2015 Vegetable Trial Report

January 2016

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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 2015.

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.

Contributors

Lynn Brandenberger, lynn.brandenberger@okstate.edu, Brian Kahn, brian.kahn@okstate.edu, Lynda Carrier, lynda.carrier@okstate.edu, Joshua Ringer joshua.ringer@okstate.edu, Department of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater

Josh Massey, josh.massey@okstate.edu, Department of Field and Research Service Unit, Cimarron Valley Research Station, Perkins

Rocky Walker rocky.walker@okstate.edu, Department of Field and Research Service Unit, Entomology/Plant Pathology Research Farm, Stillwater

John Damicone, john.damicone@okstate.edu, Tyler Pierson
Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater

Jim Shrefler, jim.shrefler@okstate.edu, Merritt Taylor, merritt.taylor@okstate.edu, Oklahoma Cooperative Extension Service, Department of Horticulture and Landscape Architecture.

Editors

Lynn Brandenberger and Lynda Carrier
Department of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater

Cover Design

Gayle Hiner
Agriculture Communications Services, Oklahoma State University, Stillwater

Seed Sources

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Crop Culture

Sweet Potato Trial

Research Results-2015
Cimarron Valley Research Station Perkins, OK
Lynn Brandenberger, Lynda Carrier
Oklahoma State University

Introduction: Sweet potato is a good dietary source for high levels of Beta carotene and vitamin C especially in orange cultivars. Roots of sweet potato also have ample amounts of complex carbohydrates and fiber (Peirce, 1987). Sweet potato (*Ipomoea batatas*) belongs to the morning glory family, originated in Central and South America and does well in hot climates. Cultivar performance varies by location, therefore the need to trial different cultivars for their adaption to local and state conditions. The objectives of this trial were to determine the performance and quality of different sweet potato cultivars in the central Oklahoma area.

Methods and Materials: The cultivars included in the trial included Beauregard B-94, Beauregard B-63, Covington, O'Henry, White Triumph, and Red Delight. Slips of Beauregard B-94 and B-63, Covington, and O'Henry were grown at the Oklahoma State University research greenhouses in a heated slip-bed from "seed" roots saved from the previous year, slips of White Triumph and Red Delight were purchased from a commercial slip producer in the area. Plots were transplanted on 6/26/15 in rows six feet apart with one foot between transplants in the row, each plot included a single row 15 feet long. Plots were grown on free-standing raised beds created using a plastic layer/bedder for the installation of drip irrigation line during bed formation. Crop fertility was provided by the application of urea post-plant at a rate of 25 lbs. N per acre and another application of 20-20-20 through the drip irrigation system for a total of approximately 34 lbs. of N per acre. Weed control was managed with a pre-plant application of Valor SX (flumioxazin) at 3 oz. per acre rate. The trial was harvested on 10/28/15 using a one-row tractor mounted digger. Sweet potatoes for each plot were graded into U.S. # 1's, jumbos, canners, and culls, with each grade being weighed and recorded.

Results and Discussion: U.S. # 1's are roots that range between 2-3.5" in diameter and 3-9" in length. Yield of U.S. #1's did not vary between cultivars in the trial, but ranged from 129 to 3,582 lbs. per acre (Table 1). The highest recorded yield of U.S. # 1's was for Covington. Canners are sweet potatoes that range between 1-2" in diameter and 2-7" in length. Differences in canner yield were significant and ranged from a low of 177 to a high of 5,663 lbs. per acre for Red Delight and O'Henry, respectfully. Jumbos are roots that are larger than 3.5" in diameter and longer than 9" in length. Yield of Jumbos ranged from 0 for Covington, White Triumph, and Red Delight to 726 lbs. per acre for O'Henry. Total marketable yield includes U.S. # 1's, canners, and Jumbos. Yield for all marketable classes ranged from 307 to 8,163 lbs. per acre with O'Henry having the highest yield of the six cultivars in the trial. Percentage of U.S. # 1's ranged from 21 to 63%.

Conclusions: Of the six cultivars included in the trial, O'Henry had the highest overall yield (8,163 lbs. per acre). Other cultivars in the trial included Beauregard B-94, Beauregard B-63, Covington, White Triumph, and Red Delight which had overall yields of 3,630, 1,694, 5,582, 984, and 307 lbs. per acre, respectfully. Cultivar decisions can be based upon performance in university trials, but if yield is the prime consideration then on-farm trialing is the best way to determine what will work best. Other factors that will need to be considered include customer desires i.e. color, shape, size, and of course taste. Of those included in the trial there were three orange fleshed cultivars (Beauregard B-94 and B-63 and Covington) one red fleshed cultivar (Red Delight) and two white fleshed cultivars (O'Henry and White Triumph).

In general yields were very low in the trial primarily due to deer feeding in the plots. We did erect fencing, but it was not effective in keeping the deer out. The most effective action taken against deer feeding was the application of sprays containing capsaicin (pepper spray) to the tops of sweet potato plants in the plots.

Acknowledgements: The authors want to thank Cimarron Valley Research Station personnel for support, maintenance, and care of this trial. We also want to thank Dan Swart for assistance in harvesting the trial.

References: Peirce, L.C. 1987. Vegetables-characteristics, production, and marketing. Wiley, NY.

Table 1. Summer 2015 Sweet Potato Variety Trial, Perkins, OK.

	lbs./acre				%	lbs./acre
Variety	**US #1's[z]**	**Canners[y]**	**Jumbos[x]**	**Total Marketable[w]**	**of US #1's[v]**	**Culls[u]**
Beauregard B-94	1517 a[t]	1888 b	226 a	3630 a	41 a	1484 a
Beauregard B-63	887 a	532 b	274 a	1694 a	34 a	807 a
Covington	3582 a	2001 b	0 a	5582 a	44 a	1742 a
O'Henry	1775 a	5663 a	726 a	8163 a	21 a	1888 a
White Triumph	355 a	629 b	0 a	984 a	28 a	1549 a
Red Delight	129 a	177 b	0 a	307 a	63 a	339 a

[z] **US #1's** – Roots 2" to 31/2" diameter, length of 3" to 9", must be well shaped and free of defects.
[y] **Canners** – Roots 1: to 2: diameter, 2: to 7: in length.
[x] **Jumbos** – Roots that exceed the diameter, length and weight requirements of the above two grades, but are of marketable quality
[w] **Total Marketable**-US #1 + Canners + Jumbos.
[v] **% US #1's** – Calculated by dividing the weight of US #1's by the total marketable weight (Culls not included).
[u] **Culls** – Roots must be 1: or larger in diameter and so misshapen or unattractive that they could not fit as marketable roots in any of the above three grades.
[t] 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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Snap Bean Variety Trial

Research Results-Spring 2015, Stillwater, Oklahoma

Brian Kahn and Lynda Carrier

Objectives: Objectives of this trial were to evaluate 14 cultivars for yield, earliness, and overall quality.

