2018 Vegetable Trial Report

January 2019

MP-164.9

Department of Horticulture and Landscape Architecture
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

The Department of Horticulture and Landscape Architecture, cooperating departments and experimental farms conducted a series of experiments on field vegetable production. Data were recorded on a majority of aspects of each study, and can include crop culture, crop responses and yield data. This report presents those data, thus providing up-to-date information on field research completed in Oklahoma during 2018.

Small differences should not be overemphasized. Least significant differences (LSD) values are shown at the bottom of columns or are given as Duncan's letter groupings in most tables. Unless two values in a column differ by at least the LSD shown, or by the Duncan's grouping, little confidence can be placed in the superiority of one treatment over another.

When trade names are used, no endorsement of that product or criticism of similar products not named is intended.

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Crop Culture

Bio-Intensive Cover Cropping for Soil Improvement

Cimarron Valley Research Station
Lynn Brandenberger, Lynda Carrier, Hailin Zhang, and Josh Massey

Oklahoma State University

Introduction and Objectives: Soil health is critical for the continued productivity of production soils in the vegetable industry. One aspect of soil health is the level of organic matter contained in field soils. Often within the state soil organic matter may be well below 1% (0.5 to 0.7%). Organic matter in soils is critical because of its effect on nutrient stabilization, water availability, tilth, crop establishment, and crop dependence on the soil for rooting and growth. States in the southern plains like Oklahoma have a warm season that is several months longer than in the northern plains. The result of all the warm weather is that the soil microbes that break down organic matter have more time to work. This coupled with clean-tillage systems which speed up microbial activity and which are predominant in vegetable farming adds to the reduction of soil organic matter. Organic matter can be added to soil in a number of ways including compost, manure, organic fertilizers, etc. Some of the issues associated with these sources of organic matter obviously include availability and cost, but also may include the potential for food-borne disease. As an alternative, cover crops can be thought of as a "Grow in Place" source of organic matter with a much lower potential for contamination of fresh produce. Cover crops have an added advantage in that they protect the soil from erosion and can reduce available weed-seeds by shading out weed populations. The objective of this long-term study (5 year) is to compare three different cover crop regimens to a clean fallow system to determine each treatment's effect on soil organic matter levels and crop responses to them.

Materials and Methods: The study area was divided into four different areas (each area is 90' x 330') within the fenced vegetable area at the Cimarron Valley Research Station. Three of the areas will follow a specific cover crop practices and the fourth area will be maintained as a fallow area when not planted to crops. The three cover crop and fallow areas are:

Treatment area # 1 cover crop combinations:

a. Cool season: Cereal rye + Crimson clover
b. Warm season: Sorghum-Sudan + Cowpea

Treatment area # 2 cover crop combinations:

a. Cool season: Wheat + Crimson clover
b. Warm season: Forage cowpea

Treatment area # 3 cover crop combinations:

a. Cool season: Cereal rye + Austrian winter pea + Tillage radish
b. Warm season: Pearl millet + Forage cowpea

Treatment area #4 fallow treatment:

a. Both cool and warm seasons will consist of clean fallow using either tillage, mowing, with some postemergence herbicides to maintain the area when not planted to crops.

Each area will be utilized for vegetable crop research plots and will be rotated between summer and winter cover crops each year. This would mean that if a vegetable crop is not being grown in a given area there will be a cover crop growing on any open land within the three cover crop areas. Replicated soil samples (3 samples) were collected from each area this past fall and

sampling will continue each year for the duration of the study. Soil sample results include pH, N-P-K, and percent organic matter.

Results: Soil pH ranged from 6.1 in the fallow section to 6.6 in section one (Table 1). Section one had the highest soil pH with 6.6 and the fourth section was lowest at 6.1. Although there were differences, in general all sections had a soil pH that shouldn't result in nutrient availability issues.

Both nitrogen and phosphorus were generally low, nitrogen ranging from approximately 9 to 24 lbs. per acre and phosphorus ranging from approximately 21 to 32 lbs. per acre (Table 1). Although there were differences between sections for these nutrients those differences were not large and each section would benefit from the addition of nitrogen and phosphorus. Potassium levels ranged from 429 to 534 lbs. per acre. Section four had the highest level of potassium at 534 lbs. per acre, but even section three which had 429 lbs. per acre would be considered adequate for most vegetable crops.

Organic matter ranged from 1.7% for section three to 2.0 and 2.2%, respectively, for sections one and four (Table 1). Both sections one and four had the highest levels of organic matter which is interesting from the standpoint that section four is the fallow only section with no cover crops. It's likely that there is some organic matter carryover from the Bermuda grass cover that was part of this section prior to fencing the vegetable area.

Conclusions: After this year the coauthors determined that it would benefit the project if a graduate student were involved that could investigate additional aspects to the study including a more complete sampling procedure and measurements on compaction and water infiltration rates. It will be interesting to see how things develop regarding both fertility and organic matter in the different sections and the authors look forward to observing other aspects of soil quality as the study continues.

Acknowledgements: The authors would like to thank the staff at the Cimarron Valley Experiment station for assistance with this study.

Table1. 2018 Soil sample results, Cimarron Valley Research Station, Perkins, OK

		lbs./acre			%
Section	**pH**	**Nitrogen**	**Phosphorus**	**Potassium**	**Organic matter**
1	6.6 a[z]	9.0 c	27.7 a	473 ab	2.0 ab
2	6.4 b	24.0 a	21.3 b	494 ab	1.9 bc
3	6.2 c	12.0 b	20.3 b	429 b	1.7 c
4	6.1 c	21.7 a	31.7 a	534 a	2.2 a

[z]Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1.

Section 1 Warm Season
Sorgum Sudan + Forage cowpea

Section 2 Warm Season
Forage cowpea

Section 3 Warm Season
Pearl Millet +Forage cowpea

Section 4 Warm Season
Fallow

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Cabbage Cultivar Trial - Perkins

Cimarron Valley Research Station
Lynn Brandenberger, Lynda Carrier, Joshua Massey
Oklahoma State University

Introduction: Cabbage is an important crop for fresh market vegetable farms in Oklahoma. Cabbage and other brassica heading crops (broccoli, cauliflower, etc.) can be grown both in the spring and early fall growing seasons.

Methods and Materials: The cabbage trial included 8 varieties of green cabbage. The trial was transplanted on March 30th from transplants started on February 26th. The system for growing the trial included free-standing raised beds with a single drip irrigation line/bed installed using a bedder-shaper, with no plastic mulch. Cover crop was left between the rows of cabbage and consisted of winter wheat plus crimson clover. The trial was organized in a randomized block design with four replications. Each plot included 12 transplants arranged in staggered double-rows with six transplants per row and 1.5 feet between transplants in their respective row. Weed control for the trial consisted of a preemergence herbicide (Spartan Charge) applied prior to transplanting and hand-hoeing/weeding. The trial was hand hoed two times during the season. Fertility for the trial was based upon soil test results that called for the application of nitrogen fertilizer only. Nitrogen was applied through the drip irrigation system utilizing urea (46-0-0) as our nitrogen source and the total amount applied was 102 lbs. of actual nitrogen per acre. Management of insect pests included scouting and the application of approved insecticides for control primarily of cabbage looper.

Trial Conditions: We observed that the cover crop strips helped considerably by providing wind protection during the growing season. The field that contained the trial experienced a low temperature event of 24oF on 4/7/18 which was one week after transplanting with proceeding low temperatures in the high 20's to high 30's. This "hard" freeze severely damaged the cabbage in the trial and in fact at one point plowing up the trial was considered. Following this freeze the trial began to recover about two weeks after the freeze, recovering sufficiently to complete the trial. In general the trial was successful with several cultivars that performed well. There was some insect damage from cabbage looper on plants in the trial.

Harvest Data: Actual days to harvest ranged from 77 to 82 days in the trial (Table 1). Artost had the lowest number of days to harvest (77) of all cultivars in the trial and was followed by Blue Vantage, Charmant, Escazu, and Pennant all of which recorded 80 days from transplanting to harvest. Other cultivars recorded 82 days to harvest (Bronco and Gallican). Varieties did not vary significantly for number of marketable heads of cabbage. Artost had the highest number of heads with 7,895 followed by Charmant with 7,351 heads of cabbage per acre. Average weight per head was highest for Gallican (3.7 lbs./head) followed by Artost and Pennant with 3.4 and 3.1 lbs./head, respectively. Marketable yield did not vary significantly, but ranged from a low of 17,451 lbs./acre to a high of 26,980 lbs./acre. The three highest marketable yields recorded were from Artost, Blue Vantage, and Pennant which produced 26,980, 21,780, and 20,854 lbs./acre, respectively. Non-marketable yields were lowest for Pennant and Artost which produced 545 and 817 lbs./acre of cull heads, respectively.

Quality Results: Data collected for head quality included internal core length, height and diameter of heads, compactness and sweetness ratings (Table 2). Compactness ratings were on a 1 to 5 scale with 1 representing a loose and puffy head and 5 indicated heads that were

solid and compact. Sweetness ratings were also on a 1 to 5 scale with 1 representing bitter-poor tasting cabbage and 5 representing very sweet tasting cabbage.

Core length was measured in inches and shorter core lengths are considered desirable. Core length ranged from a low of 3.0 inches for Gallican to a high of 3.8 inches for Escazu. Head height and diameter play a part in determining the shape of heads of cabbage, all cabbage in the trial had higher head heights than diameters. Escazu had the highest average head height (10.7 inches) compared to several other varieties while Charmant had the shortest head height (9.2 inches). Several varieties had head heights higher than 10 inches, these included Artost (10.2 inches), Gallican (10.5 inches), and Pennant (10.6 inches). Head diameter was measured in inches from side to side on cut cabbage at the widest point of measured heads. Head diameters were widest for Escazu and Pennant which had 7.2, and 7.0 inches average, respectively. The remaining varieties ranged from 5.9 to 6.8 inches in diameter with Artost, Blue Vantage, and Gallican having head diameters of 6.8, 6.3, and 6.7 inches, respectively. Compactness of cabbage heads is a measure of maturity. Compactness ranged from a low of 1.3 (Escazu) to a high of 4.6 (Bronco) with two other varieties having compactness ratings of 4.0 (Charmant) and 3.5 (Artost) out of a possible 5.0. Sweetness ratings ranged from a low of 2.9 for Escazu to a high of 4.5 for Charmant, both Charmant and Gallican had sweetness ratings that were 4.0 or higher. Seed company comments about each cultivar are summarized in Table 3.

Conclusions: Generally crop damage from the April hard-freeze was extensive with most plants having dead leaves into the growing point and several also had some damage to their growing points. The fact that a majority of plants recovered and produced a marketable harvest proves that cabbage is one of the toughest and resilient of brassica head crops. Each of the varieties in this year's trial were also in the 2017 trial. When comparing between the two years the average yield in 2018 was approximately 77% of what it was in 2017, not considering what occurred that's not great, but under the circumstances not bad. The reader should also consider that there were easily two weeks of time lost to the damage incurred from the freeze, providing some explanation for the poor performance of longer season varieties. The highest yielding cabbage Artost was also the earliest (77 days), sweetness ratings were highest for Charmant and Gallican. In conclusion, the authors want to caution farmers that these results are only from one season and further on-farm trialing would be advisable for cabbage growers prior to settling on cultivars to use in their operations.

Acknowledgements: The authors wish to thank personnel from the Cimarron Valley Research Station for their help and assistance in completing this trial and also wish to thank seed companies for supplying seed for this trial and Micah Anderson helping us transplant the trial.

Table 1. 2018 Spring Cabbage Variety Trial, Marketable Yield data, Perkins, OK.

				Pounds		
Cultivar	**Seed Source**	**Days to Harvest**	**Count (no./acre)**	**Avg. wt./head**	**Marketable Yield/acre**	**Non market[z] Yield/acre**
Artost	Seedway/Bejo	77	7,895 a[y]	3.4 ab	26,980 a	817 b
Blue Vantage	Twilley	80	7,079 a	2.9 b	21,780 a	2,532 ab
Bronco	Seedway/Bejo	82	7,079 a	2.9 b	19,248 a	2,505 ab
Charmant	Sakata	80	7,351 a	2.8 b	20,718 a	2,205 ab
Escazu	Syngenta	80	5,990 a	3.0 b	17,451 a	1,443 ab
Gallican	Syngenta	82	5,445 a	3.7 a	19,956 a	4,274 a
Pennant	Syngenta	80	6,806 a	3.1 ab	20,854 a	545 b

[z] Non market= Heads weighing less than 1.5 lbs., doubles, and brown interior color.
[y] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 2. 2018 Spring Cabbage Variety Trial, Cabbage Quality data, Perkins, OK.

		Head measurements in inches				
Cultivar	**Seed Source**	**Core length[z]**	**Height[y]**	**Diameter[x]**	**Compactness[w]**	**Sweetness[v]**
Artost	Seedway/Bejo	3.5 ab[u]	10.2 abc	6.8 ab	3.5 b	3.5 c
Blue Vantage	Twilley	3.4 abc	9.9 bcd	6.3 bc	2.4 c	3.6 c
Bronco	Seedway/Bejo	3.4 abc	9.8 cd	5.9 c	4.6 a	3.6 c
Charmant	Sakata	3.2 bc	9.2 d	6.1 c	4.0 ab	4.5 a
Escazu	Syngenta	3.8 a	10.7 a	7.2 a	1.3 d	2.9 d
Gallican	Syngenta	3.0 c	10.5 abc	6.7 ab	2.8 c	4.0 b
Pennant	Syngenta	3.5 abc	10.6 ab	7.0 a	1.8 d	3.1 d

[z] Core length=measurement from center cut, length of growing point (core)
[y] Height is measured from top of head (outer wrapper leaves removed) to base of trimmed butt.
[x] Diameter distance across a cut cabbage side to side.
[w] Compactness Scale is 1=loose and puffy to 5=solid and compact.
[v] Sweetness rating scale 1-5, 5=very sweet, 1=bitter, poor flavor.
[u] Numbers in a column and type section (Green, Red, Savoy) followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 3. Seed company notes for 2018 Cabbage Variety Trials				
Variety	**Company**	**type**	**Days to harvest**	**Descriptions from Seed Companies**
Artost	Seedway/bejo	green	68	Uniform with excellent density and holding ability. Good yields; cut early for a boxed cabbage or later for slaw. Adapted to most growing regions of the US and Canada. Replaces Morris.
Blue Vantage	Twilley	green	72	Mid-season maturity with large, dense heads which are short cored. 3.5 - 4 lbs. Fusarium yellows race 1 resistant and tip-burn tolerant. Ideal for fresh and coleslaw markets In Texas, it is a standard variety for long-distance shipping.
Bronco	Seedway/bejo	green	80	Very fancy, heads protected by waxy leaves. Nice sweet flavor. Excellent yields, shipping quality, and disease resistance. Heads stay small enough for boxing.
Capture	Seedway/bejo	green	85	An excellent choice if you need large, flavorful heads for slaw. When grown at high density, attractive heads for fresh market boxing. Very strong black rot resistance and widely-adapted, including the South. **LATE Not included in data due to very small heads**
Charmant	Sakata	green	65	Uniform, solid, medium-sized round heads 2.5 - 3 lbs. with blue-green color, a tight internal structure and a short core. Has holding ability in early-market. Resistant to Fusarium yellows race 1 Fresh mkt, for processing and shipping
Escazu	Syngenta	green	98	Yield and high quality heads. Beautiful blue-green leaves wrap around 3-5 lb., 7-8" round heads.
Gallican	Syngenta	green	73	Early maturing, uniform plants with tolerance to environmental stresses. High yields, good field holding ability. Medium frame plant produces 6.5" round heads with green wrappers.
Pennant	Syngenta	green	88	Noted for its wide adaption, holding ability helps maximize its potential. Heads boast excellent interior quality, sweet flavor and tolerance to tip burn. Medium frame plant produces large 8" heads with blue-green wrappers.

Figure 1. Spring 2018 cabbage trial, photos of interior cut of cabbage varieties.

Artost

Charmant

Blue Vantage

Escazu

Bronco

Gallican

Capture (Langston)

Pennant

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Cabbage Cultivar Trial - Langston

Micah Anderson, Eric McHenry
Langston University
In Cooperation with
Oklahoma State University

Introduction: Cabbage is an important crop for fresh market vegetable farms in Oklahoma. Cabbage and other brassica heading crops (broccoli, cauliflower, etc.) can be grown both in the spring and early fall growing seasons.

