g/pep	19.1^{b}	19.1^{b}	21.6^{a}	15.6^{c}	0.76	<0.01
Total of all harvests						
Count	252	233	274	266	15.1	0.29
Weight (g)	5336^{ab}	5069^{b}	6873^{a}	4995^{b}	353	0.01
LSMean Weight (g/pep	21.3^{b}	21.8^{b}	25.1^{a}	18.9^{c}	0.43	<0.01

[1] Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abc] Least means within a row with different superscripts differ ($P < 0.05$).

Group F (Chili Type, Table 7)

Data for pepper Type F are presented in Table 7. Harvest period 1, cultivar 31 had a greater pepper count as compared with all other cultivars. Cultivars 31 and 34 did not differ in weight (182 g and 75.4 g, respectively); however, cultivar 31 was greater than all other cultivars. Mean weight did not differ among cultivars in harvest period 1. The differences reported are possibly due to cultivar 31 producing peppers in all 4 replications; whereas, other cultivars had 2 or more replications that did not produce any peppers.

Cultivar 36 had the greatest count and weight as compared with all other cultivars in harvest period 2. Cultivar 36 had a mean pepper weight greater than cultivar 33 but was not different when compared with any other cultivar.

Harvest period 3, cultivars 31 and 34 yielded at minimum 43 more peppers than any other cultivar. However, cultivar 34 yielded 1,198g more total weight as compared with cultivar 31. This is due to cultivar 34 having a 7.1 g/pepper greater mean weight as compared with cultivar 31.

Cultivars 31, 34, and 36 had greater counts as compared to all other cultivars for total harvest periods. Cultivars 31, 34, and 36 did not differ in total weight produced; however, cultivar 34 and 36 had a greater mean weight as compared with cultivar 31.

Table 7. Least Square Means for Pepper Group F[1] (Chili Type)

Harvest Period	Cultivar						SEM	P - value
	31	32	33	34	35	36		
Harvest Period 1								
Weeks 1 to 4								
Count	9^{a}	1^{b}	0^{b}	2^{b}	0^{b}	1^{b}	1.33	<0.01
Weight (g)	182^{a}	18.1^{b}	0^{b}	75.4^{ab}	5.6^{b}	22.3^{b}	26	<0.01
LSMean Weight (g/pepper)	24.9	9.6	0	11.9	5.4	5.4	5.87	0.11
Harvest Period 2								
Weeks 5 to 8								
Count	67^{b}	39^{c}	33^{cd}	20^{d}	49^{cd}	99^{a}	6.72	<0.01
Weight (g)	1086^{b}	809^{bc}	500^{c}	466^{c}	639^{c}	2017^{a}	120	<0.01
LSMean Weight (g/pepper)	16.6^{cd}	21.1^{ab}	16.5^{d}	23.7^{a}	17.4^{bcd}	20.6^{abc}	1	<0.01
Harvest Period 3								
Weeks 9 to 12								
Count	122^{a}	60^{b}	62^{b}	135^{a}	61^{b}	79^{b}	13.4	<0.01
Weight (g)	1226^{b}	1018^{bc}	1029^{bc}	2424^{a}	616^{c}	896^{bc}	224	<0.01
LSMean Weight (g/pepper)	10.9^{b}	18.3^{a}	17.9^{a}	18.0^{a}	12.2^{b}	12.7^{b}	0.88	<0.01
Total of all harvest								
Count	197^{a}	99^{b}	93^{b}	157^{a}	98^{b}	176^{a}	17.8	<0.01
Weight (g)	2453^{ab}	1831^{bc}	1529^{c}	2961^{a}	1256^{c}	2862^{a}	288	<0.01
LSMean Weight (g/pepper)	13.0^{c}	19.3^{a}	17.5^{ab}	19.0^{ab}	14.1^{c}	16.7^{b}	0.71	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[abcd]Least means within a row with different superscripts differ ($P < 0.05$).

Group G (Habanero Type, Table 8)

Data for pepper Type G are presented in Table 8. Harvest period 1 cultivar 28 produced more peppers than cultivar 27 (17 peppers and 4 peppers, respectively). Mean pepper weights did not differ between cultivars 27 and 28 (15.7 g/pepper and 18.6 g/pepper, respectively). Therefore, a difference in total yield between cultivars 27 and 28 was expected for period one.

Harvest period 2, count and weight did not differ between cultivars 27 and 28; however, cultivar 28 had a greater mean weight as compared with cultivar 27 (15.4g/pepper and 11.5g/pepper, respectively). The mean weight difference was not great enough to cause a difference in total weight.

Harvest period 3, there was no difference among count, total weight, or mean weight between cultivar 27 and 28.