Materials and Methods: The study was conducted at the Entomology/Plant Pathology Research Farm in Stillwater. Plots were fertilized with 50 lbs. N/acre, harrowed, and then direct seeded on April 21 at a rate of ≈ 6 seeds/ft. Plots were 20 feet long with 3 feet between rows. Cultivars were replicated 3 times in a randomized block design. Plots were sprayed with S-metolachlor herbicide on April 21 at the rate of 1.5 pints/acre. Thinning to 60 plants per 20-ft-plot was completed on May 16. Plants were top-dressed with urea to supply 30 lbs. N/acre on May 30. Each cultivar was harvested by hand one time at prime maturity (June 16, 19, 20, 22, and 25) by pulling up and de-podding all plants in 10 feet of each plot. Data were recorded on stand, plant height, yield, pod quality, and pod length. Random samples of ≈ ½ lb. from each plot were used for sieve sizing. Weights were recorded for each sieve size category.

Results and Summary: Results are shown on the following page. Plants grew relatively well despite record rainfall, and no differences were found in stands. However, there was enough plot-to-plot variation that cultivar differences in yield could not be shown. The six cultivars with above-average yield each had some good points. 'Prevail' and 'Inspiration' had relatively attractive pods. Pods of the wax bean 'Carson' often had greenness and lumpiness; it did not appear refined enough for selective markets. 'Matador' gave marginal performance. The cultivars BA0958, Boone, and Eureka were monitored for an additional week but never set enough pods to justify a harvest. They may have poor heat tolerance.

Acknowledgments: We thank Rocky Walker and Robert Lopez for assistance with field plot maintenance.

Table 1. Spring Snap Bean Replicated Variety Trial – Stillwater, 2015[z]

Cultivar	Seed Source	Yield[y] (bu/A)	Days to Harvest	Stand (plants/ft)	Plant height (in.)	Pod quality[x]	Pod Length (in.)	Sieve size (% by wt.) 1	2	3	4	5
Sybaris	Seedway	95	59	3.5	11	3.3	3.7	0	2	61	37	0
Ambition	Seedway	87	56	2.9	11	2.8	3.8	3	14	52	25	6
Inspiration	Seedway	83	62	3.2	10	3.8	3.9	0	5	75	20	0
Lewis	Seedway	82	59	3.2	12	3.2	3.6	0	3	43	54	0
Prevail	Seedway	80	60	3.4	12	3.8	3.3	1	5	65	29	0
Valentino	Seedway	75	59	3.1	10	3.3	3.8	0	5	60	35	0
Carson[w]	Seedway	69	59	3.4	10	2.2	3.6	0	5	55	35	5
Momentum	Syngenta	66	56	3.1	10	3.2	3.8	5	22	63	10	0
Bronco	Seedway	54	62	3.2	13	3.2	3.7	1	7	54	34	4
Caprice	Seedway	41	62	3.1	11	2.7	3.6	0	3	69	28	0
Matador	Seedway	25	65	3.5	14	2.3	3.3	1	9	23	64	3
	Mean	69	60	3.3	11	3.1	3.6	1	7	56	34	2
	LSD $_{0.05}$	NS	-	NS	1	0.5	0.2	-	-	-	-	-

[z] Seeded April 21, 2015. Plot size: 3' x 20' (3 replications). Harvested June 16, 19, 20, 22, 25; each cultivar was harvested once.
[y] One bushel = 30 pounds.
[x] Ratings: 1=poor, 5=excellent.
[w] Carson is a yellow-podded (wax) bean.

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Native American Seed Increase Study
(Preliminary report for 2015)

Joshua Ringer, Lynda Carrier, Lynn Brandenberger, Justin Moss
Oklahoma State University

Sites included in study:
Plant Pathology/Entomology and Cimarron Valley Research Stations
Private sites

Introduction:
A partnership was developed with the Mvskoke Creek Sovereign Foods Initiative (MSFI) and the Choctaw Nation in order to develop research that helps identify promising indigenous varieties, identify the main constraints to production, and develop efficient irrigation methods for use with these crops. The purpose was to provide production information to help Native American small holder farms produce legumes and other specialty crops for farmers markets, farm to school programs, and local food markets. Our primary goal was to help sovereign nations seed preservation groups preserve, produce, and improve their native varieties for cultural and economic purposes. The project was a way in which the Oklahoma State University Horticulture and Landscape Architecture Department could play a part in the growing agricultural plans of Sovereign Nations in Oklahoma.

The purpose of the seed increase trial was to grow a mixture of selected crops (increasing seed) in order that indigenous seed are available for research plantings during the 2016 summer growing season. A second purpose of the seed increase study was to describe some of the growing characteristics of the indigenous crops from the seed increase trial.

Methods and Materials:
Several crop species which included a mixture of traditional Native American seeds were made available by a Native American seed saver. Crop species included seeds of four corn varieties: Binger Blue; Raccoon Corn; Yellow Flint; Chickasaw, three cucurbits: Water melon; Wichita Squash; Indian Pumpkin, and three legumes Cow pea, bush bean and red bean. A material transfer agreement was signed with the Native American Seed Saver in order to clarify ownership of the seed sources. Because of the small amounts of seed for several of the varieties half of the seeds were saved back from each seed lot in case of crop failure.
The different corn varieties were planted at different sites to prevent cross-pollination of these open-pollinated corn varieties. Two OSU research sites were included in the project (Plant Pathology/Entomology Research Station and Cimarron Valley Research Station) and two non-OSU sites were also included (1 site near Stillwater and 1 site near Mulhall, OK).

The corn varieties were planted with 3’ row centers with 12’’ between seeds. Due to the differing numbers of seeds there were differing planting amounts ranging from 14 to 30 seeds per row. Corn was planted in four rows to encourage good pollination. The cucurbits were planted using 6‘ row centers with 2.5’ between seeds. The legumes were planted using 3’ row centers with 3’’ between seeds.

At the Plant Pathology/Entomology Research Station site Chickasaw Corn, Indian pumpkin, and Hidatsa Indian Red Bean were planted. At the Cimarron Valley Research Station site Yellow Flint Corn, Wichita Squash, and Pottawatomie Pea was planted. At the Non-OSU site near Stillwater Binger Blue Corn and Arikara Yellow sand Hill (bush bean) was planted. Planting ranged from June 3 – 11, 2015.

The pre-plant fertilizer treatment was 25 lbs. actual N (46-0-0). The pre-plant pre-emergence herbicide treatment was Dual Mangum®. Automated Drip irrigation was set up at each of the sites so that sufficient water would be received.

Results and Discussion:
Planting was late due to the availability of seeds and researcher logistics. In spite of this, heavy rains that occurred in April and May would have caused difficulties for the legumes but would have benefitted the corn and cucurbits.
Due to potential cross pollination with other cucurbits the Wichita squash plot plants were transplanted from the Cimarron Valley Research Station site to the Non-OSU site near Stillwater. The transplanted squash plants adjusted well to the new site and potential cross-pollination was averted.

Problems encountered during the growing season included grazing from deer and rabbit. Electric fencing powered by solar chargers was utilized at the Plant Pathology/Entomology and Cimarron Valley Research Station sites to minimize damage. The main crops affected were corn and legumes. The Indian Pumpkin showed signs of rabbit or deer incisor marks but no damage to the plant. The non-OSU site near Mulhall was not fenced in and the Raccoon Corn and Crowder Pea plots experienced total loss. Watermelons were not affected.