Methods and Materials: The cabbage trial included 7 different green varieties. The trial was transplanted on April 4th from transplants started on February 26th. The system for growing the trial included free-standing raised beds with a single drip irrigation line/bed installed using a bedder-shaper, with no plastic mulch. Cover crop was left between the rows of cabbage and consisted of winter wheat plus crimson clover. The trial was organized in a randomized block design with three replications. Each plot included 12 transplants arranged in staggered double-rows with six transplants per row and 1.5 feet between transplants in their respective row. Weed control for the trial consisted of a preemergence herbicide (Prefar) applied prior to transplanting and hand-hoeing/weeding. The trial was hand hoed twice during the season. Fertility for the trial was based upon soil test results that called for the application of nitrogen only. Nitrogen was applied through the drip irrigation system utilizing urea (20-20-20) as our nitrogen source and the total amount applied was 200 lbs. of actual nitrogen per acre. Management of insect pests included scouting and the application of approved insecticides for control primarily of cabbage looper.

Yield Results: There were no differences observed between varieties for the number of marketable heads of cabbage, but the number of heads ranged from a low of 7,079 (Bronco) to a high of 10,346 for both Escazu and Gallican (Table 1). Average weight of heads of cabbage varied from a low of 2.2 lbs. to a high of 3.4 lbs. Bronco had the largest heads at 3.4 lbs. and both Escazu and Pennant recorded average head weights of 2.7 lbs. Marketable yield per acre ranged from a low of 16,480 lbs. for Blue Vantage to a high of 27,987 lbs. Escazu. Other varieties ranged from a low of 23,159 lbs. (Pennant) to a high of 26,987 lbs. for Gallican. Non-marketable yield ranged from a low of zero for Bronco to 3,340 lbs. for Blue Vantage.

Quality Results: Data that was collected related to quality included compactness, internal core length in heads, height and diameter of heads, and a sweetness rating based on tasting each cultivar. Gallican had the shortest core length 2.7 inches while Bronco had the longest core length of 3.8 inches (Table 2). Other core lengths ranged from a low of 2.8 (Pennant, Blue Vantage) to a high of 3.1 inches for Artost and Charmant. No major differences were observed for head height, but they ranged from 9.2 to 10.2 inches. Head diameters did not vary, but ranged from 5.5 to 6.4 inches. Escazu recorded the largest head diameter at 6.4 inches while Blue Vantage had the smallest at 5.5 inches. Compactness ratings were on a 1 to 5 basis with 1 representing a loose or puffy head interior and 5 representing a solid and compact head. No major difference in compactness were recorded, but they ranged from 2.8 for Gallican to a high of 3.7 for Bronco. Sweetness ratings were also on a 1 to 5 basis with 1 representing very bitter taste and 5 representing very sweet. There were significant differences in taste between the varieties. Gallican and Charmant were the sweetest varieties with sweetness ratings of 4.0 and 3.9, respectively. The least sweet varieties included Escazu and Pennant which had ratings of 2.9 and 3.0, respectively.

Conclusions: Seed company comments about each cultivar are summarized in Table 3. The highest yielding cabbage Escazu was also the latest (83 days) and the least sweet (2.9 sweetness rating). Regarding sweetness ratings, Gallican had the sweetest heads in the trial with a sweetness rating of 4.0 compared to other varieties that were lower. In conclusion, the authors want to caution farmers that these results are only from one season and further on-farm trialing would be advisable for cabbage growers prior to settling on cultivars to use in their operations. Figure 1 included photos of each variety even Capture which was not included in the harvest data due to very small size from being very late maturing.

Acknowledgements: The authors wish to thank Dr. Lester Clark for allowing us to use space on his farm for this year's cabbage trial. We also wish to thank seed companies for supplying seed for this trial.

Table 1. 2018 Spring Cabbage Variety Trial, Marketable Yield data Langston, OK.

				lbs		
Cultivar	**Seed Source**	**Days to Harvest**	**Count (no./acre)**	**Avg. wt./head**	**Marketable Yield/acre**	**Non market[z] Yield/acre**
Artost	Seedway/Bejo	69[y]	9,438 a	2.5 ab	24,031 a	1,706 ab
Blue Vantage	Twilley	69	7,260 a	2.2 b	16,480 a	3,340 a
Bronco	Seedway/Bejo	83	7,079 a	3.4 a	25,047 a	0 b
Charmant	Sakata	69	9,438 a	2.5 ab	23,595 a	1,379 ab
Escazu	Syngenta	83	10,346 a	2.7 ab	27,987 a	599 ab
Gallican	Syngenta	69	10,346 a	2.6 ab	26,735 a	762 ab
Pennant	Syngenta	83	8,712 a	2.7 ab	23,159 a	1,634 ab

[z] Non market= Heads weighing less than 1.5 lbs., doubles, and brown interior color.
[y]Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 2. 2018 Spring Cabbage Variety Trial, Cabbage Quality data, Langston, OK.

		Head measurements in inches				
Cultivar	**Seed Source**	**Core length[z]**	**Height[y]**	**Diameter[x]**	**Compactness[w]**	**Sweetness[v]**
Artost	Seedway/Bejo	3.1 b	9.2 a	6.1 a	3.3 a	3.6 ab
Blue Vantage	Twilley	2.8 b	9.2 a	5.5 a	3.6 a	3.4 ab
Bronco	Seedway/Bejo	3.8 a	10.2 a	6.3 a	3.7 a	3.4 ab
Charmant	Sakata	3.1 b	9.0 a	5.8 a	3.9 a	3.9 a
Escazu	Syngenta	3.0 b	10.0 a	6.4 a	3.0 a	2.9 b
Gallican	Syngenta	2.7 b	9.5 a	6.1 a	2.8 a	4.0 a
Pennant	Syngenta	2.8 b	9.5 a	6.1 a	3.1 a	3.0 b

[z] Core length=measurement from center cut, length of growing point (core)
[y] Height is measured from top of head (outer wrapper leaves removed) to base of trimmed butt.
[x] Diameter distance across a cut cabbage side to side.
[w] Compactness Scale is 1=loose and puffy to 5=solid and compact.
[v] Sweetness rating scale 1-5, 5=very sweet, 1=bitter, poor flavor.
[u] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. Internal quality of cabbage varieties

Artost

Charmant

Blue Vantage

Escazu

Bronco

Gallican

Capture

Pennant

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Cauliflower Cultivar Trial - Perkins

Cimarron Valley Research Station
Lynn Brandenberger, Lynda Carrier, Joshua Massey
Oklahoma State University

Introduction: Cauliflower is an important crop for fresh market vegetable farms in Oklahoma. Cauliflower and other brassica heading crops (broccoli, cabbage, etc.) can be grown both in the spring and early fall growing seasons.

Methods and Materials: The cauliflower trial included 18 varieties including white, green, purple, and orange colored varieties (Table 1). The trial was transplanted on March 30th from transplants started on February 26th. The system for growing the trial included free-standing raised beds with a single drip irrigation line/bed installed using a bedder-shaper, with no plastic mulch. Cover crop was left between the rows of cauliflower and consisted of cereal rye plus crimson clover. The trial was organized in a randomized block design with three replications. Each plot included 12 transplants arranged in staggered double-rows with six transplants per row and 1.5 feet between transplants in their respective row. Weed control for the trial consisted of a preemergence herbicide (Prefar) applied prior to transplanting and hand-hoeing/weeding. The trial was hand hoed two times during the season. Fertility for the trial was based upon soil test results that called for the application of nitrogen fertilizer only. Nitrogen was applied through the drip irrigation system utilizing urea (46-0-0) as our nitrogen source and the total amount applied was 102 lbs. of actual nitrogen per acre. Management of insect pests included scouting and the application of approved insecticides for control primarily of cabbage looper.

Trial Conditions: We observed that the cover crop strips helped considerably by providing wind protection during the growing season. The field that contained the trial experienced a low temperature event of 24°F on 4/7/18 which was one week after transplanting with proceeding week low temperatures in the high 20's to high 30's. This "hard" freeze severely damaged the cauliflower in the trial and in fact at one point plowing up the trial was considered. Following this freeze the trial began to recover about three weeks after the freeze, but did not recover sufficiently to complete the trial.

Conclusions: Generally crop damage from the April hard-freeze was extensive with most plants having dead outer leaves and many had damage to their growing points. The cauliflower in the trial never fully recovered and the trial was terminated in June. Future plans are being considered and may result in attempting the trial again in fall 2019.

Acknowledgements: The authors wish to thank personnel from the Cimarron Valley Research Station for their help and assistance in completing this trial and also wish to thank seed companies for supplying seed for this trial and Micah Anderson helping us transplant the trial.

Table 1. Spring 2018 cauliflower varieties, Seed company notes on each variety, Perkins OK.

#	Variety	Source	Color	days
1	Accent	Stokes	White	65
2	Candid Charm	Sakata	White	65
3	Christof	Syngenta	White	70-75
4	Freedom CMS	Stokes	White	66
5	Minuteman	Stokes	White	53
6	Shasta	Syngenta	White	71/90
7	Snowbowl	Sakata	White	65-70
8	Snow Crown	Johnnys & Territorial	White	50 - 68
9	Symphony	Syngenta	White	72
10	Puntoverde	Johnnys	Romanesco green	78
11	Veronica	Johnnys	Romanesco green	78
12	Vitaverde	Stokes	Green	76
13	Graffiti	Syngenta	Purple deep	80
14	DePurple	Syngenta	Purple	68
15	Mulberry	Territorial	Purple	85-95
16	Purple of Sicily	Territorial	Purple	90
17	Cheddar	Johnnys	Orange	58 - 68
18	Flame Star	Syngenta	Orange	62
19	Orange Burst	Territorial	Orange	80-90

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Cowpea Variety Trial - Perkins

Cimarron Valley Research Station
Perkins, OK
In conjunction with University of Arkansas Cowpea Breeding Program
Lynn Brandenberger, Lynda Carrier, Joshua Massey
Oklahoma State University

Introduction: Considering the variability of our state's climate and the cost of crop inputs, cowpea is a well-adapted summer crop that can thrive with fewer inputs than many vegetable crops that are grown. It is one of the most drought and heat tolerant crops that growers can produce and can function well with minimal inputs of fertilizer. Cowpeas have high levels of complex carbohydrates, protein, and several compounds such as folate which is critical for the development of healthy babies during pregnancy. The objective of this study was to provide Oklahoma producers with information on crop maturity and yield potential of advanced breeding lines and cultivars from the University of Arkansas breeding program.

Methods and Materials: The trial included 3 replications of 15 entries in a randomized block design. Entries in the trial varied for flower color, plant growth habits that range from fully determinant to a range of determinant-indeterminate, seed color ranged from cream (no eye color), to black-eyed, pink eyed, red, red-white, black-white, and all black. Plots received preplant fertilizer on 6/22/18 with 50 lbs. nitrogen/acre using urea (46-0-0) broadcast over the site just prior to finish tillage. Plots consisted of two rows 20 feet long with 36 inches between rows. Seed were spaced 5 seeds per foot and were direct seeded on 6/22/18 utilizing a research plot planter. Immediately following planting all plots received a preemergence application of Dual Magnum (S-metolachlor) at 1.43 lb. ai/acre tank-mixed with Pursuit (Imazethapyr) at 0.063 lb. ai/acre followed by an overhead irrigation of approximately 0.5 inch for herbicide incorporation. Supplemental water during the growing season was supplied from drip-irrigation utilizing one drip-line per row. Plots were evaluated for percent plant stand, flowering and percent dry pods on 8/13/18. Pre-harvest defoliation of the trial was done with one application of glyphosate at a rate of 2.5 pints/acre on 8/29/18. All plots were hand-harvested beginning on 9/13/18. Decisions to harvest were made based on a majority of pods within a line/cultivar being dry, then they were harvested, harvest was completed by 9/19/18. Within hours of harvest the pods from a plot were machine threshed using a stationery thresher (Kincaid bundle thresher). Following threshing seed weights were recorded.

Results: Bloom color observations were made primarily for use in identifying cultivars and breeding lines for future work (Table 1). Percent plant stands were recorded on 8/13/18 and ranged from 26 to 93% for advanced lines 016-182 and 09-741, respectively. Other lines/cultivars ranged between 40-90% stand. Plant stands began well, but by the time stands were evaluated several had decreased significantly. Stand loss was due primarily to ashy stem blight (*Macrophomina phaseolina*) and from various Fusarium and Pythium species.

Flowering provides some evidence for the earliness or lateness of any particular breeding line/cultivar. Flowering was evaluated on 8/13/18 and ranged from 4 to 96% (Table 1). Earliest flowering was observed for lines 16-167 (96%) Early Scarlet (94%), Excel (90%), and AR BE #1 (89%). Pod set also provides evidence of earliness. Percent pod set on 8/13/18 ranged from 3 to 93%. Cultivars/lines that had 90% or higher pod set in mid-August included breeding line 16-167, Early Scarlet, and Excel. Cultivars/lines that had less than 15% pod set included Ebony (3%) and 09-741 (13%). Six cultivars/lines ranged between 50 and 78% pod set these included AR BE #1, 09-671, 09-692, 09-393, 07-303, and 16-182.

Yields were recorded following hand-harvest and threshing. Yields varied significantly ranging from a low of 234 lbs./acre to a high of 1141 lbs./acre (Table 1). The top three yielding cowpeas

were 09-741, Excel, and 09-671 which recorded yields of 1141, 1100, and 929 lbs./acre, respectively. Early Scarlet an industry standard yielded 836 lbs./acre while several others were also in the same range of being above 800 lbs./acre.

Conclusions: Although this trial was handled to produce mature dry seed several of the trial entries warrant being included in on-farm trials for fresh-peas. Several were early to bloom and set fruit. There are several cultivar/lines of cowpea in the trial that have potential for commercial production in Oklahoma. Seed types in the trial ranged widely from cream types (no eye) to red and black seed coats, black-eye, pink-eye, and what we called red Holsteins (red/white) and a black calicos (black/white) (Figure 1). Some cultivar/lines were early maturing while others required a longer season to fully mature. Several yielded well with high yielders ranging from 800 lbs. per acre and higher. The authors would encourage farmers to pay attention for newly released cultivars from the list of numbered advanced breeding lines and to carry out their own on-farm trials once these lines are released for commercial production.

Acknowledgements: The authors want to thank our collaborator Steve Eaton at the University of Arkansas for his advice and for providing seed for the completion of this trial.

Table 1. 2018 Cowpea Variety Trial. Stands, flowering, podding, and yield. Perkins, OK,

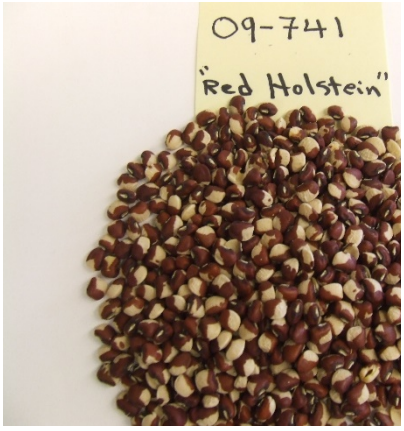
Variety	Seed type	Bloom color	Days to harvest	8/13/18			shelled yield (lbs./acre)[y]
				% Stand	% Flower	% Pods	
Ebony	Black	Purple	88	88 abc[z]	4 f	3 f	668 abcd
16-167	Black Calico	White	84	90 ab	96 a	93 a	621 bcd
AR BE #1	Blackeye	White	87	60 abcde	89 abc	76 abc	696 abcd
09-671	Blackeye	White	84	68 abcd	75 abcde	50 cd	929 abc
Early Acre	Cream	White	87	40 de	65 de	32 de	594 cd
01-1781	Cream	White	89	62 abcde	60 e	30 de	825 abc
AR-ES-01	Cream Crowder	White	87	62 abcde	68 cde	32 de	783 abc
09-692	Pinkeye	White	83	60 abcde	71 bcde	63 bc	803 abc
Early Scarlet	Pinkeye	White	83	77 abc	94 ab	93 a	836 abc
Empire	Pinkeye	White	88	62 abcde	60 e	37 de	829 abc
Excel	Pinkeye	White	83	85 abc	90 abc	92 a	1100 a
09-393	Pinkeye	White	84	55 bcde	85 abcd	78 ab	598 cd
07-303	Red	Purple	84	53 cde	80 abcde	72 abc	675 abcd
09-741	Red Holstein	White	88	93 a	18 f	13 ef	1141 a
16-182	Red Holstein	White	84	26 e	82 abcde	77 abc	234 d

[y] Shelled yield=hand harvested, mechanically shelled, yield in lbs./acre.
[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. 2018 Cowpea trial photos

07-303

09-741



16-182

16-167

Ebony

Pre-harvest

Post-harvest

Kincaid bundle thresher

Kincaid bundle thresher

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Linking yield, Nutrition, and Soil Ecology with Cowpea Trials

Cimarron Valley Research Station
Perkins, OK
Adam B. Cobb and Gail W.T. Wilson
Oklahoma State University

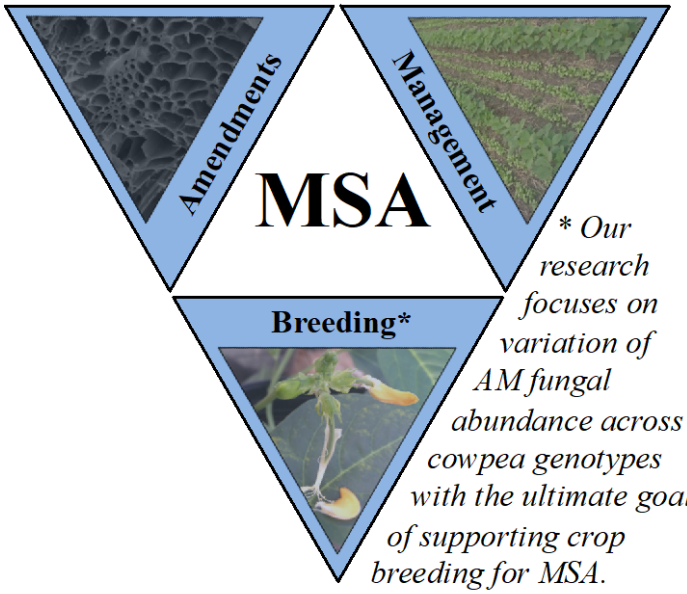
Introduction and Objectives: Dwindling phosphorus reserves are a looming crisis for agriculture (Herrera-Estrella and Lopez-Arredondo, 2016) because global supplies may be within a few decades of exhaustion (Chen and Graedel, 2016). Increasing crop nutrient use efficiency is critical to national and global food security and sustainability. Fortunately, symbiotic partnerships between agronomic crops and soil fungi are a possible solution to these challenges (Andrews et al., 2012; Denison, 2012).