Total of all harvest periods, count and weight did not differ between cultivars 27 and 28; however, cultivar 28 had a greater mean weight as compared with cultivar 27 (13.7g/pepper and 10.9g/pepper, respectively).

Manju and Sreelathakumary (2002) reported a mean weight of 5.02 g ± 0.15 SEM for habanero peppers grown in Kerala, India for peppers over 4 harvest periods. The reported pepper weight is approximately half the mean weight of habanero peppers (type G) produced in this study.

Table 8. Least Square Means for Pepper Group G[1] (Habanero Type)

Harvest Period	Cultivar 27	Cultivar 28	SEM	*P* - value
Harvest Period 1				
Weeks 1 to 4				
Count	4^{b}	17^{a}	1.45	<0.01
Weight (g)	82.4^{b}	310^{a}	13.60	<0.01
LSMean Weight (g/pepper)	15.7	18.6	1.06	0.12
Harvest Period 2				
Weeks 5 to 8				
Count	197	159	20.05	0.26
Weight (g)	2261	2457	265.00	0.62
LSMean Weight (g/pepper)	11.5^{b}	15.4^{a}	0.18	<0.01
Harvest Period 3				
Weeks 9 to 12				
Count	83	90	5.46	0.38
Weight (g)	725	852	80.00	0.31
LSMean Weight (g/pepper)	8.7	9.4	0.56	0.42
Total of all harvests				
Count	286	268	16.31	0.48
Weight (g)	3073	3629	259.10	0.19
LSMean Weight (g/pepper)	10.9^{b}	13.7^{a}	0.32	<0.01

[1]Data were analyzed using a square root of (x + 1) transformation due to failure of normality.

[ab]Least means within a row with different superscripts differ ($P < 0.05$).

V. Conclusion

In this study the focus was on yield, weight, and mean weights of 36 different cultivars of peppers when grown in South Central Kentucky. Although each group of peppers differs in shape, size, and weight we can compare them based on yield. Group G (Habanero Type) produced the highest yield out of all of the groups. There were significant differences in fruit size, appearance, and maturity, in terms of color, across the groups analyzed. The most successful cultivar is determined by the producer or consumer based on desired characteristics.

For producers seeking a larger pepper for fresh market production cultivars: 5 (Bell), 1 (Snack), 15 (Mini bell), 21 (Tapered), 18 (Jalapeno), 34 (Chili), and 28 (Habanero) would be ideal. If a higher yield is desired than cultivars: 11 (Bell), 2 (Snack), 20 (Mini bell), 23 (Tapered), 18 (Jalapeno), 31 (Chili), and 27 (Habanero) ranked highest (Tables 2-8).

Literature Cited

Bessin, R. (2003). Common Insects Attacking Peppers. University of Kentucky Cooperative Extension. ENTFACT-301

Bosland, P., and E. Votava (2012). Peppers Vegetable and Spice Capsicums (2nd ed.).

Boucher, J. (2012) Pepper IPM: Aphids. http://ipm.uconn.edu/documents/raw2/Pepper%20IPM%20Aphids/Pepper%20IPM%20Aphids.php?aid=59

Capinera, J. (2017). Featured Creatures: Beet armyworm. Publication number: EENY-105. http://entnemdept.ufl.edu/creatures/veg/leaf/beet_armyworm.htm

Decoteau, D. and H. Graham (1994). "Plant spatial arrangement affects growth, yield, and pod distribution of cayenne peppers." HortScience 29(3): 149-151.

Dorland, R. and F. W. Went (1947). "Plant Growth Under Controlled Conditions, VIII. Growth and Fruiting of the Chili Pepper." American Journal of Botany 34(8): 393-401.

Dufault, R., and N. Doubrava (April 2003). Pepper. Clemson University Cooperative Extension.

Fereira, J. (2008, November). U.S. Bell and Chile Pepper Statistics. Retrieved February, 2017, from http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1659

Fernandez, M. D., M. Gallardo, S. Bonachela, F. Orgaz, R. Thompson, and E. Fereres (1998). "Water use and production of a greenhouse pepper crop under optimum and limited water supply." Journal of horticulture science and biotechnology. 80(1): 87-96

Flint, M. (2014) Lady Bugs need special care to control aphids in the garden. https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=13933

Hazzard, R., Dowling, Z., and B. Dicklow (2012) Peppers: Biological control of European corn borer, and increasing incidence of anthracnose. http://ag.umass.edu/vegetable/outreach-project/peppers-biological-control-of-european-corn-borer-increasing-incidence-of

Hemphill, D. (2010, February). "Fresh Market Vegetable Production, Peppers." from http://horticulture.oregonstate.edu/content/peppers-0.