The goal of the seed increase project was to have at least 1,000 seeds of each species and valuable information to share with Native American Producers. Of the Corn varieties the Yellow Flint and Chickasaw corn produced more than 2,000 seeds. Both of these corn varieties demonstrated interesting colors and variation within the gathered seeds. This was promising considering that small scale indigenous variety production will need to have interesting characteristics in order to demand a higher market value. The Binger Blue grew slowly and produced only 5 seeds, likely due to high temperatures during seed-set. The Raccoon corn was destroyed at the site near Mulhall by rabbit foraging.
The watermelon seed production was prolific with 79,000 seeds recovered with an initial planting of 42 seeds. These watermelons are not as high in sugars as typical improved varieties. The Indian Pumpkins produced bright orange flesh and 21,000 seeds out of 80 planted seeds. The Pottawatomie Pea produced 16,500 seeds out of 200 planted seeds.

Conclusions:
This trial showed that increasing seed for Native American seed savers requires careful attention to cross-pollination issues and to animal predation. The authors will utilize the increased seed for studies to be conducted in 2016. Excess seed was returned to the Native seed saver who provided the seed for the trial as per agreement in the MTA.

Acknowledgements: The authors want to thank Plant Pathology, Cimarron Valley research station, and private collaborators for support, maintenance, and care of this trial. Special acknowledgement is given to Lynda Carrier for maintaining the study throughout 2015.

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Summer Cover Crops for Spinach Production

Research Results-2014-15
Cimarron Valley Research Station
Lynn Brandenberger, Lynda Carrier, Danielle Williams, Fred Matafari
Oklahoma State University

Introduction: The difficulty of obtaining viable plant stands and crop growth vary considerably between different vegetable crops. One of the more difficult crops to germinate in the field and to obtain viable stands is spinach. Spinach is known for stand issues due to soil crusting and high soil temperatures during the fall planting season. Production soils in the southern plains often have issues with compaction and soil crusting due to low levels of organic matter (<0.5%). The objectives for this multi-year study is to determine if organic matter added to soil from summer cover crops can have a positive effect on spinach stand establishment and subsequent crop growth.

Methods and Materials: Four summer cover crop treatments were planted on May 30, 2014 at the Cimarron Valley Research Station near Perkins, OK. The cover crops included in the study were sesbania (*Sesbania exaltata*), sorghum-sudangrass hybrid (*Sorghum bicolor x S. bicolor var. Sudanese* AKA haygrazer), cowpea (*Vigna unguiculata*), and lablab (*Lablab purpureus*), a clean tilled summer fallow treatment was also included in the study. Seeding rates for each species were 35, 30, 37, and 22 lbs. of seed per acre for sesbania, haygrazer, cowpea, and lablab, respectfully. Plots consisted of areas 40' in length and 9' in width and were planted in clean-tilled soil with a research cone planter using double disk openers with six inch spacing between rows. Clean-tilled summer fallow plots were rototilled twice during the summer and haygrazer plots were mown at a height of approximately 12 inches twice also.
All plots were mown to ground level in early September and tilled using an offset disk harrow and finished on 9/15/14 using a tractor mounted finishing tool (Triple K field cultivator) and planted on 9/16/14 using a research plot planter followed by pre application of Dual Magnum at 0.75 lbs. ai/acre. Due to poor stands of spinach the study area required replanting. Prior to replanting on 10/07/14 the entire study area was rototilled using a tractor mounted rototiller to a depth of 2-4 inches. Plots were then replanted to spinach (Olympia cultivar) at a seeding rate of approximately 500,000 seeds per acre followed by a pre application of Dual Magnum at a reduced rate of 0.5 lbs. ai/acre. Crop water needs were provided by drip irrigation using two drip lines per 4.5' planter pass. Crop ratings for percent stand and stand counts were made on 11/21/14. Stand counts were made by counting the number of seedlings within a 1.1 square foot area approximately 10 feet into the plot from the front of the plot.

Results and Discussion: Biomass of summer cover crops did not vary significantly, but ranged from 3,227 to 8,810 lbs. per acre (Table 1). Lablab and haygrazer produced the highest dry weights for biomass of the five treatments included in the study with 8,810 and 6,891 lbs., respectfully. Percent stands for spinach planted in the different cover crop treatments ranged from 56.3 for lablab to 61.3 for Sesbania with no differences being observed between treatments for percent stand (Table 2). Stand counts did not vary, but ranged from 5.5 plants/1.1 sq. ft. for haygrazer to 7.8 plants for the lablab plots.

Yield ranged from 15,875 to 24,829 lbs. per acre (Table 3). Lablab and the summer fallow treatments had the highest yields with 19,820 and 24,829 lbs. per acre, respectfully.

Conclusions: Although no differences were observed between cover crop treatments for dry weights or for spinach stand responses there are some possible reasons for this. First, dry weights were taken from relatively small areas of each plot which may have resulted in sampling errors and variability between replications. Second, since the original spinach seeding required replanting and daily temperatures had cooled considerably from the first to the second seeding this factor may be the reason no differences were observed in spinach response to cover crop treatments. The authors would conclude from the results that future research should include larger sampling areas for plots and earlier planting of the fall spinach that will follow the summer cover crops. Yields were respectable with the haygrazer treatment having the lowest yield likely due to tie-up of soil nitrogen. Sesbania, cowpea, and lablab treatments were higher and the summer fallow treatment had the highest yield. Having the summer fallow treatment record the highest yield was a little surprising, but considering that it had similar stands and the soil may have been in better tilth than the cover crop plots may explain this. The authors would recommend that additional research be carried out on these cover crops and the summer fallow treatment to determine if the first year's results were reproducible or an anomaly.

Acknowledgements: The authors want to thank Cimarron Valley research station for support, maintenance, and care of this trial.

Table 1. 2014 Summer cover crops, dry weight yields, Perkins, OK.

Treatment	Dry weight yield pounds per acre
Sesbania	4,361 a[z]
Haygrazer	6,891 a
Cowpea	3,227 a
Summer fallow	4,100 a
Lablab	8,810 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 2. 2014 Summer cover crops, Percent stand and number of seedlings for fall planted spinach, Perkins, OK.

Treatment	% Stand	Number of seedlings
Sesbania	61.3 a[z]	7.0 a
Haygrazer	57.5 a	5.5 a
Cowpea	57.5 a	6.0 a
Summer fallow	60.0 a	5.8 a
Lablab	56.3 a	7.8 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 3. 2014 Summer cover crop with 2015 overwinter spinach harvest yields, Perkins, OK.

Treatment	Spinach Yield (lbs./acre) 4/7/2015
Sesbania	17,109 b[z]
Haygrazer	15,875 b
Cowpea	18,198 b
Summer Fallow	24,829 a
Lablab	19,820 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.

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Summer Cover Crops for Spinach Establishment

(Preliminary report for 2015)
Cimarron Valley Research Station

Lynn Brandenberger, Lynda Carrier, Hailin Zhang
Oklahoma State University

Introduction: Production soils in the southern plains often have issues with compaction and soil crusting due to low levels of organic matter (<0.5%). The objectives for this multi-year study are to determine if organic matter added to soil from summer cover crops can have a positive effect on spinach stand establishment and subsequent crop growth.