Arbuscular mycorrhizal (AM) fungi form beneficial associations with up to 71% of land plants (Smith and Read, 2008), including most agricultural crops. In natural ecosystems, AM fungi can improve plant nutrition, disease resistance, and water use efficiency (see Gosling et al., 2006), and they present a great opportunity to improve farm systems (Ellouze et al., 2014; Rodriguez and Sanders, 2015).

Cowpea (*Vigna unguiculata*) benefits from hosting AM fungi, but there is wide variation in the response of crop genotypes to diverse AM fungal communities (Johnson et al., 2016; Cobb et al., 2018). According to the Census of Agriculture (USDA, 2014), US farmers harvested over 10,000 ha of cowpea in 2012, and cowpea can help reduce global malnutrition (Anyango et al., 2011; Vilakati et al., 2016).

One key to successful cowpea cultivation may be enhancing mutualistic partnerships with AM fungi. However, AM fungal abundances, diversity, and benefits have been depleted in many agroecosystems due to farm management practices such as high phosphorus fertilizer application, monoculture, and heavy tillage (Richardson et al., 2011; Cobb and Wilson, 2018). We have developed a framework for integrated research called ***Mycorrhiza Smart Agriculture*** (Figure 1). The primary aim of our current research is to enable crop breeders to improve the capacity of host-crops to effectively partner with an array of local AM fungi. Development of crops that more effectively utilize AM symbioses could provide considerable economic and environmental benefits. If AM fungi can be managed *in-situ* as "natural biofertilizers" in farm systems, they can nutrition of crops and reduce soil erosion (Cobb et al. 2016; Cobb et al. 2017).

Figure 1. Conceptual diagram of *Mycorrhiza Smart Agriculture* (MSA): aiming to enhance abundance, diversity, and benefits of AM fungal communities.



The objectives of our trial were to assess cowpea seed production and nutritional quality of 15 cowpea genotypes, representing a range of cowpea genetics, and link these aboveground

outcomes with the abundance of AM fungi associated with each genotype. Results may elucidate traits connected with AM symbiosis in cowpeas, and ultimately reduce the need for commercial fertilizers (and costs to food producers) through improved cowpea breeding. Developing cowpea genetics with an emphasis on AM symbiosis is a key step toward enhancing resource-use efficiency and soil stability while maintaining or improving cowpea yield and nutrition.

Methods: Cowpea genotypes were planted in randomized complete blocks at the OSU Cimarron Research Station in June. See 2018 Cowpea Variety Trial for detailed methods. Prior to defoliation and harvest, we collected all seeds produced from representative plants within each plot to determine seed yield (dry weight in lbs.) of ten cowpea plants. Fresh soil samples were also collected in proximity to the roots of each harvested plant. Soil samples were immediately freeze-dried and will be used to determine relative abundances of soil microbial functional groups (gram- positive and negative bacteria, AM and saprophytic fungi), and total microbial biomass using phospholipid and neutral lipid fatty acid (PLFA/NLFA) analyses. Quantification of PLFA/NLFA biomarkers will be accomplished with a modified Bligh and Dyer (1959) extraction (Allison and Miller, 2005), and samples will be analyzed using a GCMS unit (Agilent MS 5975C/GC 7890A). These biomarkers are constituents of cellular membranes and can be used to estimate the relative abundance of microbial biomass in soil. Collaborators at USDA-ARS will assess seed total protein (LECO FP-528), and mineral concentrations (Farnham et al., 2011).

Results: Preliminary results indicate differences in cowpea yield among genotypes with substantial variation between harvested replications (Table 1). Subsamples of seeds are currently being prepared for nutritional analyses. Soil microbial analyses are ongoing with the goal of linking above- and belowground variables to examine if AM fungal abundance influences cowpea yield and nutrition, ultimately improving the “toolbox” of cowpea breeders to facilitate Mycorrhiza Smart Agriculture.

Acknowledgements: We thank Dr. Lynn Brandenberger and Lynda Carrier for logistical support and ongoing collaboration on this project.

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Table 1. Seed yield (dry weight in lbs.) of ten cowpea plants, Perkins, OK

Genotype	Type	Rep1	Rep2	Rep3	Average
AR BE #1	Black Eye	0.65	0.42	0.58	0.55 ± 0.07
AR-09-692	Pink Eye	0.69	1.25	0.25	0.73 ± 0.29
AR-ES-01	Cream Crowder	0.88	2.24	0.65	1.26 ± 0.49
Early Acre	Cream	0.87	0.86	0.33	0.69 ± 0.18
Early Scarlet	Pink Eye	0.70	0.40	0.94	0.68 ± 0.16
Ebony	Black	0.89	1.23	0.79	0.97 ± 0.13
Empire	Pink Eye	1.26	0.68	1.66	1.20 ± 0.28
Excel	Pink Eye	0.59	0.33	0.54	0.49 ± 0.08
01-1781	Cream	1.35	1.21	0.76	1.11 ± 0.18
07-303	Red	1.98	0.86	0.67	1.17 ± 0.41
09-393	Pink Eye	0.74	0.95	0.59	0.76 ± 0.10
09-671	Black Eye	0.69	0.52	0.53	0.58 ± 0.05
09-741	Red Holstein	0.71	1.04	0.36	0.71 ± 0.19
16-167	Black Calico	0.53	0.45	0.58	0.52 ± 0.04
16-182	Red Holstein	0.27	1.11	0.66	0.68 ± 0.24

* Preliminary results: means ± standard error.

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Fresh Market Cowpea Variety Trial - Langston

Micah Anderson and Eric McHenry
Langston University

Introduction: Fresh cowpea is a favorite among buyers at local farmers markets. Not only are customers excited about this southern vegetable, but cowpea also has high levels of complex carbohydrates, protein, and several compounds such as folate which is critical for the development of healthy babies during pregnancy. The objective of this study was to provide Oklahoma producers with information on different varieties of cowpea for fresh market regarding days to harvest, crop maturity and yield potential of several commercially available cowpea varieties.

Methods and Materials: The trial included 3 replications of 10 varieties entries in a randomized block design. Entries in the trial varied according to seed characteristics including pink-eyes, black-eyes, cream, solid black, mixtures of black and white and red and white with plant growth habits that range from fully determinant to a range of determinant-indeterminate. Plots received some fertilizer (approximately 25-30 lbs. of nitrogen/acre) delivered through the drip irrigation system during the season. Plots consisted of two rows 5 feet long on top of free-standing raised beds that were six feet center to center. Seed were spaced 3 seeds per foot in each row and were direct seeded by hand during the second week of July. Supplemental water during the growing season was supplied from drip-irrigation utilizing one drip-line per bed. Plots were evaluated for fresh market weights at harvest (September). Decisions when to harvest were made based on a majority of pods within a line/cultivar being well filled. Following harvest each plots pods were weighed and recorded.

Results: Yields varied significantly with Quick Pik and Coronet recording the highest yields in the study (Table 1). Harvest weights ranged from a low of 2,178 lbs. per acre for Ozark Razorback, Holstein, Ebony, and Elite to highs of 3,630 lbs. per acre for Quick Pik and Coronet. Varieties that ranged in yield between the high and low yielding ones included Arkansas BE # 1, California BE # 5, Early Scarlet, and Empire which recorded yields of 3,146, 2,904, 2,420, 2,662 lbs. per acre, respectively.

Conclusions: The top yielding peas in the study were Quick Pik and Coronet, both which are pink-eye purple hulls. Peas were market tested and it was found that customers preferred pink-eye purple hull peas over all other types. One aspect of the trial was the difference in difficulty in hand-harvesting different varieties based upon whether varieties were determinate (bush-type) or indeterminate (viney). Determinate types were easier and quicker to harvest than indeterminate types.

Acknowledgements: The authors want to thank our Dr. Lester Clark for the use of his garden area and for suppling some crop inputs for this trial.

Table 1. 2018 Fresh market Cowpea Variety Trial, Langston, OK, Harvest data.

Cultivar	Seed Source	Type	Fresh market yield pounds/acre	
Arkansas BE #1	U of Arkansas	Black Eye	3146	ab [z]
California BE #5	CT Smith	Black Eye	2904	ab
Coronet	CT Smith	Pink Eye	3630	a
Early Scarlet	U of Arkansas	Pink Eye	2420	ab
Ebony	U of Arkansas	Black	2178	b
Elite	CT Smith	Cream	2178	b
Empire	U of Arkansas	Pink Eye	2662	ab
Holstein	Baker	Black & White	2178	b
Ozark Razorback	Southern Exposure	Red & White	2178	b
Quick Pik	CT Smith	Pink Eye	3630	a

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05

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Melon Trial - Langston

Langston, OK
Micah Anderson and Eric McHenry
Langston University

Introduction: Melons are a popular item for fresh market growers throughout Oklahoma. Direct fresh market works out well for consumers since melons can be riper when they are harvested and taken to market, allowing consumers sweeter and better quality produce to purchase. Another aspect of locally grown fresh produce is that produce is often picked and shipped directly to the market reducing the number of opportunities for potential food safety issues.

Methods and Materials: This observational trial included planting one field area for each of the different entries. The different entries included one cantaloupe (Super 45) and four different watermelons Sweet Jim (seedless), Peddler (25-30 lb. red-meat), Yellow Doll (10-12 lb. yellow-meat), and Gold Stripe (15-18 lb. golden-orange). All entries were direct seeded on June 12, 2018 in rows eight feet apart and approximately five feet apart in the row. The trial was drip irrigated and soil beds were covered in black plastic mulch over approximately 3/8 of an acre area for the entire trial. Fertility needs of the plants were met with existing N-P-K in the soil and supplemental applications of 20-20-20 water-soluble fertilizer injected through the drip system. Harvesting was started on 8/13/18 with seven total harvests, end harvest being on 10/9/18. Individual fruit weights were recorded for each entry at harvest. Melons were an integral part of the local farmers market and actually were a key item for initiating the market in the Langston area.

Results: In general the trial was very useful for us to help start the local farmer's market in the Langston area. Super 45 (Table 1) was the only cantaloupe in the trial and averaged 3.6 lbs. per fruit and yielded a total of 2,217.5 lbs. The authors felt that Super 45 was small for a cantaloupe, but it had a very nice sweet taste. Average fruit size for watermelons ranged from a high of 20.6 lbs. for Peddler to a low of 6.0 lbs. for Yellow Doll. Other watermelons in the trial included Gold Stripe and Sweet Jim and they had 13.3 and 9.0 lbs. average fruit weight, respectively. Overall yield ranged from a low of 1,851lbs. for Sweet Jim (Seedless) to a high of 8,823.5 lbs. for Peddler. Gold Stripe and Yellow Doll had overall yields of 2,676.5 and 4,240.5 lbs., respectively.

Conclusions: When growing watermelons for market growers will want to consider the size and type of watermelon that their customers prefer. Although Peddler yielded the highest in the trial (8,823.5 lbs.) its average fruit weight (20.6 lbs.) was possible too high for what customers may want. Yellow Doll on the other hand did yield less, but may be more desirable to customers since average fruit weighed about six pounds. Yellow Doll also yielded about 2/3 more fruit than Peddler which would likely result in higher profit. Although the trial was planted fairly late in the season (June 12) the use of drip irrigation and black plastic mulch allowed for more rapid crop growth and higher yields and quality than likely would have occurred with bare soil culture.

Acknowledgements: The authors want to thank our Dr. Lester Clark for the use of his garden area and for suppling some crop inputs for this trial.

Table 1. 2018 Melon trial at Langston. Harvest data.

Variety	Seed Source	Type	Average fruit. lbs.	Total yield Lbs.
Super 45	Dewitt	Cantaloupe	03.6	2,217.5
Gold Stripe	Dewitt	Watermelon	13.3	2,676.5
Peddler	Dewitt	Watermelon	20.6	8,823.5
Sweet Jim	Dewitt	Watermelon	09.0	1,851.0
Yellow Doll	Dewitt	Watermelon	06.0	4,240.5

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2018 Okra Mulch Study - Stillwater

Alisa Sims, Lynda Carrier, Lynn Brandenberger
Oklahoma State University

Introduction: *First, I'd like to begin discussing about the* variety that I was utilized in the study which is called "Heavy Hitter" a selection of okra developed from the variety called Clemson Spineless. Peirce (1987) stated that okra (Abelmoschus esculentus) was introduced to the U.S in the early 1700s, either by French settlers in Louisiana or by slaves from Africa. Peirce (1987) added that Okra (Abelmoschus esculentus) has moderate levels of vitamin A and C and calcium, phosphorus, and potassium, and is higher than many vegetables in thiamine, riboflavin, and niacin.

Biodegradable mulch (BDM) is a relatively new product in the United States. In general, BDM costs more than polyethylene mulches (Velandia 20118). Like polyethylene mulches, this mulch is said to effectively eliminate weeds, help reduce erosion, can moderate soil temperature and with an additional benefit of being 100% Biodegradable, with no formation of toxic residues (Miles 2018). Biodegradable plastic or paper mulch offers crop production benefits similar to polyethylene plastic mulch (PE) but is designed to be tilled into the soil after use, thereby eliminating waste and disposal challenges associated with PE mulch use (Velandia 2018). These additional benefits offset challenges faced when using PE mulches such as 1) the negative environmental impacts associated with the way PE mulches are traditionally disposed of (e.g., landfilling, on-farm burning and stockpiling); and 2) costs associated with end-of-season activities such as plastic mulch removal and disposal. The disposal of PE mulches in landfills raises some concerns as the complete decomposition of these mulches in the soils could take more than 300 years, and this process could potentially form chemical byproducts that are harmful to the environment (Ghimire 2018).

Plastic mulches have been used commercially on vegetables since the early 1960s Marr (1993). Muskmelons, tomatoes, peppers, cucumbers, squash, eggplant, watermelons, and okra are vegetable crops that have shown significant increases in earliness, yield, and fruit quality when grown using plastic mulch Sanders (2001). Mulching thus stabilized production by eliminating various constraints, and made it possible for more intensive multiple cropping by advancing the harvest (Iguchi 1997). Some disadvantages are costs. Depending on row spacing and bed width, plastic mulch costs approximately $350 to $700 per acre, including installation and removal (Shrefler 2016). Non-degradable plastic mulch must be removed from the field and can take up to eight hours of labor to remove from on acre (Shrefler 2014)

Drip Irrigation is a highly recommended agricultural practice and is used to conserve water since water is applied directly to the root zone. The frequency of irrigation will depend on soil type and stage of crop growth Sanders (2001). Lamont, et al. added that crop yields can increase through improved water and fertility management and reduced disease and weed pressure. When drip Irrigation is used with polyethylene mulch, yields can increase further.