ITRC. (1996). Row crop drip irrigation on peppers study – High Rise Farms. ITRC Report No. R 96-001

Jones, T., R. Bessin, J. Strang, B. Rowell, and D. Spalding (2000). Kentucky Pepper Integrated Crop Management. (IPM-13) Cooperative Extension Service.

Jovicich, E., D. Cantliffe, S. Sargent, L. Osborne (2003). "Production of greenhouse-grown peppers in florida." HS979

Jovicich, E., D. Cantliffe, P. Stoffella (2004). "Fruit yield and quality of greenhouse-grown bell peppers as influenced by density, container, and trellis system." HortTechnology 14(4): 507-513

Jovicich, E., D. Cantliffe, J. VanSickle, P. Stoffella (2005). “Greenhouse-grown colored peppers: a profitable alternative for vegetable production in florida.” HortTechnology 15(2) 355-369

Kaiser, C., and M. Ernst (2014). Hot Peppers and Specialty Sweet Peppers. University of Kentucky Cooperative Extension. Center for Crop Diversification Crop Profile (CCD-CP-101).

Manju, P. R. and I. Sreelathakumary (2002). "Genetic variability, heritability and genetic advance in hot chilli (capsicum chinense jacq.)." Journal of Tropical Agriculture **40**: 4-6.

Massachusetts, University of (2013). Growing peppers in the home garden.

McMahon, M., A. Kofranek, and V. Rubatzky (2007). Hartmann's Plant Science: Growth, Development, and Utilization of Cultivated Plants (4th ed.). Columbus, Ohio: Pearson Prentice Hall.

Orzolek, M., L. Kime, S. Bogash, J. Harper, and R. Harsh (2010). Agricultural Alternatives: Pepper Production. University Park, PA: Publications Distribution Center, The Pennsylvania State University.

Roberts, P., K. Pernezny, and T. Kucharek (2015). Anthracnose on pepper in Florida. PP-178. http://edis.ifas.ufl.edu/pdffiles/PP/PP10400.pdf

Romero, A., C. Kousik, D. Ritchie (2001). "Resistance to bacterial spot in bell pepper induced by acibenzolar-*s*-methyl." The American Phytopathological Society **85**(2): 189-194.

Saha, S. K., and L. Hank (2014). Midwest Vegetable Trial Report: Kentucky Bell Pepper Variety Trial.

Sezen, S., A. Yazar, and S. Eker Effect of drip irrigation regimes on yield and quality of field grown bell pepper. In: Water saving in Mediterranean agriculture and future research needs [Vol. 1]. Bari: CIHEAM, 2007. p.261-276

United States Department of Agriculture. (2016, April 29). Retrieved February, 2017, from https://www.nass.usda.gov/Statistics_by_Subject/result.php?CA81FA26-B918-3AB2-8396-7A3B2C04E0C4§or=CROPS&group=VEGETABLES&comm=PEPPERS

Waterer, D. (2003). Yields and economics of high tunnels for production of warm-season vegetable crops. HortTechnology 13(2): 339-343.

Wells, O. and B. Loy (1993). "Rowcovers and high tunnels enhance crop production in the northeastern united states." HortTechnology 3(1): 92-95.

Youngman, R. and E. Day (2009) VCE Publication: European corn borer. 444-232

Zandstra, B., C. Stephens, and E. Grafius (1985). Peppers: Commercial Vegetable Recommendations (E1815).

Fig. 1 Plug trays received from Ball Horticultural & Pan American Seed Company.

Fig. 2 Plants after transplanting in greenhouse at WKU AREC.

Fig. 3 View of plot at WKU AREC.

Fig. 4 Cultivar 20 note the lack of seeds produced.

Cultivar	Ball #	Type	Prefix/Name
1	5485	B	Cute Stuff Red
2	5484	B	Cupid
3	5483	A	SBGR
4	5482	A	SBGR
5	5481	A	Paladin
6	5480	A	Intruder
7	5479	A	Better Belle II
8	5487	B	SBGR
9	5488	A	Summer Sweet
10	5489	A	SBGY-a
11	5490	A	Eros
12	5491	A	SBGY
13	5493	C	Carmen
14	5494	C	Sweet Delilah
15	5495	C	STGY
16	5504	E	La Bomba II
17	5505	E	HTGR
18	5506	E	HTGR
19	5486	B	SBGR
20	5498	C	STGR
21	5499	D	STTGR
22	5500	D	STCS
23	5497	D	Sweetie Mix
24	5501	D	STTGC
25	5503	E	Centella
26	5502	D	STTGC
27	5513	G	Helios
28	5514	G	CH
29	5492	C	Cortes
30	5496	C	STGR
31	5510	F	BH
32	5511	F	BS
33	5509	F	BH
34	5512	F	BS
35	5507	F	Aji Crystal
36	5508	F	BH

Table 9. Cultivars utilized in the experiment.