Methods and Materials: Four summer cover crop treatments were planted on July 13, 2015 at the Cimarron Valley Research Station near Perkins, OK. The cover crops included in the study were sesbania (*Sesbania exaltata*), sorghum-sudangrass hybrid (*Sorghum bicolor x S. bicolor var. Sudanese* AKA haygrazer), cowpea (*Vigna unguiculata*), and lablab (*Lablab purpureus*), a clean tilled summer fallow treatment was also included in the study. Seeding rates for each species were 35, 30, 37, and 22 lbs. of seed per acre for sesbania, haygrazer, cowpea, and lablab, respectfully. Plots consisted of areas 40' in length and 9' in width and were planted in clean-tilled soil with a research planter using six inch spacing between rows. Summer fallow plots were mown twice to two inches above the soil line and haygrazer plots were mown at a height of approximately 12 inches twice also.
Samples for biomass were collected from each plot on 9/18/15 from a two x ten foot area (20sq. ft.) all plots were mown to ground level following biomass harvest. After mowing all plots were tilled twice using an offset disk harrow and finished on 10/07/15 using a tractor mounted finishing tool (Triple K field cultivator) and planted on the same day using a research plot planter. Plots were planted to spinach (Olympia cultivar) at a seeding rate of approximately 500,000 seeds per acre followed by a preemergence application of Dual Magnum at a rate of 0.75 lbs. ai/acre. Crop water needs were provided by micro sprinkler irrigation using a single ¾" supply line for the micro sprinklers per two planter passes running the length of the field (approximately 260ft.). Crop ratings for percent stand and stand counts were made on 11/10/15. Stand counts were made by counting the number of seedlings within a 1.1 square foot area approximately 10 feet into the plot from the front of the plot. Soil samples were collected from each plot on 11/03/15 and analyzed for pH, N-P-K, and organic matter.

Results and Discussion: Biomass of summer cover crops did not vary significantly, but did range from 2,559 to 4,193 lbs. dry weight per acre (Table 1). Sesbania and haygrazer produced the highest dry weights for biomass of the five treatments included in the study with 2,886 and 4,193 lbs., respectfully. Percent stands for spinach planted in the different cover crop treatments ranged from 68 for cowpea to 86% for haygrazer (Table 2). Although no differences were observed between treatments for percent stand, the haygrazer treatment had the highest number of plants in plant counts (9 for haygrazer vs. 3 for cowpea). Soil pH, phosphorus, potassium, and percent organic matter did not vary between treatments (Table 3). Soil nitrogen did vary with the lowest level of 24.8

lbs. N per acre recorded for the haygrazer treatment and the high of 46.3 lbs. N per acre recorded for the cowpea treatment.

Conclusions: Dry weights for different cover crops did not vary significantly, but the haygrazer treatment which produced the highest amount of biomass did have the highest number of spinach plants per square foot when plant counts were made. Plant stands were also the highest for the haygrazer treatment. When soil samples were analyzed treatments did not vary for a majority of the tests (pH, P_2O_5, K_2O, organic matter), but nitrogen levels were highest for the cowpea treatment which is a well-adapted cover crop species for Oklahoma. This study will be harvested as an over-winter spinach crop in spring of 2016 which will conclude the study. At the conclusion of the study the authors will report on potential recommendations for cover crop selection for overwintering spinach crop production.

Acknowledgements: The authors want to thank Cimarron Valley research station for support, maintenance, and care of this trial.

Table 1. 2015 Summer cover crop biomass fresh and dry weight per acre, Perkins, OK.

	Biomass (lbs./acre) 9/8/2015			
	Fresh weight		**Dry weight**	
Treatment	**Cover crop**	**Tumble pigweed**	**Cover crop**	**Tumble pigweed**
Sesbania @ 35 lbs./acre	11,598 a [z]	3,158 a	2,886 a	708 a
Haygrazer @ 30 lbs./acre	10,836 a	0 a	4,193 a	0 a
Cowpea @ 37 lbs/acre	15,954 a	1,906 a	2,559 a	218 a
Lablab @ 22 lbs./acre	10,400 a	2,232 a	2,777 a	490 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.
Summer fallow plots were not harvested and are therefore not included in the table.

Table 2. 2015 Spinach stands following summer cover crops. Perkins, OK 11/10/15

Treatment	% Stand	Number plants (1 square ft.)
Sesbania @ 35 lbs./acre	74 a [z]	7.5 ab
Haygrazer @ 30 lbs./acre	86 a	9.0 a
Cowpea @ 37 lbs/acre	68 a	3.0 b
Summer Fallow	73 a	4.5 ab
Lablab @ 22 lbs./acre	73 a	4.5 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.

Table 3. 2015 Summer cover crop soil test results from 11/3/2015, Perkins, OK.

		(lbs./acre)			(%)
Treatment	**pH**	**N**	**P**	**K**	**OM**
Sesbania @ 35 lbs./acre	6.7 a [z]	34.5 ab	29.3 a	382 a	1.71 a
Haygrazer @ 30 lbs./acre	6.9 a	24.8 b	27.3 a	374 a	1.66 a
Cowpea @ 37 lbs/acre	6.8 a	46.3 a	37.8 a	482 a	1.83 a
Summer Fallow	6.7 a	43.5 ab	32.5 a	422 a	1.62 a
Lablab @ 22 lbs./acre	6.7 a	33.0 ab	33.3 a	426 a	1.76 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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Spring Sweet Corn Variety Trial

Research Results-2015, Stillwater, Oklahoma

Brian Kahn and Lynda Carrier

Objectives: Objectives of this trial were to evaluate 14 cultivars (yellow or bicolor) for yield, earliness, and overall quality. All cultivars were in the sh_2 isolation group.

Materials and Methods: The study was conducted at the Entomology/Plant Pathology Research Farm in Stillwater. Plots were fertilized with 50 lbs. N/acre, harrowed, and then direct seeded on May 2. Plots were 20 feet long with 3 feet between rows and 2 rows per plot. Cultivars were replicated 3 times in a randomized block design. Plots were sprayed with S-metolachlor herbicide on May 4, at the rate of 1 pint/acre. The two best plots per cultivar were rated for seedling vigor on May 23. Final thinning to 20 plants per row was completed on June 1. Persistent rainfall and associated erosion resulted in low vigor and missing plots, so the trial was terminated on June 25.

Results and Summary: The extreme weather provided a good test for stand establishment under cool, wet conditions. Results are shown in Table 1 below.

Table 1. Vigor Ratings for Spring 2015 Sweet Corn Variety Trial, Stillwater[z].

Cultivar	Company/Source	Kernel color[y]	Vigor rating[x]
Honor XR	Illinois	BC	4.2
XTH 1181	Illinois	Y	4.0
Awesome XR	Illinois	BC	3.5
XTH 1876	Illinois	Y	3.5
SC 1336	Stokes	Y	3.5
Prestige XR	Illinois	BC	3.0
Stellar XR	Illinois	BC	3.0
GSS 0966	Syngenta	Y	3.0
Vision	Illinois	Y	2.8
ACes	Harris	BC	2.5
Cabo	Syngenta	BC	2.5
Battalion	Syngenta	BC	2.0
BSS 0982	Syngenta	BC	1.2
Supersweet Jubilee Plus	Syngenta	Y	1.0

[z]Seeded May 2, 2015; Plot size: 6 ft. x 20 ft. (2 rows/plot, data from 2 best out of 3 plots per cultivar.)