As discussed many types of mulches are known for increasing yield, reduction of weeds, improved soil moisture, increased soil nutrition, reduced soil erosion and compaction. In this vegetable crop mulch study we compared traditional bare soil production to the practice of utilizing (black) plastic mulch, and biodegradable paper mulch.

Methods and Materials: The study was conducted using plastic and paper mulches comparing them to bare soil production. On May 10th black-plastic mulch and paper mulch were applied,

bare soil and both mulch treatments included free-standing raised soil beds with drip irrigation tape also applied at the same time (Figure 1). On May 11th Okra seeds (variety Heavy Hitter) were direct seeded into six-packs as well as soilless growing media (SunGro Professional Growing Mix) in the greenhouse. Okra were transplanted on May 24th with a total of six transplants in each plot planted two feet apart in the row. In addition, all treatment plots also received six pre-germinated seed of okra as a backup to potential poor transplant survival. Crop nutritional needs were met with 3lbs. of 10-30-20 applied twice and one application of 1.5 lbs. of 10-30-20 as well as one 3 lbs. application of Urea 46-0-0 providing 48lbs. nitrogen, 43lbs. $P_2$05, and 29lbs. K_2O on a per acre basis.

Insect pests included tobacco horn worm, yellow-striped armyworm and aphids. Bacillus thuringiensis dust was applied twice and Warrior (lambda-cyhalothrin) was used once for worm control and neem-oil was applied for control of aphids. The experiment was set up as a randomized block design with five replications. Harvest data collection began on 7/12/2018 and continued to 8/31/2018 for a total of 17 harvests. Fruit was removed from plants using hand-clippers then each plot's harvest was recorded as the number and weight of marketable and culls harvested.

Results and Discussion: Percent weed coverage ranged from zero for paper mulch to 10 and 30%, respectively, for plastic mulch and bare soil on 5/29/18 (Table 1) and 22, 34, 36%, respectively, for paper, plastic mulch, and bare soil treatments on 6/15/18. Although no significance was observed for weed coverage there was a definite trend toward reduced weed coverage from both mulching materials. Time for hand weeding plots varied significantly on 5/29/18. Hand weeding required 225 seconds for paper mulch, 165 seconds for plastic mulch, and 308 seconds for bare soil with both mulch treatments taking significantly less time than the bare soil treatment on 5/29/18. Removal time was zero for both paper mulch and bare soil treatments while time required for the plastic mulch removal was 184 seconds/plot.

Yields were highest for the plastic mulch treatment (Table 2). Marketable yield ranged from a high of 529 bushels/acre for the plastic mulch treatment to a low of 413 and 416 bushels for paper mulch and bare soil, respectively. Total yields which included both marketable and culls was again highest for plastic mulch (581 bushels/acre) while both paper mulch and bare soil were significantly less. Average fruit number per plant was highest for plastic mulch compared to the other treatments. Average fruit weight was highest for the bare soil treatment which recorded 0.035 lbs. per fruit.

Conclusions: In general, okra appears to perform better on plastic mulch likely due to the warming effect that it has on the soil and the increased plant growth that results from it. Okra plant height in plastic mulch generally was higher than the okra grown in bare soils or paper mulch (data not shown). Plastic mulch took less time to weed compared to paper mulch and bare soil on 5/29/18. In summary, the authors conclude that although okra responded well to plastic mulch culture, growers should also consider not only the cost of installing plastic mulch, but also the labor and disposal costs for the material at season's end.

Acknowledgements: Mr. Ron Cook for supplying Heavy Hitter okra seed and Omniafiltra LLC for donating the paper mulch.

Table 1. 2018 Okra mulch study, weed coverage, weeding and removal times, The Botanic Garden, Stillwater, OK.

	% Weed coverage		Weeding time in seconds		Removal time
Treatment	**5/29/18**	**6/15/18**	**5/29/18**	**6/15/18**	**seconds**
Paper	0 a[z]	22 a	225 b	70 a	0
Plastic	10 a	34 a	165 b	171 a	184
Bare soil	30 a	36 a	308 a	156 a	0

[z]Numbers in a column followed by the same letter exhibited no significant differences based upon Duncan's Multiple Range Test where P=0.05.

Table 2. 2018 Okra mulch study, harvest results, The Botanic Garden, Stillwater, OK.

	----------Bushels of fruit/acre[z]----------			Ave. number	Individual
Treatment	**Marketable**	**Non-marketable**	**Total marketable + non**	**Fruit/plant**	**Fruit weights**
Paper	413 b[y]	36 a	449 b	81 b	0.028 ab
Plastic	529 a	52 a	581 a	103 a	0.027 b
Bare soil	416 b	48 a	464 ab	81 b	0.035 a

All okra plots were harvested 7/12/18 to 8/31/18 (17 harvests).
[z]Bushels of fruit per acre based upon 30 pounds per bushel.
[Y]Numbers in a column followed by the same letter exhibited no significant differences based upon Duncan's Multiple Range Test where P=0.05.

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Figure 1. Mulch study photos

Transplanting through mulch

Okra on paper mulch

Flowering and fruiting of okra

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Onion Variety Trial - Langston

Micah Anderson, Horticulture Extension Agent, Langston University
Jim Shrefler, Area Extension Horticulturist, Oklahoma State University
Grower Cooperator Dr. Lester Clark

The choices of commercially acceptable red onion cultivars available to Oklahoma growers is rather limited. Recently, several new red onions became available on the market. These are classified as being intermediate in their day-length requirements for bulb development, making them potential candidates for use in Oklahoma. To evaluate these onion cultivars for suitability to Oklahoma growing conditions an observational trial was initiated in 2017 by growing plants in a high tunnel at the Wes Watkins Agricultural Research and Extension Center in Atoka County. Cultivars tested included 5 red and 3 yellow varieties. Seed were sown November 6, 2017 and began to emerge within one week. Plants were grown through the winter and removed from the high tunnel on April 12. Plants were transplanted to the field on April 18, 2018. Onions were harvested on July 3. After trimming off the tops the bulbs were classified based on diameter and weighed.

Due to wet conditions during the month of June weed growth became heavy and onions were harvested before reaching full maturity. Bulb fill was well advanced at the time of harvest in two cultivars, 1015Y and Monastrell. This would be expected for 1015Y as it is a short day onion that is typically harvested in late June in Oklahoma. Other cultivars fell in various stages of maturity with some being in very early stages of bulb development. Estimated bulb yields were determined based on average individual bulb weight. Yield was estimated for onions grown in two rows, with rows planted side by side and with bulbs spaced at 6 inches apart within the row. These yields ranged from 2 to 48 pounds for 50 feet of row, which would equal 100 square feet of garden space. All of the cultivars except Chianti had produced bulbs of greater than 2 inch diameter by the time they were harvested. Had the onions been given more time to develop, the estimated yields and the percent of large size bulbs would likely have increased from the values presented here. Based on these results, the cultivars should be further evaluated to determine their full potential to produce large, quality onion bulbs and to further determine the expected harvest dates for each cultivar.

Onion cultivars, sources, colors, yield parameters and bulb development comments at the onion trial at Langston University in 2018.

Cultivar	Source	Color	Estimated Yield (lbs. per 100 square feet)	Percent of bulbs of 2-3.25 inch diameter	Comments
Monastrell	Vitalis Biologische Zaden	red	33	59	Bulb fill well advanced at harvest
Cabernet F1	Vitalis Biologische Zaden	red	24	37	Bulb fill intermediate at harvest
Chianti	D. Palmer Seed	red	2	0	Bulb fill in very early stage at harvest
Cherry Mountain	D. Palmer Seed	red	22.5	23	Bulb fill in early stage at harvest
Red Wing	Johnny's Selected Seeds	red	48	55	Bulbs fill in early stage at harvest
Candy	Morgan County Seed	yellow	65	72	Bulb fill intermediate at harvest
Ovation	Morgan County Seed	yellow	55.5	73	Bulb fill in early stage at harvest
1015Y	Morgan County Seed	white	30.5	42	Bulb fill well advanced at harvest

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Organic Onion Variety Trial 2017 - Lane

Jim Shrefler and Lane Faulkenberry

Good quality cultivars that are adapted to local conditions are needed to successfully grow organic bulb onions. There are several red onion cultivars that are available on the market as seed that is either organic or untreated. These cultivars are classified as intermediate in day-length requirements for bulb development, thus making them potential candidates for use in Oklahoma. A trial was conducted in 2017 in a high tunnel located on certified organic land at the Wes Watkins Agricultural Research and Extension Center at Lane to evaluate these cultivars for suitability to Oklahoma growing conditions. Eight cultivars of onions were used as shown in the table along with the sources. Seed were sown in early January in Speedling trays with 1" x 1" cells using an organic approved growing media. Onions were kept in an unheated greenhouse until March 21, at which time trays were moved to the high tunnel. On March 22 onion plants were removed from trays and transplanted to the floor soil of the high tunnel. The planting area was covered with white on black plastic mulch with the white side facing upward. Plot size for each cultivar was 1 foot by 3 feet and there were two rows of onions spaced 6 inches between rows and 4 inches between plants within a row. A randomized block experimental design with four replications was used. Onions were watered as needed with drip irrigation. Plants were observed periodically to assess pest incidence, general condition and maturity. Maturity was determined based on leaf fall when the onion necks become weak. Onions were harvested when individual cultivars reached maturity. Following harvest, onions were transported to a large garage building where plants were placed on tables and allowed to dry at ambient temperatures. Tops were trimmed and bulbs were classified based on diameter and then counted and weighed. Bulbs considered to be in good condition were placed in brown paper grocery bags and kept indoors where temperatures were maintained at about 70^{o}F. The stored bulbs were observed periodically for deterioration and those becoming soft or showing signs of decay were discarded. A final evaluation of bulb condition was made in mid-November of 2017.

Onions were harvested when the leaves became weak at the neck and fell. Depending on the cultivar, this began in mid-June and was completed by about August 1. The first cultivars to mature were Monastrell, Cabernet, and Allure. Chianti and Crimson matured within two weeks after these. Cherry Mountain and Red Wing matured nearly 6 weeks later than the first group.

Yield results are shown in the table. Total number of bulbs differed across cultivars. These differences would be attributable to factors such as plant death or decay of bulbs prior to harvest. The numbers of small diameter bulbs (< 2 inches) also differed across cultivars with Monastrell, Cherry Mountain and Red Wing having the fewest of this size category. Large size bulbs ranged in diameter from 2 to 3.25 inches. These differed across cultivars with Red Wing, for each of pelleted or unpelleted seed, having the greatest numbers. It is noteworthy that Red Wing, as well as Monastrell and Cherry Mountain, had high numbers of bulbs of two inch diameter or greater as compared to smaller bulbs. Onion bulb weights also differed across cultivars with Red Wing and Cherry Mountain being the greatest.

Based on visual observation (no data shown), bulb condition in mid-November varied across cultivars. Monastrell and Cabernet were found to be in generally good condition. Chianti, Cherry Mountain and Red Wing were in fair condition due to incidences of decay and sprouting. Crimson and Allure each showed extensive sprouting.

The assistance of Mr. Jim Vaughn and Mr. Shannon Reece of the Wes Watkins Agricultural Research and Extension Center is greatly appreciated.

Onion cultivars, sources and yield parameters in the organic cultivar trial at the Wes Watkins Agricultural Research and Extension Center at Lane in 2017.

Cultivar	Source	Yield parameters per 100 square feet			
		Number of onion bulbs			Onion bulb weight (lbs.)
		Total	< 2 inch diameter	≥ 2 inch diameter	
Monastrell	Vitalis Biologische Zaden	143 d[z]	11 c	132 bc	46 bc
Cabernet F1	Vitalis Biologische Zaden	268 ab	125 b	143 bc	47 bc
Chianti	D. Palmer Seed	286 a	139 b	147 bc	46 bc
Cherry Mountain	D. Palmer Seed	186 cd	32 c	154 bc	52 ab
Red Wing	Johnny's Selected Seeds	268 ab	36 c	232 a	74 a
Red wing (pelleted)	Johnny's Selected Seeds	225 bc	46 c	179 ab	58 ab
Crimson	NMSU	247 ab	221 a	25 d	24 c
Allure	NMSU	236 ab	143 b	93 cd	37 bc

[z] Means within a column followed by a common letter are not statistically different based on Duncan's Multiple Range Test with P=0.05.

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Direct Seeding Establishment of Bell and Spice Pepper

Cimarron Valley Research Station
Andi Nichols, Lynn Brandenberger, Lynda Carrier
Oklahoma State University

Introduction: Pepper crops grown in Oklahoma include peppers for fresh markets such as farmer's markets, restaurants, etc. and pungent peppers grown for use in salsas, sauces, and the like. Pepper production accounts for 500-600 acres of production in Oklahoma, with an overall annual value of 2 million U.S. dollars. Our producers face multiple issues each year including pests, disease and greenhouse costs associated with transplant production. Research on direct seeding establishment was initiated in 2018 and will continue into 2020 with the goal of establishing productive and efficient direct seeding methods for peppers in Oklahoma to alleviate some of the input costs and issues that local producers face.

Methods and Materials: This year's study was conducted using Okala spice peppers and California Wonder bell peppers. Two planting dates were used based on soil temperatures. The first planting took place on May 15, 2018 with an average soil temperature of 88.4^{o}F and the second planting was on May 29, 2018 with an average soil temperature of 85^{o}F. Other treatments included seed priming and cover crops. Seed priming agents were selected from greenhouse trial results that took place in March 2018 at the OSU research greenhouses located in Stillwater, OK. The results showed significant increases in emergence for bell pepper from the potassium chloride (KCL) treatment and significant increases in emergence for spice pepper from the calcium chloride ($CaCl_2$) treatment. The same priming methods were used for field trial seeds and non-treated seeds were used as a control. Four cover crop treatments are located within the field and have been in cycle for two years before the trial began(Table 1). Seeds were planted at $^{1}/_{2}$ inch depth with our research planter at a seeding rate of 1-2 seeds/row foot. Plots were 13 feet long with 4 foot alleys and each row was placed within their corresponding cover crop treatment area and consisted of 16 plots with 4 treatment reps.

Table 1: Cover Crop Treatments

Treatment #	1	2	3	4
Warm Season	sorghum Sudan and cowpeas	cowpea	pearl millet and cowpea	fallow
Cool Season	cereal rye and crimson clover	winter wheat and crimson clover	cereal rye, Austrian winter pea, tillage radish	fallow

Results and Discussion: Data was collected on plant counts for emergence every 3-4 days for the first two weeks following the start of emergence of each planting date. Primed bell peppers showed the most significant emergence rates throughout the season (Tables 2-9). This year's data was also greatly affected by two major pest invasions. Early on there were significant issues with cut worms which eventually led to the loss of the entire first planting. Later on, blister beetles invaded many plots within cover crop treatment areas 3 and 4 which also led to major losses. Weed pressure from various species played a major role in management issues as well. Planting will be done differently next year to provide space for tillage equipment used for weed control.

Conclusion: While this year's losses were severe, the early significance shown in emergence data is encouraging. Researchers also gained valuable experience of how to better manage direct seeded peppers and their requirements. Over the next two growing seasons, we expect

to see major improvements in results as well as improved control measures in terms of pests and weeds.