[y]BC=yellow/white bicolor; Y=yellow.

[x]Vigor rating: 1=will not make stand, 3=acceptable stand and average vigor, 5=thick stand and good vigor.

$LSD_{0.05}$ = 1.2.

Producers should consider data from several years before selecting cultivars, and always test a new cultivar on a small acreage at first.

Acknowledgments: We thank Rocky Walker and Robert Lopez for assistance with field plot maintenance. The rain simply overwhelmed our combined efforts.

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Tomato Trial for Heat-set Capabilities

Research Results-2015
Omega, OK
Lynn Brandenberger, Lynda Carrier,
Brian Kahn and Zack Meyer
Oklahoma State University

Cooperating with Don's Produce, Omega, OK

Introduction and Objectives: Tomato is a major produce item that people request and is a "must have" for fresh market vegetable farmers. This crop is a dietary source of several nutrients (calcium, potassium, vitamin A, and folate) (Source: USDA National Nutrient Database). Although it doesn't have the level of nutrients of some other vegetable crops it is a component of many dishes and is also consumed raw. Of the vegetable crops grown within the state, tomato requires a high level of management and attention to detail in order to be successful. One of the biggest problems for tomato growers is fruit set which usually stops completely during the hotter periods of June and July. The objective of this study was to trial tomato varieties for heat-set capabilities and use drip irrigation and plastic mulch to manage moisture levels to determine if gains can be made in tomato yield during the hot months of summer.

Methods: Tomato transplants were grown at the Oklahoma State University research greenhouse. All cultivars included in the trial were determinant hybrid cultivars. Tomatoes were transplanted at the field site near Omega on 4/24/15. The study was organized in the field as a randomized block design with three replications. Plots were 9 feet long (length of row) and six feet wide (row center spacing). Each plot consisted of one row and included six transplants with an in-row spacing of 1.5 feet between plants. Plots were grown on white on black plastic mulch (white side up) using drip irrigation, with transplants planted through the plastic mulch. Fertility needs of the study were met with the pre-plant incorporation of 2.2 tons/acre of pelleted chicken litter and fertilization every other week with 10-20-10 through the drip system. Nitrogen applied through the drip system was approximately 112 lbs. of nitrogen per acre. There were 15 harvests of the trial between 7/02/15 and 9/19/15. Data recorded at harvest included total number of fruit, total harvest weight, and weight of cull fruit. Early harvest yield was based upon the yield of the first three harvests.

Results: Marketable yield, early yield, culls, total yield, and average fruit weight did not vary between the six cultivars included in the trial (Table 1). Yield of marketable fruit ranged from 10,589 to 12,138 lbs. per acre. Valley Girl had the highest marketable yield with 12,138 lbs. of fruit per acre while BHN 964, Charger, Red Morning, Tasti-Lee, and Volante had marketable yields of 11,304, 10,962, 11,444, 10,589, and 11,119 lbs. per acre, respectively. Early harvest yields (first 3 harvests) ranged from a low of 3,130 for Tasti-Lee to a high of 3,721 lbs. per acre for Red Morning. Cull yields ranged between 253 lbs. to 847 lbs. per acre for Valley Girl and BHN 964, respectively. Average weight per fruit did not vary with all cultivars ranging between 0.39 and 0.40 lbs. per fruit.

Conclusions: Although parameters that were measured did not vary between cultivars in the trial it should not come as a surprise since these cultivars were the best performing in trials over several years (four years). The trials that began in 2012 have included sites in most areas of the state with all of the cultivars included in this trial being top performers in either 2013 or 2014. Of the six cultivars Valley Girl has been in the top five performer group in 10 different trials during 2013 and 2014, Red Morning five times, and Charger three times. The authors would encourage tomato growers to take a look at past trial reports and see how the different cultivars performed on farms in their area. Trial reports are available at: http://www.hortla.okstate.edu/research-and-outreach/research/vegetable-trial-reports.

Acknowledgements: The authors wish to thank Don Blehm for his work and support in completing this year's trial. The authors would also like to thank the Oklahoma Department of Agriculture, Food, and Forestry for partial funding for this trial.

References:

USDA National Nutrient Database, http://ndb.nal.usda.gov/ndb/search/list accessed on 12/22/15.

Table 1. 2015 Heat-set Tomato Variety Trial-Don Blehm-Omega, OK

Variety/line	Seed source	Yield (lbs./A) Marketable	Early yield	Culled	Total	Average mkt. fruit wt. (lbs)
BHN 964	Rupp	11,304 a[z]	3,418 a	847 a	12,151 a	0.40 a
Charger	Rupp	10,962 a	3,565 a	406 a	11,369 a	0.40 a
Red Morning	Harris	11,444 a	3,721 a	422 a	11,866 a	0.40 a
Valley Girl	Johnny's	12,138 a	3,587 a	253 a	12,390 a	0.39 a
Tasti-Lee	Twilley	10,589 a	3,130 a	492 a	11,081 a	0.39 a
Volante	Seedway	11,119 a	3,574 a	255 a	11,374 a	0.39 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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Winter Cover Crops Followed by Pumpkin

Research Results- 2015
Cimarron Valley Research Station
Lynn Brandenberger and Lynda Carrier
Oklahoma State University

Introduction: Organic matter (O.M.) is a key ingredient to healthy soils since it helps to glue soil particles together (aggregation) stores and releases nutrients, creates channels for air and water in the soil, and provides feed stocks for soil organisms such as beneficial fungi, bacteria, and worms. Many soils in the southern plains have O.M. levels below 0.5% which creates problems for continual production of annual crops. Soils with adequate levels of O.M. will be more productive and will recover faster from the natural wear and tear of crop production. Cover crops are one means of improving soil quality for Oklahoma vegetable producers. One advantage that cover crops have over manures, composts, etc. is the much lower risk of food safety problems compared to animal manures or even some types of compost. Objectives for this multi-year study are to determine if increases in soil O.M. can be made with winter cover crops proceeding summer vegetable crops and what combinations of cover crops and summer vegetables will be compatible with one another.

Methods and Materials: Four winter cover crop treatments included hard red winter wheat (*Triticum aestivum* L.), crimson clover (*Trifolium incarnatum*), and Austrian winter pea (*Pisum sativum arvense*), a combination of crimson clover with Austrian winter pea, and a non-planted control was also included in the study. Prior to fall seeding of cover crops, weeds were controlled for the entire plot area using 41% glyphosate at a rate of 3 quarts per acre. Plots were direct seeded using a Great Plains no-till grain drill on October 8, 2014 in plots that were 45' in length and 9' wide. Seeding rates were 75, 15, and 75 lbs. per acre for wheat, crimson clover, and Austrian winter pea, respectively, with the combination treatment using the same seeding rates for clover and pea as the single species plots. No supplemental irrigation was provided for the cover crop treatments which depended entirely upon natural rainfall for germination and growth. The study was arranged in a randomized block design with five replications.