Table 2: 2018 Pepper Emergence (5-15-18 Planting) Cover Crop Treatment 1

	Emergence				
Treatment	**5/24/18**	**5/28/18**	**5/31/18**	**6/04/18**	**6/08/18**
Bell Primed	1.0 ab[Z]	17.0 a	14.3 a	10.3 a	8.8 a
Bell Control	0.8 ab	10.0 b	7.3 b	5.3 ab	1.8 b
Okala Primed	4.8 a	7.8 b	4.3 b	2.8 b	0.8 b
Okala Control	0 b	3.8 b	2.0 b	0.8 b	0.3 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 3: 2018 Pepper Emergence (5-15-18 Planting) Cover Crop Treatment 2

	Emergence				
Treatment	**5/24/18**	**5/28/18**	**5/31/18**	**6/04/18**	**6/08/18**
Bell Primed	0.8 b[Z]	20.8 a	19.5 a	17.8 a	15.5 a
Bell Control	0.5 b	17.8 a	16.8 ab	13.8 ab	11.0 ab
Okala Primed	5.3 a	12.5 a	10.8 b	8.3 b	4.0 b
Okala Control	1.3 b	13.0 a	11.3 b	9.0 b	5.0 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 4: 2018 Pepper Emergence (5-15-18 Planting) Cover Crop Treatment 3

	Emergence				
Treatment	**5/24/18**	**5/28/18**	**5/31/18**	**6/04/18**	**6/08/18**
Bell Primed	5.0 ab[Z]	21.5 a	21.8 a	22.0 a	20.8 a
Bell Control	1.0 ab	19.5 ab	20.0 a	20.5 a	18.0 a
Okala Primed	8.5 a	9.5 ab	8.5 b	7.0 b	4.8 b
Okala Control	4.0 ab	8.0 b	6.8 b	5.0 b	2.8 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 5: 2018 Pepper Emergence (5-15-18 Planting) Cover Crop Treatment 4

	Emergence				
Treatment	**5/24/18**	**5/28/18**	**5/31/18**	**6/04/18**	**6/08/18**
Bell Primed	1.3 a[Z]	17.3 a	16.5 a	16.0 a	13.5 a
Bell Control	0.5 a	18.8 a	18.5 a	17.5 a	18.5 a
Okala Primed	2.5 a	6.0 b	5.0 b	4.3 b	3.0 b
Okala Control	2.5 a	3.0 b	3.0 b	2.3 b	2.0 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 6: 2018 Pepper Emergence (5-29-18 Planting) Cover Crop Treatment 1

	Emergence				
Treatment	**6/08/18**	**6/11/18**	**6/14/18**	**6/17/18**	**6/21/18**
Bell Primed	1.5 a[Z]	5.8 a	11.0 a	12.5 a	11.5 a
Bell Control	0.3 a	2.5 a	4.3 b	3.3 b	7.8 ab
Okala Primed	0.3 a	1.8 a	3.3 b	3.5 b	3.3 b
Okala Control	0.3 a	2.8 a	3.8 b	4.0 b	3.0 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 7: 2018 Pepper Emergence (5-29-18 Planting) Cover Crop Treatment 2

	Emergence				
Treatment	**6/08/18**	**6/11/18**	**6/14/18**	**6/17/18**	**6/21/18**
Bell Primed	0.0 a[Z]	10.0 a	16.5 a	15.8 a	16.0 a
Bell Control	0.3 a	5.8 ab	10.3 b	13.8 a	15.8 a
Okala Primed	0.5 a	3.0 b	1.8 c	3.8 b	3.3 b
Okala Control	0.5 a	4.3 b	6.0 c	5.0 b	4.3 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 8: 2018 Pepper Emergence (5-29-18 Planting) Cover Crop Treatment 3

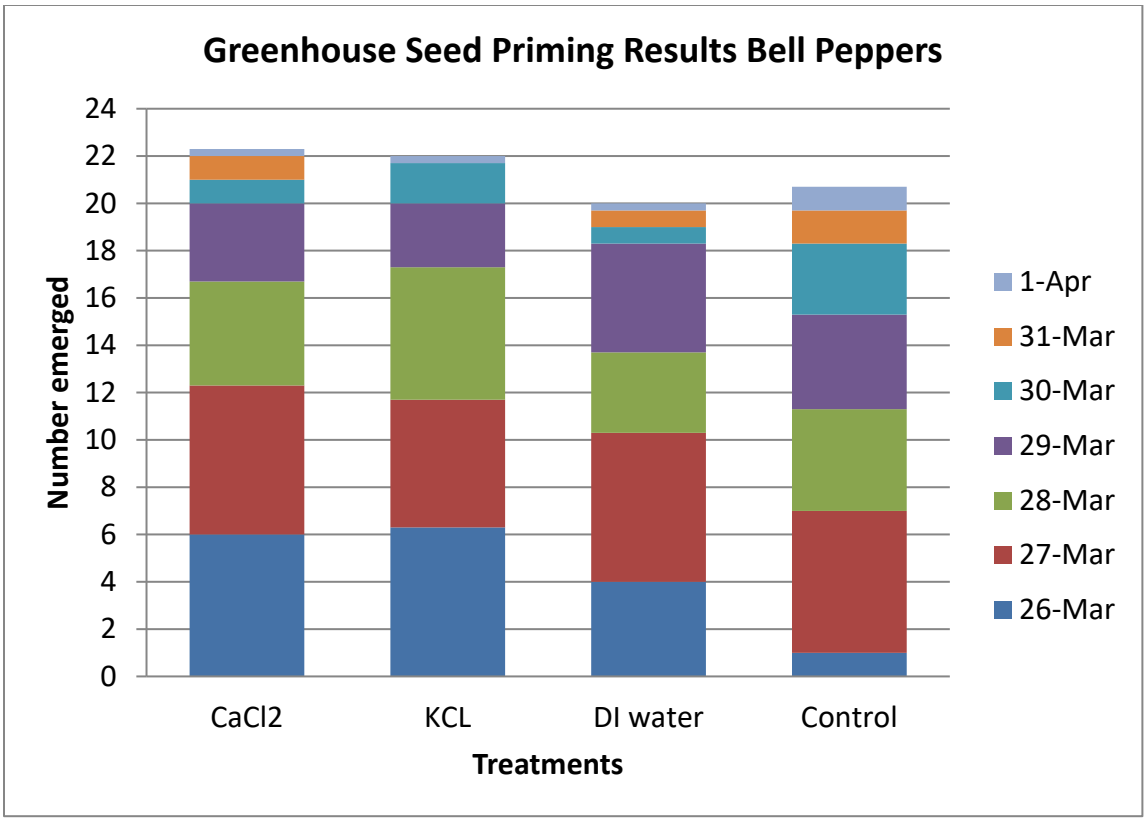
	Emergence				
Treatment	**6/08/18**	**6/11/18**	**6/14/18**	**6/17/18**	**6/21/18**
Bell Primed	0.0 a[Z]	2.3 a	3.8 a	6.8 a	7.3 a
Bell Control	0.0 a	1.3 a	3.0 a	6.3 a	10.0 a
Okala Primed	0.3 a	1.5 a	6.0 a	5.5 a	3.3 a
Okala Control	0.3 a	2.0 a	2.5 a	3.3 a	3.8 a

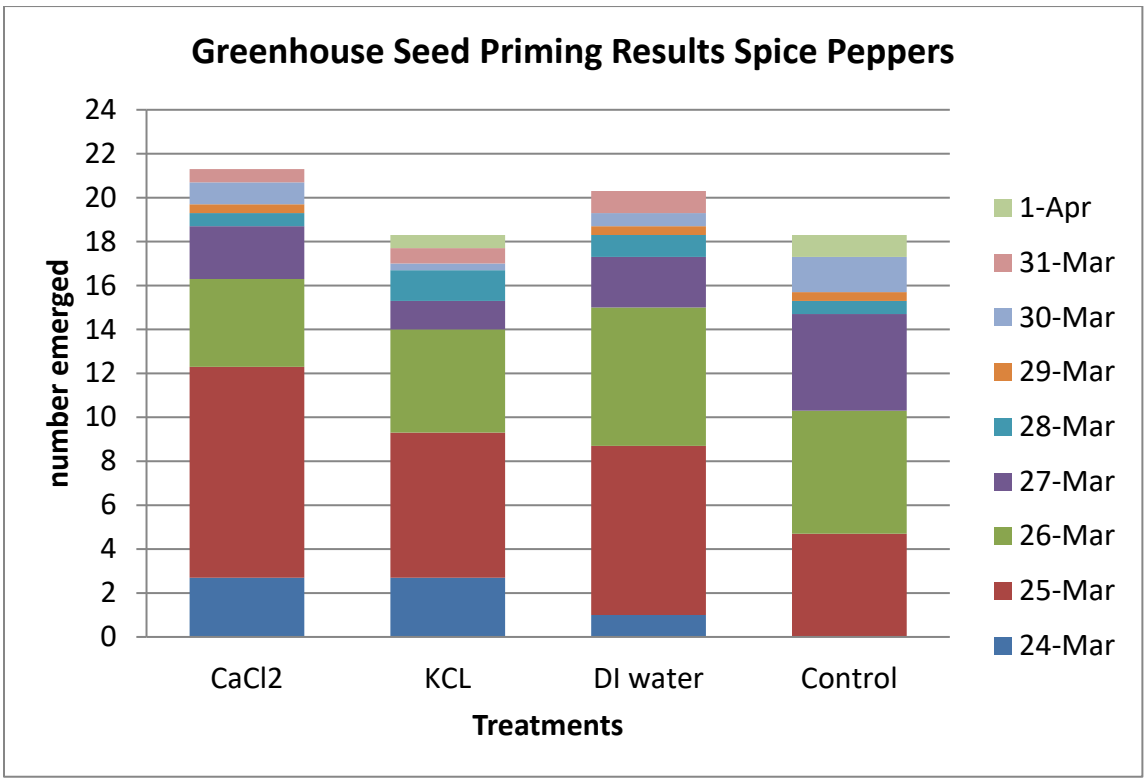
[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 9: 2018 Pepper Emergence (5-29-18 Planting) Cover Crop Treatment 4

	Emergence				
Treatment	**6/08/18**	**6/11/18**	**6/14/18**	**6/17/18**	**6/21/18**
Bell Primed	0.0 b[Z]	6.3 a	21.0 a	19.5 a	22.5 a
Bell Control	0.0 b	5.5 a	13.5 a	16.3 a	14.0 ab
Okala Primed	0.3 b	4.3 a	13.3 a	11.8 a	8.8 b
Okala Control	2.3 a	5.8 a	13.0 a	11.0 a	10.5 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.


Greenhouse Seed Priming Results Bell Peppers
Number emerged
24
22
20
18
16
14
12
10
8
6
4
2
0
CaCl2
KCL
DI water
Control
Treatments
1-Apr
31-Mar
30-Mar
29-Mar
28-Mar
27-Mar
26-Mar


Greenhouse Seed Priming Results Spice Peppers
number emerged
24
22
20
18
16
14
12
10
8
6
4
2
0
CaCl2
KCL
DI water
Control
Treatments
1-Apr
31-Mar
30-Mar
29-Mar
28-Mar
27-Mar
26-Mar
25-Mar
24-Mar

Pumpkin Variety Trial - Perkins

Cimarron Valley Research Station
Perkins, OK
Lynda Carrier, Lynn Brandenberger, Joshua Massey
Oklahoma State University

Introduction: Pumpkins are an important cash crop for vegetable producers within the state. Many cultivars of pumpkin contain high levels of beta carotene and other important nutrients for those that consume them. That said a major market for pumpkins within the U.S. is the fall holiday market which includes pumpkins for decorating and making Jack O' Lanterns. Based on the varieties from last year's trial, we reviewed the results, looked at desired characteristics and yield, then made selections and carried out a much smaller trial in 2018.

Methods and Materials: Trial plots were established by direct seeding by hand on 6/13/18 in strip-tilled rows. The trial included 9 varieties replicated 3 times and also six single plot observational specialty varieties (Table 1). Planting was on free-standing raised beds, bare soil with 10ft. row centers and finished seed spacing of two seeds every two feet in 30ft. long plots (30 seeds/plot). Strips of winter cover crops were left between rows as a wind-break and some were utilized for spray alleys. All plots received a mix of preemergence herbicide that included Sandea (halosulfuron) at 0.024 lbs. active ingredient (ai/acre) per acre, Command 3ME (clomazone) at 0.15 lbs. ai/acre, Curbit (ethalfluralin) at 0.56 lbs. ai/acre and Glyphosate at 3 pts/acre on 6/13/18. Plots received approximately 90 lbs. of actual nitrogen per acre from urea (46-0-0) and Blossom booster (10-20-10) applied through the drip irrigation system. Plots were scouted for pest problems weekly and insect control was initiated on 7/18/18 primarily control of squash bug, disease control began on 8/7/18 for control of powdery mildew and other pathogens. Crop water needs were met using regular scheduled irrigations from the drip irrigation system.

Results: Yield in pounds per acre varied significantly for the Jack O' Lantern group of pumpkins (Table 2). The Jack O' Lantern types recorded the highest yields, from a high of 33,244 lbs. of fruit per acre to a low of 8,367 lbs. per acre. The highest yielding cultivars in this group were Mustang PMR, Camaro PMR, Mvskoke (Creek/Seminole), recorded 33,244, 30,469 and 22,860 lbs. of fruit per acre, respectively. Mvskoke had significantly less plants per acre than the other Jack O' Lanterns. Seeds from Mvskoke were saved from a previous year's seed increase and germination was not as good as other varieties. The highest yielding Pie pumpkin was Hijinks with 13,351 lbs. per acre, however there were no significant differences for yield within the group.

Yield for the specialty pumpkins was reported as number of fruit per plot due to the small number of plots and variance in plot stands (Table 3). Specialty pumpkins ranged from a high of 5.3 fruit/plant for Blaze to a low of 0.5 fruit/plant with Winter Luxury.

The number of fruit per acre for the Jack O' Lantern group ranged from a high of 2,952 for Racer Plus to a low of 1,307 fruit per acre for Valenciano. (Table 2). The Pie pumpkins produced a high of 3,630 for Fall Splendor Plus and a low of 2,710 fruit per acre with Moonshine (Table 2).

Average fruit weights for the Jack O' Lantern pumpkins ranged from a low of 6.0 to a high of 15.3 lbs. per fruit (Table 2). Mvskoke (Creek/Seminole), Mustang PMR, and Camaro PMR had average fruit weights of 15.3, 11.9, and 11.1 lbs. per fruit, respectively, as the largest in this category. Rival PMR, Valenciano, and Racer Plus had the smallest sized fruit in this category with average fruit weights being 8.9, 6.5, and 6.0 lbs., respectively. Fall Splendor Plus, Hijinks,

and Moonshine were the three pie pumpkin varieties with average fruit weights of 2.9, 3.8, and 4.0 respectively. Average fruit weights for the specialty pumpkins ranged from 1.0 lbs. for Toad and 6.6 lbs. for Knuckle Head (Table 3).

Conclusions: This year's trial included 9 cultivars from four different seed sources for the replicated trial and six different cultivars for the specialty pumpkin observational trial. Overall most cultivars were hybrids, except Mvskoke (Creek/Seminole) which was a Native American Heirloom cultivar. Although prized because of its high level of beta carotene this pumpkin performed well in other ways, but there was quite a bit of variability in fruit size and this should be taken into consideration for those doing on-farm trials. Mustang PMR had the largest pumpkins and was the highest yielding, however Racer Plus had the highest number of fruit. In the pie pumpkins Hijinks yielded well overall with average fruit weights in the 3 to 4 lbs. range. The specialty pumpkins were provided by Johnny's and Sakata seed, but seed were limited and therefore we were only able to plant one plot of each cultivar. Because of this we did have some issues with poor stands from some of these and we didn't analyze data from these plots as there were no replications to compare data from.

Consumer preferences were noted for each of the types included in the trial. Observations indicated that the most popular types included the multi-colored specialty types including: Both Blaze and Carnival were well received as were Knuckle-Head and Toad. Turks Turban and Winter Luxury were low yielding. Preferences for the Jack O' Lantern types included those with dark orange color and a round shape as were the white colored pumpkins. Rival PMR and Camaro PMR both had nice color and shape, Both Moonshine and Valenciano being white pumpkins were popular. The Mvskoke pumpkin was well received due to it being a Native American heirloom, 'peach' color and its diverse shapes. Pie pumpkins with good handles were popular, Fall Splendor Plus and Hijinks both had longer handles and children were able to pick them up easily.

Variety trials provide growers with information to help them make the best choices for producing a particular crop on their farm. Every farm is different and often cultivars will have specific areas that they will perform well in and other areas where they do not. Cultivar performance will also vary from year to year due to differences in weather, disease, and insect pressure. The authors want to state that it is an advantage for growers to do some trialing of promising cultivars on their own farm before "betting" the entire year's crop on a specific cultivar. Last, the authors would encourage the reader to take a look at the photos in Figure 1 that show the mature pumpkin fruit at harvest.

Acknowledgements: The authors wish to thank Tim Hooper for his valuable help during the harvest of the trial. We also want to thank the personnel from the Cimarron Valley Research Station for their help and assistance in completing this trial and also wish to thank seed companies for supplying seed for this trial.

Table 1. 2018 Pumpkin variety trial, Perkins, OK, Variety descriptions from seed companies.

Variety	Seed Source	Hybrid or Open pollinated	Type	Days to maturity	Weight in lbs.	Color
Group 1 Jack O' Lantern						
Camaro PMR	Twilley	Hybrid	Jack O' Lantern	110	20-23	Orange
Mustang PMR	Seedway	Hybrid	Jack O' Lantern	100	22	Orange
Mvskoke (Creek/Seminole)	Sanmann	Open pollin.	Jack O' Lantern	100	16	Orange
Racer Plus	Johnny's	Hybrid	Jack O' Lantern	85	12-16	Orange
Rival PMR	Johnny's	Hybrid	Jack O' Lantern	90	15-20	Orange
Valenciano	Johnny's	Hybrid	Jack O' Lantern	110	10-15	White
Group 2 Pie						
Hijinks	Sakata	Hybrid	Pie	100	7-9	Orange
Moonshine	Johnny's	Hybrid	Jack O' Lantern/Pie	110	8-12	White
Fall splendor Plus	Sakata	Hybrid	Pie	105	4-6	Orange
Specialty types						
Blaze	Johnny's	Hybrid	Specialty	100	3	Bi-color
Carnival	Johnny's	Hybrid	Specialty	95	1.5	Multi-color
Knuckle Head	Johnny's	Hybrid	Specialty	105	12-16	Warty
Toad	Sakata	Hybrid	Specialty	85	1.5-2.5	Warty
Turk's Turban	Johnny's	Hybrid	Gourd	95	3-7	Multi-color
Winter Luxury	Johnny's	Hybrid	Pie netted	105	6-9	Orange

Table 2. 2018 Pumpkin replicated variety trial, Perkins, OK, Harvested on 9/20/18.

Variety	Seed Source	Avg # plants/acre	Yield (lbs/acre)	Number fruit/acre	Average wt. (lbs.)
Group 1 Jack O' Lantern					
Camaro PMR	Twilley	2710 a	30,469 a	2807 a	11.1 b
Mustang PMR	Seedway	3049 a	33,244 a	2710 ab	11.9 ab
Mvskoke (Creek/Seminole)	Sanmann	1258 b	22,860 ab	1597 bc	15.3 a
Racer Plus	Johnny's	3291 a	17,866 ab	2952 a	6.0 c
Rival PMR	Johnny's	2516 a	21,163 ab	2420 abc	8.9 bc
Valenciano	Johnny's	2662 a	8,367 b	1307 c	6.5 c
Group 2 Pie					
Hijinks	Sakata	3824 a	13,351 a	3533 a	3.8 a
Moonshine	Johnny's	3001 a	10,886 a	2710 a	4.0 a
Fall splendor Plus	Sakata	3340 a	11,227 a	3630 a	2.9 b

[z] Numbers in a column and crop group followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 3. 2018 Specialty Pumpkin Demonstration varieties, Perkins, OK Harvested on 9/20/18

Variety	Seed Source	Number seeds planted[z]	Number Plants	% Germ.	Yield Number fruit	Avg wt. (lbs.)	Average Number fruit/plant
Specialty Pumpkins							
Blaze	Johnny's	32	20	63	106	2.2	5.3
Carnival	Johnny's	23	5	22	24	1.6	4.8
Knuckle Head	Johnny's	39	30	77	20	6.6	0.7
Toad	Sakata	110	101	92	255	1.0	2.5
Turk's Turban	Johnny's	35	32	91	23	1.9	0.7
Winter Luxury	Johnny's	24	23	96	12	3.5	0.5

[z]Specialty pumpkins were not replicated, harvested once, ripe fruit only.

Figure 1. 2017 Pumpkin replicated variety trial, Perkins, OK, Photo record of mature pumpkin fruit at harvest.

Camaro PMR

Mustang PMR

Mvskoke (Creek/Seminole)

Racer Plus

Rival PMR

Valenciano

Hijinks

Moonshine

Fall Splendor Plus

Blaze

Carnival

Knuckle Head

Toad

Turk's Turban

Winter Luxury

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Spring Fresh Radish Trial - Perkins

Cimarron Valley Research Station, Perkins, OK
Lynn Brandenberger and Lynda Carrier
Oklahoma State University

Introduction and Objectives: This trial was completed as an observational trial in cooperation with the South East Vegetable Guide group. The trial was repeated at four different locations (Louisiana, Kentucky, Tennessee, and Oklahoma. Each site received seed from the trial coordinator in Louisiana and planted according to their respective sites. The primary objective was to observe the performance of each of the 16 cultivars in the trial across different locations and environmental conditions to provide information for making recommendations in SE U.S. Vegetable Crop Handbook.

Methods and Materials: Soil preparation included using a tractor drawn rotary mower to terminate the winter cover crop, rototilling twice with a tractor drawn rototiller at 4-6 inches depth during a three week period prior to planting. Final soil preparation was completed on 3/13/18 by applying Treflan (trifluralin) PPI at a rate of 0.75 lbs. a.i./acre, applying 50 lbs. actual nitrogen per acre using 17-17-17 then finish tilling with a tractor drawn rototiller at 2-3 inches depth. Direct seeding was completed using a research cone planter configured to plant four rows on six inch centers in plots that were five feet long, seed spaced at 12 seeds/foot. Water needs of the crop were provided through a micro-sprinkler system that covered the entire bed width.
Harvests were initiated on 4/26/18 and completed on 5/11/18. Harvest protocol included inspection of radish plants for root development and harvesting when a majority of roots had attained marketable size then harvesting a two feet length of the two middle rows of each plot. Immediately following harvest, roots were washed then sorted for marketable and non-marketable roots based on U.S.D.A. #1 standard of roots being $\geq$5/8 inch in diameter with few or no blemishes. Ratings were made for the exterior root color and interior color/texture of roots, ratings were on a 1 to 5 scale where 1 would be the least desirable and 5 would be the most desirable.

Results and Discussion: Plant stands ranged from a low of 15% for Ping Pong to a high of 75% for Bacchus and 70% for Runder Schwarzer (Table 1). Eight cultivars had yields that exceeded 1.2 lbs. of marketable roots per two square feet of row space. Nero and Stargazer had yields of 3.8 and 3.7 lbs., respectively compared to several other cultivars that had less than 1.0 lbs. Reasons for cull roots included split roots, small roots (<5/8 inch diameter), curved roots, and just plain ugly roots. Exterior color ratings were recorded and ranged from a low of 1.0 which represented the least desirable appearance to a high of 4.8 which was close to the highest rating possible (Figure 1). Five cultivars had exterior color ratings that were 4.0 or above, this included Bacchus (4.0), Cherry Bell (4.8), Ping Pong (4.8), Pink Beauty (4.2), and Runder Schwarzer (4.0). Interior color ratings ranged from a low of 2.0 for Red Head to a high of 4.5 for both Bacchus and Pink Beauty.

Acknowledgements: The authors wish to thank Kathryn Fontenot with Louisiana State University for coordinating the trial and for securing and sending seed to each site.

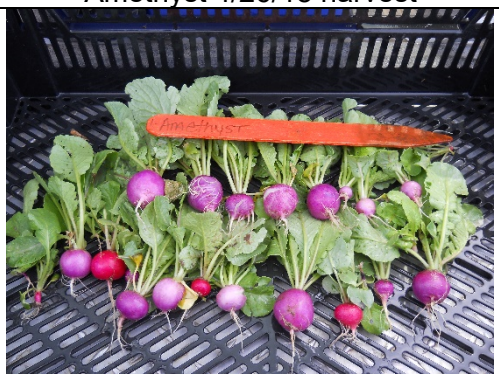
Spring 2018 Radish Observational Trial Results, Oklahoma State University

Variety	Harvest date	Plant Stand %	Number USDA#1	Weight USDA#1	Cull Reasons	Exterior color rating	Interior color rating
Amethyst	4/26/18	65	13	0.55[z]	Small/splits	3.0[y]	3.5[x]
Bacchus	4/26/18	75	30	1.33	Splits	4.0	4.5
Cherry Bell	4/26/18	35	15	0.86	Splits	4.8	3.0
Cook's Custom Blend	4/26/18	65	17	0.87	Small/splits	3.5	3.0
Easter Egg	4/26/18	35	12	0.55	Splits	3.5	4.0
Mardi Gras	4/26/18	25	4	0.24	Small/splits	1.0	4.0
Nero	5/11/18	45	16	3.80	Small	3.5	4.0
Ping Pong	5/07/18	15	11	1.50	Few culls	4.8	4.0
Pink Beauty	4/30/18	65	23	1.35	Small/splits	4.2	4.5
Red Head	4/30/18	45	18	0.64	Small	4.0	2.0
Runder Schwarzer	5/11/18	70	14	2.45	Small	4.0	4.0
Sora	4/30/18	65	13	0.55	Small/splits	3.5	4.0
Sparkler	5/07/18	50	14	2.60	Small	3.5	3.0
Stargazer	5/11/18	65	11	3.70	Small	2.0	3.0
Valentine	5/11/18	25	4	0.95	Small/curved Ugly	1.0	3.5
Watermelon	5/11/18	20	4	1.20	Small/ugly	1.0	2.5

[z]Weight of USDA#1 radishes is given in pounds harvested from two rows both two feet in length.
[y]Exterior color rating based on a 1 to 5 scale with 1 being least desirable and 5 being most desirable color.
[x]Interior color and quality rating based on a 1 to 5 scale with 1 being the least desirable color and texture and 5 being the most desirable color and texture.

Figure 1. 2018 Perkins, OK radish trial photos

Amethyst 4/26/18 harvest



Amethyst internal quality

Bacchus 4/26/18 harvest

Bacchus internal quality

Cherry Bell 4/30/18 harvest

Cherry Bell wider view

Cook's Custom Blend 4/26/18 harvest

Cook's Custom Blend internal quality

Easter Egg 4/26/18 harvest

Easter Egg internal quality

Mardi Gras 4/30/18 harvest

Mardi Gras internal quality

Nero 5/11/18 Harvest

Nero internal quality

Ping Pong 5/7/18 harvest

Ping Pong internal quality

Pink Beauty 4/30/18 harvest

Pink Beauty internal quality

Red Head 4/30/18 Harvest

Red Head internal quality

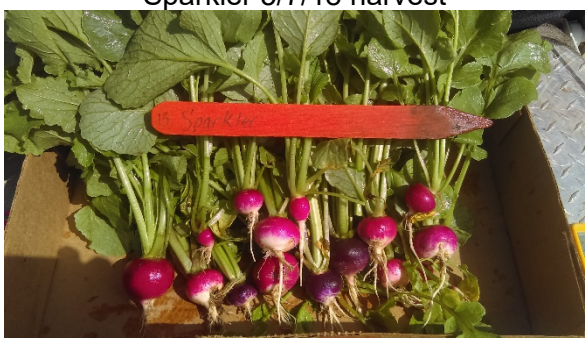
Runder Schwarzer 5/11/18 harvest

Runder Schwarzer internal quality

Sora 4/30/18 harvest

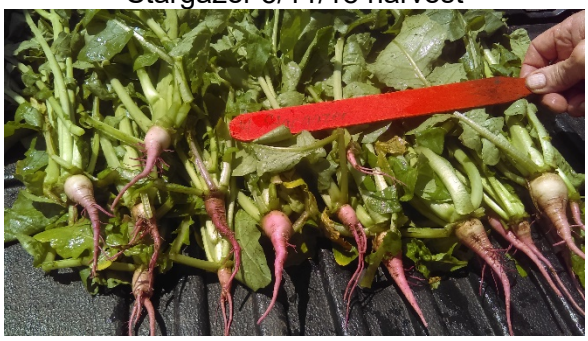
Sora internal quality

Sparkler 5/7/18 harvest

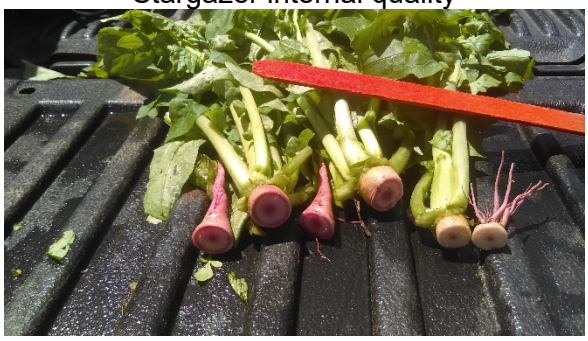


Sparkler internal quality

Stargazer 5/11/18 harvest



Stargazer internal quality



Valentine 5/11/18 harvest

Valentine internal quality

Watermelon 5/11/18 harvest

Watermelon internal quality

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Tomato Mulch Study – Stillwater

Joel Kliewer, Lynda Carrier, Lynn Brandenberger
Oklahoma State University
Stillwater, OK

Introduction and Objectives: Tomato [*Lycopersicon lycopersicum* (L.) Karsten] originated in South America in Bolivia or Peru. It is a warm weather crop and a member of the Solanaceae family—also known as the nightshade family. Tomatoes did not become popular in the United States until later in the 1800s but were introduced in 1710. Mulches are often used when cultivating tomatoes; they maintain moisture, reduce weeds, and help fruit quality (Decoteau, pp. 380-92). In the 1950s, polyethylene mulch (plastic) was introduced and provided many benefits for vegetable farmers by ultimately modifying the microclimate the plants grew in and causing better growth conditions (Lamont, 2005). Plastic mulches do have problems though, they must be disposed of at the end of the season and are not environmentally friendly. One problem with polyethylene mulch is that, in perennial crops especially, it can deteriorate into pieces over time and contaminate the soil. However, other biodegradable mulches have been studied and found to be possible replacements-both in environmental and agronomic aspects (Touchaleaume et. al, 2016; Coolong, 2010).

Due to the possible environmental hazards and removal issues with plastic mulch—such as disposal, researchers are looking into biodegradable plastic mulches that can attain the same benefits without the problems of polyethylene mulches. Some have shown similar results but have yet to gain popularity worldwide (Miles, 2017). Paper mulch has been looked into as far back as 1931 and was found to improve plant growth, moisture retention, and weed control. However, it was considered unfeasible because of its cost, set up, and maintenance (Smith, 1931). Technological advances since this time have allowed for easier laying of paper mulch; this and its eco-friendly properties make it a prime candidate for further research for wide scale use.

Comparing different mulches is important in determining which will work best for the specific needs of a grower and which will yield more produce. Plastic mulch and biodegradable mulches were examined and their effects were compared in a study done with tomatoes by Moreno and Moreno. The marketable yields were similar with both types of mulches, but each has its advantages and disadvantages. The biodegradable mulch can deteriorate much faster than the plastic, but can be left in the field to add to the soil. Plastic mulch requires removal at the end of the season; it also has more of a negative effect on the microbiological properties of the soil than the biodegradable mulch. Both increased the temperature of the soil, but plastic increased it the most (Moreno and Moreno, 2008). Therefore, depending on the growing climate of an area, one or the other might be more preferred.

The objectives for this trial were to examine weed control, weeding time, and yield differences in tomatoes from three different treatments (paper and plastic mulches, and bare soil).

Methods: Tomatoes were direct seeded into soilless media [Sungro Professional Growing Mix] in the finish containers [Landmark plastic; 4 x 9 (36 cell) six-packs] on 3/19/18 and were grown in a university greenhouse until 4/20/18 when transplants were moved to an outdoor hardening-off facility. The cultivar used was Bella Rosa which is a determinate variety. Treatments included paper and plastic mulches and bare soil. Raised beds, mulching materials, and drip tape were installed on 5/10/18. Tomatoes were transplanted into all plots on 5/11/18 with in-row spacing at two feet apart with a total of six plants per treatment plot. Tomatoes were supported using the stake and weave method with baling twine and metal pipes. Three lbs. of 46-0-0 fertilizer was added through an injector on 6/8/18. Additionally, on 6/15/18, 6/27/18, and 7/19/18 10-30-20 fertilizer was also added through an injector at a rate of three lbs., three lbs., and one and a half

lbs. per application respectively. An equivalent of 51.5-54.5-36.3 lbs. per acre of N, P_2O_5, and K_2O was applied during the trial period to meet crop fertility needs according to soil testing results. Insect pests included tobacco horn worm and yellow-striped armyworms which were treated with Warrior insecticide. (lambda-cyhalothrin)—applied on 7/5/18 at a rate of 1.25oz./acre. The experimental design included a randomized block design with five replications. Treatment plots consisted of free-standing raised soil beds with drip irrigation tape buried in the middle. Weed coverage was subjectively measured on 5/29/18 and 6/15/18 and the time required to weed each plot was also recorded on these days. Harvest started on 7/12/18 and after that was done regularly on Mondays, Wednesdays, and Fridays—a total of 15 harvests were recorded. Fruit were determined as marketable or culls, and those in both categories were counted, then weighed for each plot.

Results: Significant differences were observed for weed coverage between bare soil and mulched plots on both recording dates, however, there were no differences between paper and plastic mulched plots (Table 1). Percent weed coverage ranged from lows of 1.8 and 1.6% for paper and plastic mulches, respectively, on 5/29/18 to a high of 17.8% for bare soil. Weeding time on 6/15/18 showed a significant difference between all treatments—bare soil required the most time (average of 214 seconds), followed by paper mulch (average of 90.2 seconds), and plastic mulch (average of 36.3 seconds).