All cover crop plots were terminated on 5/13/15 using a combination of Poast (sethoxydim at 2 pts./acre) + glyphosate at 3 qts./acre + ammonium sulfate at a rate of 8.5 lbs./100 gallons of spray volume. Following herbicide burn-down each plot was mown with a brush-hog and strip-tilled with a 6' wide rototiller down the center of the 10' wide plot space on 6/02/15. Soil samples were collected from each plot on 6/05/15. All plots were rototilled a second time on 6/22/15 then bedded up using a mulch layer/bedder while laying a single drip irrigation tape per row center, but no mulch was applied. Each plot was direct seeded to Mustang PMR hybrid pumpkin with 20 feet between row centers, 2.5' spacing between planting spaces where two seeds were planted down the row on 6/23/15. A preemergence herbicide application was made over the top of the seeded beds on 6/24/15 using Sandea (halosulfuron-methyl) at 0.024 lbs. a.i. per acre. Irrigation was started following the herbicide application to incorporate the herbicide and initiate seed germination. Crop nutritional needs were met with the application 50 lbs. of nitrogen/acre from urea (46-0-0) on 7/20/15 and one application of

20-20-20 water soluble fertilizer (3 lbs.) applied once on 8/11/15 through the drip system for a total of 52 lbs. of nitrogen per acre. Disease control was managed by alternating applications of Bravo (chlorothalonil) and Quadris (azoxystrobin) fungicide for disease control every 10 to 14 days. Insect control measures were taken primarily for control of squash bug (Anasa tristis) alternating applications of Asana (esfenvalerate), Warrior (lambda-cyhalothrin), PermaStar 8 (permethrin), and SpinTor (spinosad). Pumpkins were harvested on 9/25/15 and again on 10/15/15. During each harvest individual pumpkins were weighed to determine an overall plot yield and to determine number and weight of fruit per plot.

Results and Discussion: Marketable yield ranged from a low of 17,642 to a high of 21,181 lbs. of fruit per acre (Table 1). The highest yielding treatment was the winter pea-crimson clover mixture, but there were no significant differences in yield between treatments. Fruit number per acre did not vary between treatments, but ranged from a low of 1,234 for the wheat cover crop to a high of 1,512 fruit per acre for the winter pea-crimson clover mixture. Average weight per fruit ranged from 13.7 to 15.9 lbs. per fruit with the crimson clover only cover crop having the highest weight.
No differences were observed for pH, N-P-K between the cover crop treatments from results of the soil samples taken (Table 2). There were differences between treatments in the level of organic matter found. Organic matter ranged from a low of 1.63% for the winter fallow-no cover crop treatment to a high of 1.91% for the winter wheat treatment.

Conclusions: Preliminary work in 2014 indicated the need for some tillage for crop establishment when compared to the no-till method that was used. Based upon 2014 results this year's study incorporated the use of strip-tillage and a preemergence herbicide application for early season control of weed species during crop establishment. Although not mentioned above, this worked much better and reduced hand hoeing considerably.
Yields did not vary between treatments, but there was a tendency for reduced growth and yield with the winter wheat cover crop. In two of the three yield measurements taken i.e. overall yield and number of fruit per acre the winter wheat treatment was lowest. The authors hypothesize that this is likely due to the tie-up of nitrogen in the wheat cover crop versus the other cover crops which were winter legumes. That said, when reviewing the soil test data this is possibly borne out by the lower level of nitrogen in the soil test report, although again this wasn't significantly lower than the other treatments.
During the study the biggest challenge that was faced was control of squash bug. The reader probably understands this by the number of compounds that were used for control of this insect pest. Although the crop did sustain damage from squash bug, control measures were effective enough to allow for a reasonable yield from the plots in the study.

In conclusion, the pumpkin crop appeared more vigorous and did have a tendency to yield slightly more when winter legumes were used as cover crops compared to winter-wheat, but if increasing soil organic matter is the issue, then the winter wheat cover was the treatment with the highest level of organic matter in the study.

Acknowledgements: The authors want to thank Cimarron Valley research station for support, maintenance, and care of this trial. We would also like to thank Eric Rebek for advice concerning squash bug control.

Table 1. 2015 Winter cover crop pumpkin study, Perkins, OK. Harvest on 9/25/15 and 10/15/15.

Treatment	Yield (lbs./acre)	Number fruit/acre	Average wt. (lbs.)
No Cover	18,742 a [z]	1,367 a	13.8 a
Austrian Winter Pea	20,837 a	1,464 a	15.3 a
Crimson Clover	20,634 a	1,331 a	15.9 a
Winter wheat (HR)	17,642 a	1,234 a	14.5 a
Winter Pea/Crimson Clover mix	21,181 a	1,512 a	13.7 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 2. 2015 Winter cover crop soil test results. Samples taken on 6/5/2015, Perkins, OK

			(lbs./acre)		(%)
Treatment	pH	N	P	K	OM
No Cover	6.4 a [z]	28.8 a	29.6 a	366 a	1.63 b
Austrian Winter Pea	6.4 a	26.8 a	26.8 a	351 a	1.80 ab
Crimson Clover	6.4 a	28.8 a	27.2 a	353 a	1.72 ab
Winter wheat (HR)	6.6 a	16.0 a	26.8 a	389 a	1.91 a
Winter Pea/Crimson Clover mix	6.4 a	28.6 a	24.4 a	342 a	1.72 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.