Paper mulch had higher marketable yields than either plastic mulch or bare-soil treatments (Table 2, Figure 1) varying from a high of 27,777 lbs. per acre for paper mulch to lows of 21,985, and 23,993 lbs. per acre for plastic and bare soil treatments, respectively. Non-marketable yields did not vary between treatments, but overall yields which included both marketable and non-marketable yields were highest for the paper mulched treatment (43,125 lbs./acre) compared to plastic and bare-soil treatments (35,985 and 37,500 lbs./acre, respectively). Average fruit weight was highest for paper mulched tomatoes (0.48 lbs./fruit) compared to plastic mulched (0.38 lbs./fruit) and did not vary for bare-soil (0.45 lbs./fruit) compared to the paper mulch.

In summary, paper mulch provided similar weed control compared to plastic mulch and higher levels of weed control compared to bare soil. In addition yield was highest in the study with the paper mulch and there was no need to remove the paper mulch from the field at the end of the season.

Acknowledgements: The author would like to thank Dr. Lynn Brandenberger, Lynda Carrier, and Micah Anderson for all their help and guidance in the research process and Omniafiltra LLC for donating the paper mulch.

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Table 1. 2018 Mulch study with tomato, weed coverage, weeding times, mulch removal times. The Botanic Garden, Stillwater, OK

	Percentage		Seconds	
Treatment	**Weed Coverage** 5/29/18	**Weed Coverage** 6/15/18	**Weeding Time** 6/15/18	**Mulch removal time**
Paper	1.8 b[z]	3.0 b	90.2 b	0
Plastic	1.6 b	1.0 b	36.2 c	184
Bare Soil	17.8 a	11.2 a	214.0 a	0

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan’s Multiple Range Test where P=0.05.

Table 2. 2018 Mulch study with tomato, harvest results. Harvested 7/12/18 to 8/20/18 (15 harvests). The Botanic Garden, Stillwater, OK

	Marketable yield/acre		Non-marketable	Marketable + Non marketable	Average fruit weight
Treatment	**Number**	----------**Pounds**----------			
Paper	52,417 a[z]	27,777 a	15,348 a	43,125 a	0.48 a
Plastic	43,996 b	21,985 b	14,000 a	35,985 b	0.38 b
Bare Soil	43,996 b	23,993 b	13,507 a	37,500 ab	0.45 ab

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan’s Multiple Range Test where P=0.05.

Figure 1. Mulch study photos

Transplanting on paper mulch

Maturing crop 8-6-18

Harvest 8-8-18: 1 of 15 harvests

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Tomato Cultivar Trial 2017 - Boswell

Boswell, OK, Choctaw County
Marty Montague, Patti Testerman, Macy Jo Maxwell and Jim Shrefler, SE District OCES
Lynn Brandenberger and Lynda Carrier, OSU Department of Horticulture
Cooperating Growers – Rod and Christine Hammond

In southeast Oklahoma there is interest on the part of retailers to source locally grown produce and tomatoes are a primary concern. Whether for commercial scale sales or market gardeners, successful production of vegetables requires using cultivars that are adapted to the production location and that will provide adequate yields of marketable quality fruits. Trials reported recently for other areas of Oklahoma identified several cultivars that performed well for mid-summer production. This trial was conducted on a local farm to further evaluate some of these previously identified cultivars and included Solar Fire, Celebrity, Bella Rosa, Valley Girl and Red Morning.

The trial site was an established vegetable garden and was planted without bedding. Fertilizer was applied based on the grower's usual practice (which resulted in tomato plants with good vigor and color). Rows were spaced on six foot centers. Tomato plants were grown in the OSU Horticulture greenhouses in Stillwater and transplanted on May 1, 2017. Experimental plots consisted of a 12 foot section of row with six plants spaced 2 feet apart. There were three replications of each cultivar. Plants were supported using a stake and weave system. Drip irrigation was installed along the plant rows.
Fruit were harvested 8 times over four weeks by collecting all fruit that were near full pink stage. Harvested fruit were classified as either marketable (fruits with little or no blemishes) or cull (severely cracked, decayed, insect damage, sunburned). Marketable fruit were weighed and counted and culls were weighed.

Initial crop development was normal and an initial harvest was made at 8 weeks after transplanting. Over the next week there was a total of 10 inches of rain at the trial location. Substantial fruit set had already occurred and the support system stakes began to lean substantially and could not be straightened due to the weight of the vines and fruit. Exposed fruit began to show signs of sunscald. In order to protect fruit from direct exposure to sunlight, metal hoop were used to support a polyester crop blanket material above the rows. Some incidence of possible leaf spot disease became evident and an application of Azoxystrobin and liquid copper fungicides was made on July 13.

Yield data are shown in the table. For marketable yield, differences were found for each of the total number of fruit, weight of fruit harvested during the first two weeks of the harvest period and for the total harvest. Red Morning produced the greatest number of fruit while Celebrity had the lowest and the remaining cultivars fell in between these. For the early harvest period Red Morning had the highest yield while the others did not differ significantly. Over the entire harvest period, Celebrity yielded less than the other cultivars. However, there were no differences detected among that group. The weight of individual fruits that were considered marketable ranged from 0.24 to 0.36 lbs. The weights of individual Red Morning fruits were less than those of the remaining cultivars.

There were no differences among the weights of the non-marketable fruit. Based on casual observation, the main causes of loss of marketability included sunburn, cracking, chewing insect feeding damage, stink bug damage, and green shoulders. In summary, all varieties in the trial produced appreciable yields of marketable quality fruit, indicating that selection of these varieties based on the previous trialing within the state was advantageous.

Tomato cultivars, yields and fruit weights in the 2017 tomato cultivar trial at Boswell, OK.

	Marketable fruit / acre			Non-marketable fruit weight / acre (lbs)	Marketable Individual fruit weight (lbs)
Cultivar	Total Number	Early harvest weight (lbs)[z]	Total harvest weight (lbs)		
Solar Fire	68800 b[y]	2628 b	19340 a	6144	0.28 ab
Celebrity	35200 c	2668 b	11569 b	7792	0.32 a
Bella Rosa	61800 b	2228 b	22000 a	4996	0.36 a
Valley Girl	64400 b	1824 b	19008 a	6664	0.30 ab
Red Morning	99400 a	5160 a	23690 a	6328	0.24 b

[z]Early harvest is for fruit harvested during the initial two weeks.
[y]Numbers within a column followed by the same letter do not differ based in Duncan's Multiple Range Test where P=0.05.

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Pest Management

Pre-Plant Preemergence Weed Control in Pepper

Lynn Brandenberger, Lynda Carrier1, Misha Manuchehri2
Oklahoma State University Departments of
Horticulture and Landscape Architecture1 and Plant and Soil Science2
In Cooperation with
Schantz Family Farms, Hydro, OK

Introduction: Oklahoma pepper production includes both fresh market and processing peppers. These crops are normally established with transplants once the danger from frost is past. Several weed species including Palmer amaranth (Amaranthus palmeri S. Wats.), tumble pigweed (Amaranthus albus L.), carpetweed (*Mollugo verticillata* L.), goathead (Tribulus terrestris L.), spurge (Euphorbia species), buffalobur (Solanum rostratum Dun.), and purslane (Portulaca oleracea L.) are major competitors with warm season pepper crops. Although some herbicides are labeled for this crop, many are not effective enough to control weeds throughout the season. Weed control from herbicides is normally supplemented by cultivation and hand hoeing. Costs for hand hoeing can be several hundred dollars per acre if labor is available. Therefore there is a need to identify potential preemergence herbicides that can be utilized for controlling broadleaf weeds in pepper fields particularly those that can provide a more extended period of control. The objective of this study was screening herbicides that may have potential for weed control in commercial pepper production when applied early in the season as a pre-plant preemergence application.

Methods and Materials: All treatments in this study were applied pre-transplant to clean tilled soil on 4/19/18 with transplanting of pepper taking place later during the day of 4/19/18. Treatments included 13 different preemergence treatments and an untreated check for comparison (Table 1). Herbicide treatments in the study included Dual Magnum (S-metolachlor) at 0.75 lbs. ai/acre, Fierce (flumioxazin + pyroxasulfone) at 0.052, 0.104, and 0.207 lbs. ai/acre, League (imazosulfuron) at 0.094 and 0.188 lbs. ai/acre, Reflex (fomesafen) at 0.50 and 0.75 lbs. ai/acre, Surflan (oryzalin) at 0.56 and 0.84 lbs. ai/acre, and Zidua (pyroxasulfone) at 0.05, 0.10, and 0.15 lbs. ai/acre. Treatments were applied to plots four rows wide (12 feet) by 15 feet in length in a randomized design with three replications. Each treatment was applied with two passes of a six foot wide hand-boom CO_2 plot sprayer at an overall rate of 25 gallons per acre and were incorporated into the soil using overhead irrigation. Plots had crop plant counts recorded on 5/4/18. On 6/1/18 crop plant counts were recorded again along with ratings for injury to the crop and control ratings for Palmer amaranth.

Results: Crop injury ratings were made on a 0-100% basis on 6/1/18 and varied from 12 to 78% injury (Table 1). The untreated check and Reflex at 0.50 lbs. ai/acre had the lowest levels of injury at 12 and 15%, respectively. Zidua treatments had the highest level of injury at 78, 57, and 52% injury, respectively, for rates at 0.15, 0.10, and 0.05 lbs. ai/acre. Palmer amaranth control did not vary between treatments, but was zero for the untreated check. Viable pepper plants were counted in the middle two rows of each plot on two different dates and varied significantly on 6/1/18. Surflan at 0.56 lbs. recorded the highest number of living plants with 17 plants. Several treatments including the untreated check, Dual Magnum, League at both rates, Reflex at 0.5 lbs., Surflan at 0.84 lbs., and Zidua at 0.05 lbs. had plant numbers between 11-16. The lowest number of plants were observed in Fierce at all rates, Reflex at 0.75 lbs., and Zidua at 0.15 lbs. ai/acre which ranged from 3 to 7 plants per plot.

Discussion: This year's pre-plant preemergence study on pepper indicates that both League and Surflan may merit further consideration for the IR-4 program and future labeling. Both of these materials appear to be tolerated well by pepper based on the 6/1/18 plant counts.

Materials that appear to be the most damaging in the study included Fierce at all rates, the higher rate of Reflex, and the higher rates of Zidua all which resulted in lower plant numbers on 6/1/18. That said, there were many setbacks due to weather i.e. nine days during the first half of April recorded below freezing temperatures some as low as 20°F. The cool spring combined with general plant establishment issues, etc. could very well account for the lack of clear-cut results and the need for future work with several of these compounds that showed promise this year and in 2017.

Acknowledgements: The authors want to thank the Schantz family for providing an area for the study and for their support of the effort. They also want to thank the Oklahoma Department of Agriculture Food and Forestry for their support through the Specialty Crop block grant program.

Table 1. 2018 Pepper Herbicide study Pre-transplant preemergence weed control. Crop injury, Weed control, and Plant counts. Hydro, Ok

Applied 4/19/18	6/1/18		Number plants in 2 - 15' rows	
Treatment (lbs. ai/acre)	% Injury to crop	% Control Palmer Amaranth	5/4/18	6/1/18
Untreated check	12 d [z]	0 b	10 a	11 abcd
Dual Magnum 0.75	30 bcd	100 a	10 a	10 abcd
Fierce 0.052	38 abcd	98 a	8 a	7 cd
Fierce 0.104	30 bcd	100 a	9 a	7 cd
Fierce 0.207	60 ab	100 a	9 a	3 d
League 0.094	33 bcd	100 a	10 a	15 abc
League 0.188	38 abcd	83 a	12 a	16 ab
Reflex 0.50	15 cd	100 a	9 a	13 abc
Reflex 0.75	37 abcd	100 a	8 a	7 cd
Surflan 0.56	20 bcd	100 a	11 a	17 a
Surflan 0.84	27 bcd	100 a	10 a	15 abc
Zidua 0.05	52 abcd	100 a	10 a	14 abc
Zidua 0.10	57 abc	83 a	10 a	9 bcd
Zidua 0.15	78 a	100 a	8 a	3 d

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

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Post-Plant Preemergence Weed Control in Pepper

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Horticulture and Landscape Architecture1 and Plant and Soil Science2
In Cooperation with
Schantz Family Farms, Hydro, OK

Introduction: Oklahoma pepper production includes both fresh market and processing peppers. These crops are normally established with transplants once the danger from frost is past. Several weed species including Palmer amaranth (Amaranthus palmeri S. Wats.), tumble pigweed (Amaranthus albus L.), carpetweed (*Mollugo verticillata* L.), goathead (Tribulus terrestris L.), spurge (Euphorbia species), buffalobur (Solanum rostratum Dun.), and purslane (Portulaca oleracea L.) are major competitors with warm season pepper crops. Although some herbicides are labeled for this crop, many are not effective enough to control weeds throughout the season. Weed control from herbicides is normally supplemented by cultivation and hand hoeing. Costs for hand hoeing can be several hundred dollars per acre if labor is available. Therefore there is a need to identify potential preemergence herbicides that can be utilized for controlling broadleaf weeds in pepper fields particularly those that can provide a more extended period of control. The objective of this study included screening preemergence herbicides that may have potential for weed control in commercial pepper production when applied early in the season as a post-transplant application.

Methods and Materials: All treatments in this study were applied post-transplant to clean tilled soil on 4/20/18 with all transplanting of peppers taking place on 4/19/18. Treatments included 13 different preemergence treatments and an untreated check for comparison (Table 1). Herbicide treatments in the study included Dual Magnum (S-metolachlor) at 0.75 lbs. ai/acre, Fierce (flumioxazin + pyroxasulfone) at 0.052, 0.104, and 0.207 lbs. ai/acre, League (imazosulfuron) at 0.094 and 0.188 lbs. ai/acre, Reflex (fomesafen) at 0.50 and 0.75 lbs. ai/acre, Surflan (oryzalin) at 0.56 and 0.84 lbs. ai/acre, and Zidua (pyroxasulfone) at 0.05, 0.10, and 0.15 lbs. ai/acre. Treatments were applied to plots four rows wide (12 feet) by 15 feet in length in a randomized design with three replications. All herbicide treatments were applied with two passes of a six foot wide hand-boom CO_2 plot sprayer at an overall rate of 25 gallons per acre and were incorporated into the soil with approximately 1.24 inches of rainfall during the period of 4/20/18-4/21/18. Ratings for crop injury and control of Palmer amaranth were completed on 6/1/18 using a 0 to 100% scale. Viable pepper plants were counted in the middle two rows of each plot on three different dates (6/1/18, 8/16/18, and 9/28/18).

Results: Injury ratings taken on 6/1/18 ranged from a low of 3% for the untreated check to a high of 82 and 100%, respectively, for Fierce at 0.104 and 0.207 lbs. ai/acre (Table 1). Other treatments that recorded significantly lower levels of injury included Dual Magnum (labeled herbicide), and Surflan at 0.56 lbs. ai/acre which recorded 13 and 10% injury, respectively. No differences were recorded for control of Palmer amaranth on 6/1/18. The number of viable pepper plants varied between treatments on 6/1/18 and 8/16/18. The untreated check, Dual Magnum, both rates of League and Surflan ranged between 16 to 18 plants per plot on 6/1/18. All three rates of Fierce, Reflex at 0.75, and Zidua at 0.10 and 0.15 lbs. ai/acre ranged from zero to a high of five plants per plot on 6/1/18. On 8/16/18 Surflan at 0.84 lbs. ai/acre had 18 plants per plot and was not different in plant numbers from the untreated check, Dual Magnum, and both League treatments which recorded from 12 to 16 plants per plot. The lowest number of plants per plot were recorded for all rates of Fierce, Reflex at 0.75, and the 0.10 and 0.15 lbs. ai/acre rates of Zidua which ranged from zero to six plants per plot.

Discussion: This year's post-plant preemergence study on pepper provides some indication that there are some herbicides that might be considered for the IR-4 program and future labeling. Peppers in this study exhibited tolerance to both League and Surflan with some of the highest plant counts in the study being recorded for these materials. On the other hand, all rates of Fierce and the two higher rates of Zidua were very damaging to the crop when applied post-transplant. That said, there were some setbacks due to weather i.e. nine days during the first half of April recorded below freezing temperatures some as low as 20°F. The cool spring combined with general plant establishment issues could very well account for the problems that were observed in the study with overall low plant numbers and the need for future work with several of these compounds that showed promise this year and in 2017.