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Pest Management

Companion Plantings for Management of Squash Bug

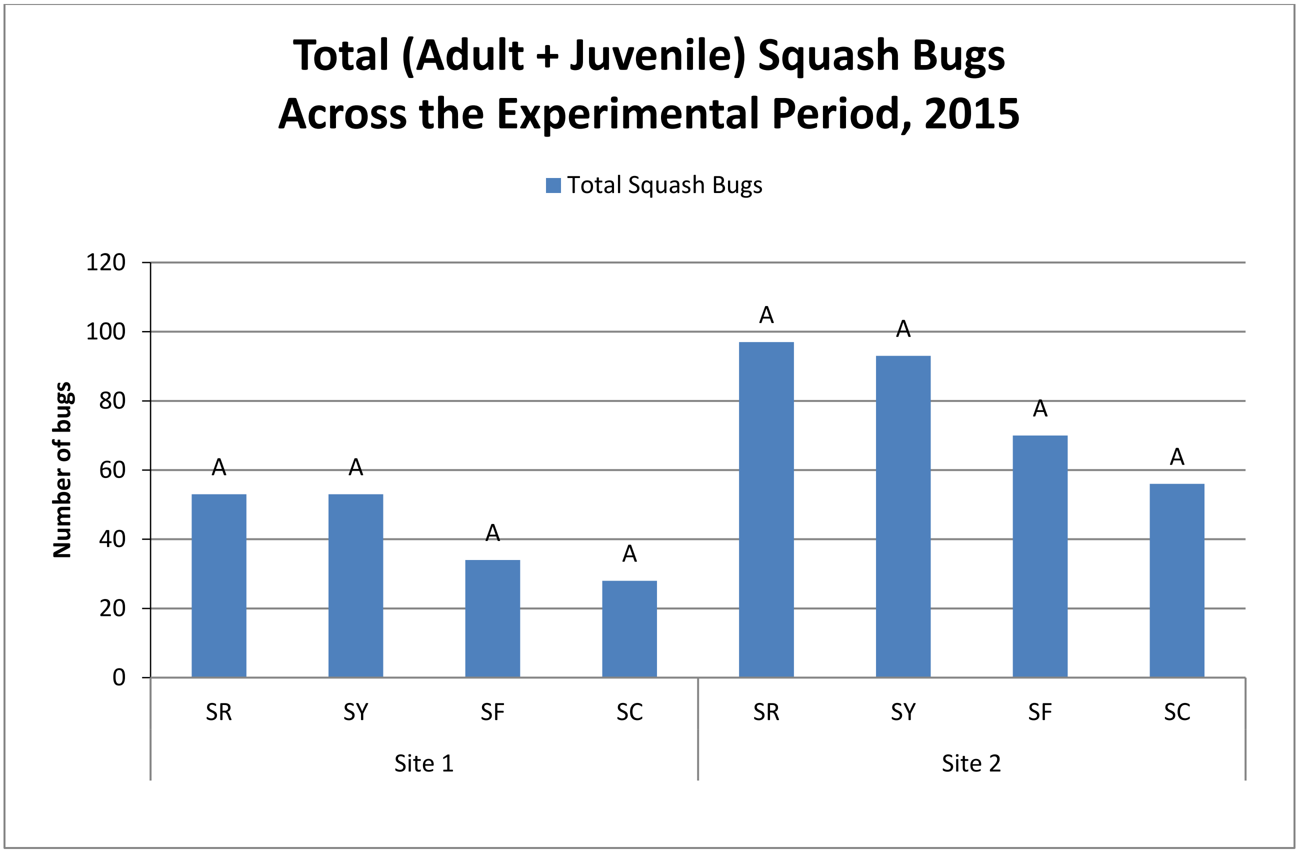
Companion Plants as Tools for Pest Management of Squash Bug On Summer Squash

Project Coordinator: B. Kahn
Cooperators: E. Rebek, L. Brandenberger, K. Reed, J. Motes, W. Whitmore

Introduction and Methods: The concept of companion planting as a potential pest management tool has received some attention recently as interest in sustainable and organic vegetable production has grown. However, the few published scientific studies have shown mixed results, and none have addressed squash bug management. We conducted four studies from 2013 through 2014. In 2015, we conducted a capstone study at the Cimarron Valley Research Station at Perkins, plus on-farm trials at the Motes and Whitmore farms. Transplants of 'Lioness' summer squash were planted in the field between May 12-19, 2015 along with companion herbs as appropriate. Counts were made of squash bugs on the squash plants on five to eight dates. Squash were harvested regularly at all sites. Our on-farm treatments and some insect count results are shown on the following page (locations have been given site codes). Treatments at Perkins in 2015 included a control and four combinations of squash row arrangement and feverfew planting time.

Results and Discussion: At Perkins in 2015, the four treatments involving companion planting with feverfew reduced total squash bugs by an average of 48% compared to the control, but statistical significance could not be shown. The three on-farm treatments also did not affect squash bug populations at either site. Plot-to-plot variation was high, making it difficult to detect statistically significant differences. None of the treatments affected marketable squash yields at all three sites.

We did not expect complete control with the herbs. We hypothesized that companion planting would produce reductions in squash bug populations, or at least a delay in squash bug build-up on the squash crops. However, after three years of research, we have concluded that companion planting with feverfew or with white yarrow inconsistently effects squash bug populations on summer squash. Therefore, these strategies appear to be of limited value to commercial producers.



SR = early-season vented row cover, no herbs
SY = companion planting with white yarrow
SF = companion planting with feverfew
SC = control, no row cover and no herbs
Within each site, means (depicted by bars) with the same letter do not differ according to the protected LSD, *P* = 0.05.

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Evaluation of Bactericides for Control of Bacterial Spot of Chili Peppers

Research Results-2015
John Damicone and Tyler Pierson
Department of Entomology and Plant Pathology, Oklahoma State University

Introduction: Bacterial spot, caused by *Xanthomonas euvesicatoria*, is the most important disease of peppers in Oklahoma. Severe outbreaks of the disease have recently been problematic in western OK. The objective of this trial was to evaluate early-season applications of bactericides for control of bacterial spot on chili peppers grown for capsaicin production.

Materials and Methods: The trial was conducted on a commercial farm near Hydro, OK in a field previously cropped to cotton. 'Ocala' peppers were transplanted into wheat cover crop stubble on 15 Apr. Peppers were managed using typical production practices for the area that included sprinkler irrigation. The experimental design was a randomized complete block with four blocks separated by a 5-ft-wide planted buffer. Plots consisted of four 20-ft-long rows spaced 36 in. apart. Plants within rows were spaced 16 in. apart. All data were taken from the two center rows. Treatments were applied broadcast through flat-fan nozzles (8002vk) spaced 18 in. apart with a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 25 gal/A at 40 psi. Applications were made on 14 to 21-day intervals beginning when plants began to grow after transplanting and before symptoms appeared. Rainfall during the cropping period (15 Apr to 27 Oct) totaled 3.88 in. for Apr, 12.07 in for May, 2.2 in. for Jun, 3.89 in. for Jul, 1.72 in. for Aug, 1.73 in. for Sep, and 2.52 in. for Oct. Plots received applications of sprinkler irrigation as necessary to promoted crop development. Bacterial spot was assessed by estimating the percentage of leaflets with leaf spot (including defoliated leaflets) and/or the percentage of leaflets defoliated in three areas per plot on 19 Jul and 24 Sep. On 27 Oct defoliation and yield were estimated on 3 plants from the center of each of the middle two rows. Plants were cut at the soil line, weighed and the defoliation was estimated on each plant.

Results: Compared to the 30-year average, rainfall was 7.2 in above normal for the cropping period. Rainfall was generally above normal from above from Apr through Jul, and below normal from Aug through Oct. Average daily temperature was below normal each month except for Sep. Bacterial spot appeared in late Jun and reached moderate levels (Table 1). Cool temperatures may have limited early season disease development when rainfall was high. None of the treatments reduced levels of bacterial spot compared to the untreated check. The effect of treatment on plant weight near the end of the season also was not statistically significant. There was a numeric trend for reduced plant weight for the Actiguard treatment, but the effect was not statistically significant. Weekly applications throughout the growing season may have provided better disease control, but a full-season schedule is not economically feasible. None of the treatments caused injury (phytotoxicity) symptoms.

Table 1. Effects of bactericide programs on control of bacterial spot of chili pepper.