Acknowledgements: The authors want to thank the Schantz family for providing an area for the study and for their support of the effort. They also want to thank the Oklahoma Department of Agriculture Food and Forestry for their support through the Specialty Crop block grant program.

Table 1. 2018 Pepper Herbicide study Post-transplant preemergence weed control. Crop injury, Weed control, and Plant counts. Hydro, Ok

Treatments applied on 4/20/18	**6/1/18**		**Number plants in 2 - 15' rows**		
Treatment (lbs. ai/acre)	**% Injury to crop**	**% Control Palmer Amaranth**	**6/1/18**	**8/16/18**	**9/28/18**
Untreated check	3 f[z]	85 a	18 a	16 ab	8 a
Dual Magnum 0.75	13 def	75 a	16 ab	13 ab	4 a
Fierce 0.052	42 c	100 a	5 cde	6 cd	5 a
Fierce 0.104	82 ab	100 a	4 cde	2 d	8 a
Fierce 0.207	100 a	100 a	0 e	0 d	4 a
League 0.094	27 cdef	92 a	17 a	15 ab	7 a
League 0.188	28 cdef	100 a	18 a	12 abc	4 a
Reflex 0.50	30 cde	100 a	9 bcd	11 abc	6 a
Reflex 0.75	38 cd	100 a	5 cde	6 cd	7 a
Surflan 0.56	10 ef	100 a	18 a	14 ab	6 a
Surflan 0.84	18 cdef	100 a	18 a	18 a	10 a
Zidua 0.05	30 cde	100 a	11 abc	10 bc	10 a
Zidua 0.10	35 cde	100 a	5 cde	6 cd	6 a
Zidua 0.15	65 b	100 a	3 de	3 d	2 a

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

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Control of Bacterial Spot on 'Red Mountain' Tomato, 2018

Brett Johnson, John Damicone, Dylon Teeter, and Brooke King
Department of Entomology and Plant Pathology

Introduction: Bacterial spot, caused by the bacterium *Xanthomonas* spp., is a destructive foliar disease of tomato. In a 2018 survey, this disease was identified in field-grown tomatoes throughout central and eastern Oklahoma. Control of bacterial spot has historically relied on spray programs with copper containing bactericides. The objective of this trial was to evaluate several commercially available bactericide and biological control products for efficacy in controlling bacterial spot of tomato in Oklahoma. The bactericidal products that were evaluated included Cueva, a formulation of copper octanoate, and Kocide 3000, a commonly used copper hydroxide formulation. The biological control product, Agriphage, contains a viral pathogen (phage) of the bacteria causing bacterial spot. The biological control product, Double Nickel, is a formulation of the *Bacillus amyloliquefaciens* strain D747, which has been shown to suppress the growth of bacterial plant pathogens. Actigard is a plant defense activator that induces systemic resistance to a wide range of plant pathogens.

Material and Methods: The trial was conducted at the Entomology and Plant Pathology Research Farm in Stillwater in a field of Easpur loam soil that was previously fallowed. Granular fertilizer (46-0-0 lb/A N-P-K) was incorporated into the soil just prior to transplanting on 11 May. The herbicides Treflan at 1.5 pt/A and Dual II Magnum at 1.5pt/A were applied between rows and incorporated before transplants were set in the field. Tomato plants were grown in formed beds covered with black plastic mulch, trellised by the stake and weave method, and drip irrigated when necessary. Plots consisted of 12-ft-long rows of 6 plants spaced 2 ft. apart. The row spacing was 8 ft. Treatments were arranged in a randomized complete block design with four replications. Replications were separated by 4-ft-wide buffer zones containing a single border plant. Treatments were directed to plants with 8005vs flat-fan nozzles using a CO2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 30 gal/A at 40 psi using two nozzles per row. All treatments except Agriphage were applied alone or in rotation on 7-d intervals beginning on 12 June. Agriphage was applied twice within a 7-d period alone or in rotation. Two border rows of tomato plants situated along each side of the trial were inoculated with *Xanthomonas* spp. on 27 June. Monthly rainfall totals were 3.88 in. for May, 5.97 in. for June, 3.12 in. for July, and 5.59 in. for Aug. Disease incidence, the percentage of leaves showing symptoms of bacterial spot including defoliated leaves, and defoliation alone, were visually assessed on three plants per plot on 10 Aug. and 9 Sept. Plots were harvested eight times between 7 July and 17 Aug. Data were analyzed by analysis of variance using the GLM procedure of SAS 9.4 and means were separated using Fisher's least significant difference test at P=0.05.

Results: Total rainfall during the cropping period of May through August was 2.68 in. above normal when compared with the 30-yr average. Temperatures were above normal in May and June, near normal in July, and below normal in August. There were no symptoms of bacterial spot prior to inoculation of border rows. Disease increased rapidly in all plots after inoculation (Table 1). The treatments of Actigard 50WG + Agriphage and Actigard 50WG + Kocide 3000 reduced bacterial spot incidence in July compared to the non-treated check. The Actigard 50WG + Agriphage treatment also reduced defoliation in July compared with the non-treated check. However, no treatment effects were evident for disease incidence or defoliation in August. Yield did not differ among treatments. However, marketable yield was numerically lowest in the Actigard 50WG + Agriphage treatment, which is consistent with reports of reduced yield resulting from Actigard 50WG. Some treatments reduced levels of bacterial spot. However, none provided

adequate disease control. This poor disease control may be due to conditions being persistently conducive for disease development.

Table 1. Evaluation of bactericides and biocontrols for control of bacterial spot on 'Red Mountain' tomato, 2018.

Treatment and rate/A (timing)[z]	Bacterial spot (%)		Defoliation (%)		Yield (cwt/A)	
	23 July	24 Aug.	23 July	24 Aug.	Marketable	Diseased
Non-treated check	87.5 ab[y]	96.7 a	41.7 a	75.9 a	49.3 a	9.1 a
Actigard 50WG 0.75 oz (1,4,7,10,13) Agriphage 2.3 pt (2,3,5,6,8,9,11,12,14,15)	71.2 c	91.7 a	23.3 b	68.3 a	39.2 a	7.3 a
Actigard 50WG 0.75 oz (1,4,7,10,13) Kocide 3000DF 1.25 lb (2,5,8,11,14)	72.9 c	93.3 a	30.9 ab	74.5 a	44.4 a	7.4 a
Double Nickel LC 3 qt (1,2,4,5,7,8,10,11,13,14)	89.2 a	89.2 a	45.0 a	70.8 a	44.4 a	8.8 a
Cueva FL 2 qt (1,4,7,10,13) Agriphage 2.3 pt (2,3,5,6,8,9,11,12,14,15)	79.2 bc	91.7 a	30.4 ab	72.5 a	48.4 a	8.1 a
P>F[x]	<0.01	0.23	0.05	0.60	0.90	0.92
LSD (P=0.05)	9.0	NS[w]	15.3	NS	NS	NS

[z] Timings 1 to 15 correspond to the spray dates of 1=12 June ,2=19 June, 3=25 June, 4=26 June, 5=3 July, 6=6 July, 7=10 July, 8=17 July, 9=20 July, 10=24 July, 11=31 July, 12=3 Aug., 13=7 Aug., 14=14 Aug., and 15=17 Aug.

[y] Means followed by the same letter are not statistically different according to Fischer's least significant difference (LSD) test at P=0.05

[x] Probability of a significant treatment effect.

[w] NS = Treatment effect not significant at P=0.05.

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Evaluation of fungicides for control of anthracnose on spinach

Stillwater, 2018
John Damicone and Dylon Teeter
Department of Entomology and Plant Pathology
Oklahoma State University

White rust (*Albugo occidentalis*) is the most important foliar disease of spinach in Oklahoma. The objective of this study was to evaluate fungicides for control of spinach white rust compared to reference treatments with the fungicides Cabrio and Cabrio alternated with Presidio. The experiment was conducted at the Entomology and Plant Pathology Research Farm in Stillwater in a field of Easpur loam previously cropped to spinach. Granular fertilizer (75-0-0 lb/A, N-P-K) was incorporated into the soil prior to planting the white rust susceptible cultivar 'Olympia' on 4 Apr 2018 at a seeding rate of two seeds per inch. Plots were top dressed with granular fertilizer (50-0-0 lb/A N-P-K) on 30 Apr 2018. The experimental design was a randomized complete block design with four replications. Fungicides were broadcast using flat-fan nozzles (Tee-jet 8002vk) spaced 18-in. apart with a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 25 gal/A at 40 psi. Treatments were applied on 7-day intervals beginning at the first true-leaf stage on 30 Apr. Rainfall during the cropping period totaled 2.06 in. for Apr and 3.88 in. for May. Plots received sprinkler irrigation as needed to promote crop and disease development. Disease was assessed by visually estimating the percentage of foliage with symptoms in three areas of each plot on 24 May. Disease incidence (percentage of leaves with symptoms) and severity (percentage of leaf area with symptoms) were also assessed on 24 May. Five, 6-in.-long row segments were harvested arbitrarily from the middle two rows of each plot. The harvested leaves were bulked and mixed, and disease severity was visually estimated on 30 blindly sampled leaves. Data were analyzed using the GLM procedure of SAS 9.3 and means were separated with Fisher's least significant difference test where indicated by a significant (P=0.05) treatment effect.

Rainfall during the cropping period was 2.43 in. below normal during the cropping period from April through May. Average monthly temperature was below normal in Apr and above normal during May. White rust did not develop in this trial but anthracnose, caused by the fungus *Colletotrichum dematium*, became severe by harvest compared to previous trials at this site. None of the treatments reduced levels of anthracnose compared to the non-treated check. Results are similar to previous trials at this site in which most fungicides except for Switch fail to control anthracnose. None of the treatments caused phytotoxicity symptoms.

Treatment and rate/A (timing)[z]	Diseased foliage[y]	Anthracnose (%) Incidence[x]	Severity[w]
LifeGard 1.11 oz (1-4)	29.2 a[v]	29.2 a	12.5 a
LifeGard 1.11 oz (1,3) Cabrio 20WG 0.75 lb (2,4)	26.2 a	26.2 a	8.3 a
CX-10252 1 qt (1-4)	24.6 a	24.6 a	9.6 a
Double Nickel LC 1 qt (1,3) Cueva 0.16F 2 qt (2,4)	32.9 a	32.9 a	13.0 a
Cabrio 20WG 0.75 lb (1,3) Presidio 4F 4 fl oz (2,4)	30.0 a	30.0 a	15.1 a
Cabrio 20 WG 0.75 lb (1,3)	29.2 a	29.2 a	8.4 a
Cabrio 20 WG 0.75 lb (1,3) Orondis Ultra 3.3F 8 fl oz (2,4)	30.8 a	30.8 a	13.8 a
Non-treated check	30.4 a	30.4 a	9.7 a
P>F[v]	0.95	0.10	0.15

[z] Timings 1 to 4 correspond to the spray dates of 30 Apr, 7 May, 14 May, and 21 May.
[y] Percentage of plot foliage with anthracnose.
[x] Percent leaves with anthracnose symptoms from 30 sampled leaves per plot.
[w] Percent leaf area with anthracnose symptoms from 30 sampled leaves per plot.
[v] Values in a column followed by the same letter are not significantly different at P=0.05 according to the LINES option of SAS PROC GLIMMIX.
[u] Probability of a significant treatment effect.

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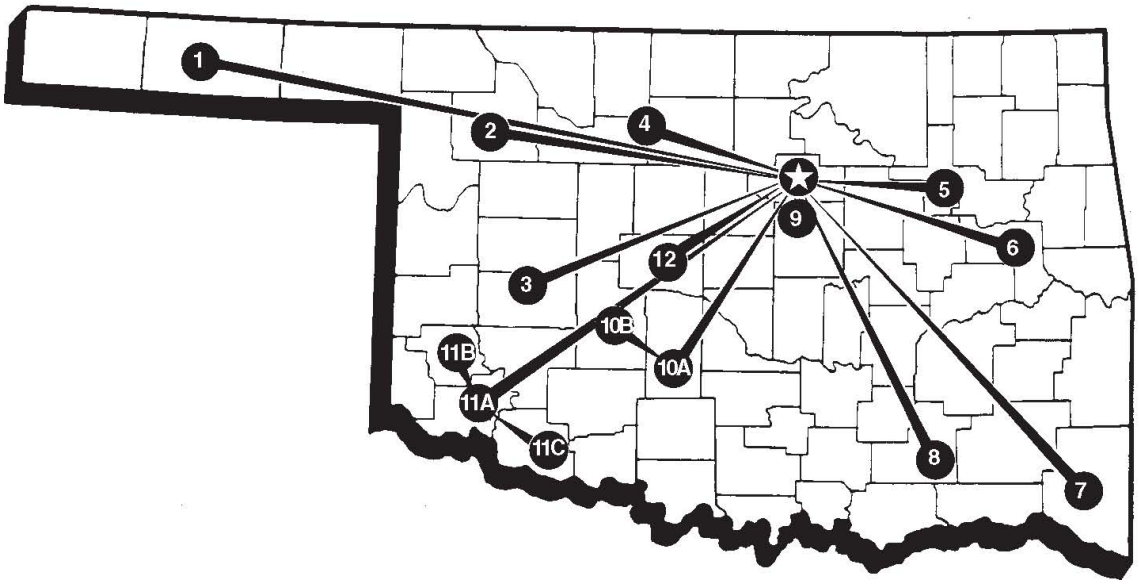
SI (METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units					*Approximate Conversions from SI Units*				
Symbol	**When you know**	**Multiply by**	**To Find**	**Symbol**	**Symbol**	**When you know**	**Multiply by**	**To Find**	**Symbol**
		LENGTH					**LENGTH**		
in	inches	25.40	millimeters	mm	mm	millimeters	0.0394	inches	in
ft	feet	0.3048	meters	m	m	meters	3.281	feet	ft
yd	yards	0.9144	meters	m	m	meters	1.094	yards	yds
mi	miles	1.609	kilometers	km	km	kilometers	0.6214	miles	mi
		AREA					**AREA**		
in^2	square inches	645.2	square millimeters	mm^2	mm^2	square millimeters	0.00155	square inches	in^2
ft^2	square feet	0.0929	square meters	m^2	m^2	square meters	10.764	square feet	ft^2
yd^2	square yards	0.8361	square meters	m^2	m^2	square meters	1.196	square yards	yd^2
ac	acres	0.4047	hectacres	ha	ha	hectacres	2.471	acres	ac
mi^2	square miles	2.590	square kilometers	km^2	km^2	square kilometers	0.3861	square miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.0338	fluid ounces	fl oz
gal	gallon	3.785	liters	L	L	liters	0.2642	gallon	gal
ft^3	cubic feet	0.0283	cubic meters	m^3	m^3	cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.7645	cubic meters	m^3	m^3	cubic meters	1.308	cubic yards	yd^3
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.0353	ounces	oz
lb	pounds	0.4536	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000 lb)	0.907	megagrams	Mg	Mg	megagrams	1.1023	short tons (2000 lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
°F	degrees Fahrenheit	(°F-32) /1.8	degrees Celsius	°C	°C	degrees Fahrenheit	9/5(°C)+32	degrees Celsius	°F
		FORCE and PRESSURE or STRESS					**FORCE and PRESSURE or STRESS**		
lbf	poundforce	4.448	Newtons	N	N	Newtons	0.2248	poundforce	lbf
lbf/in^2	poundforce per square inch	6.895	kilopascals	kPa	kPa	kilopascals	0.1450	poundforce per square inch	lbf/in^2

THE OKLAHOMA
AGRICULTURAL EXPERIMENT STATION
SYSTEM COVERS THE STATE



✪ **MAIN STATION—*Stillwater and adjoining areas***

1. **Oklahoma Panhandle Research and Extension Center—*Goodwell***
2. **Southern Plains Range Research Station—*Woodward***
3. **Marvin Klemme Range Research Station—*Bessie***
4. **North Central Research Station—*Lahoma***
5. **Oklahoma Vegetable Research Station—*Bixby***
6. **Eastern Research Station—*Haskell***
7. **Kiamichi Forestry Research Station—*Idabel***
8. **Wes Watkins Agricultural Research and Extension Center—*Lane***
9. **Cimarron Valley Research Station—*Perkins***
10. **A. South Central Research Station—*Chickasha***
    B. Caddo Research Station—*Ft. Cobb*
11. **A. Southwest Research and Extension Center—*Altus***
    B. Sandyland Research Station—*Mangum*
    C. Southwest Agronomy Research Station—*Tipton*
12. **Grazingland Research Laboratory—*El Reno***