Treatment and rate/A (timing)[z]	Bacterial spot (%) 24 Sep	Defoliation (%)			Plant weight (lb)
		19 Jul	24 Sep	27 Oct	
Kocide 3000 1.25 lb (1-3)	53.3 a[y]	10.2 a	25.6 a	23.3 a	1.48 a
Kocide 3000 1.25 lb + Dithane 75DF 2 lb	56.2 a	8.9 a	21.1 a	23.9 a	1.57 a
Actiguard 50WG 0.5 oz (1) Actiguard 50WG 0.75 oz (2,3)	55.6 a	11.1 a	22.2 a	22.2 a	1.22 a
Untreated check	48.9 a	13.3 a	22.2 a	20.5 a	1.49 a
LSD (P=0.05)[x]	NS	NS	NS	NS	NS

[z] 1 to 3 correspond to the spray dates of 1=10 Jun, 2=25 Jun, 3=17 Aug.

[y] Values in a column followed by the same letter are not significantly according to Fisher's least significant difference test at P=0.05.

[x] Least significant difference, NS=treatment effect not significant at P=0.05.

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Evaluation of Fungicides for Control of White Rust On Fall-Cropped Spinach

Research Results-2015

John Damicone and Tyler Pierson
Department of Entomology and Plant Pathology, Oklahoma State University

Introduction: White rust, caused by the fungus *Albugo occidentalis*, is the most important foliar disease of spinach in Oklahoma. The objective of this study was to compare the performance of registered fungicides for the control of white rust on spinach.

Materials and Methods: 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 susceptible cultivar 'Avon' on 21 Sep at a seeding rate of two seeds per inch. The herbicide Dual II Magnum 7.6E at 0.75 pt/A was broadcast post-emergence on 28 Sep. Plots were top-dressed with granular fertilizer (50-0-0 lb/A, N-P-K) on 12 Oct. Plots consisted of 4-row beds, 20-ft long, with rows spaced 14 in. apart. The experimental design was a randomized complete block with four replications separated by a 5-ft-wide fallow buffer. 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. Plots received a total of 2.2 in. of sprinkler irrigation at 0.1 to 0.4 in. water per application as needed to promote crop and disease development. Rainfall during the cropping period (21 Sep to 19 Nov) totaled 0.07 in. for Sep, 3.73 in. for Oct, and 2.33 in. for Nov. Disease incidence (percentage of leaves with symptoms) and severity (percentage of leaf area with symptoms) were assessed on 19 Nov. 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.

Results: Rainfall was near normal (30-yr avg.) for Sep and Oct and above normal for Nov. Average daily temperature was above normal for Sep and near normal for Oct and Nov. White rust was first observed in mid-Oct and reached severe levels compared to previous trials at this site (Table 1). Anthracnose, caused by the fungus *Colletotrichum dematium*, appeared in Nov and also reached severe levels. All treatments reduced incidence and severity of white rust compared to the untreated check. Cabrio, Presidio, and Cabrio alternated with Presidio had the lowest levels of white rust. Treatment effects on anthracnose were not statistically significant. None of the treatments caused leaf injury (phytotoxicity).

Table 1. Effectiveness of fungicides for control of white rust and anthracnose on ' Avon' spinach.

Treatment and rate/A (timing)^z	White rust (%)		Anthracnose (%)	
	Leaves w/rust	**Leaf area w/rust**	**Leaves w/spots**	**Leaf area w/spots**
Untreated check	86.5 a^y	34.54 a	26.0 a	6.79 a
Quadris 2.08F 12.3 fl oz (1-5)	31.0 b	4.54 b	29.2 a	6.37 a
Cabrio 20WG 12 ox (1-5)	0.7 d	0.04 b	27.5 a	5.07 a
Reason 4.13F 8.2 fl oz (1-5)	11.5 cd	0.57 b	39.5 a	8.64 a
Presidio 4F 4 fl oz (1-5)	0.7 d	0.01 b	19.2 a	2.56 a
Ranman 3.33F 2.75 fl oz (1-5)	21.0 bc	1.66 b	30.0 a	5.78 a
Cabrio 20WG 12 oz (1,3,5) Presidio 4F 4 fl oz (2,4)	4.0 cd	0.26 b	23.2 a	4.77 a
LSD (P=0.05)^x	17.0	7.59	NS	NS

^{z} The numbers (1-5) correspond to the spray dates of 1=16 Oct, 2=22 Oct, 3=29 Oct, 4=4 Nov, and 5=12 Nov.

^{y} Values in a column followed by the same letter are not statistically different according to Fisher's least significant difference test.

^{x} Least significant difference, NS = treatment effect not significant at P=0.05.

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Fungicide Timing for Control of White Rust
In Spring-Cropped Spinach

Research Results-2015
John Damicone and Tyler Pierson
Department of Entomology and Plant Pathology, Oklahoma State University

Introduction: White rust, caused by the fungus *Albugo occidentalis*, is the most important foliar disease of spinach in Oklahoma. The objective of this study was to identify the best starting point for calendar and weather-based fungicide programs in order to minimize the number of applications while maintaining good control of white rust.

Materials and Methods: 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 susceptible cultivar 'Avon' on 21 Sep at a seeding rate of two seeds per inch. The herbicide Dual II Magnum 7.6E at 0.75 pt/A was broadcast post-emergence on 28 Sep. Plots were top-dressed with granular fertilizer (50-0-0 lb/A, N-P-K) on 12 Oct. Plots consisted of 4-row beds, 20-ft long, with rows spaced 14 in. apart. The experimental design was a randomized complete block with four replications separated by a 5-ft-wide fallow buffer. The first spray for the calendar (7-day) program, and monitoring of the weather based program (Spinach White Rust Advisor; http://www.mesonet.org/index.php/agriculture/category/horticulture/spinach/white_rust_advisor) began at the first true leaf stage, 7 days after first true leaf, and 14 days after first true leaf. Applications made according to the weather-based program were made within 3 days of a spray recommendation. Following each application made according to the weather-based program, plots were considered protected for the next 7 days. For each program and starting point, the fungicides Cabrio 20WG at 0.75 lb/A and Presidio 4F at 4 fl oz/A were alternated with Cabrio applied first. 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. Plots received a total of 2.2 in. of sprinkler irrigation at 0.1 to 0.4 in. water per application as needed to promote crop and disease development. Rainfall during the cropping period (21 Sep to 19 Nov) totaled 0.07 in. for Sep, 3.73 in. for Oct, and 2.33 in. for Nov. Disease incidence (percentage of leaves with symptoms) and severity (percentage of leaf area with symptoms) were assessed on 17 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.

Results: Rainfall was near normal (30-yr avg.) for Sep and Oct and above normal for Nov. Average daily temperature was above normal for Sep and near normal for Oct and Nov. White rust was first observed in mid-Oct and reached severe levels compared to previous trials at this site (Table 1). Anthracnose, caused by the fungus *Colletotrichum dematium*, appeared in Nov and also reached severe levels. All fungicide programs reduced levels of white rust compared to the untreated check. It was possible to delay initial applications of calendar programs by 14 days and the advisory program by 7 days past first true leaf and maintain excellent control of white rust. However, none of the fungicide programs were effective on anthracnose. There is a need to identify fungicides or resistant varieties for anthracnose, a disease of emerging importance in Oklahoma.

Table 1. Effectiveness of fungicide programs initiated at different starting points on control of white rust and anthracnose on ' Melody' spinach.

		White rust (%)		Anthracnose (%)	
Program - Starting point (timing)[z]	**Sprays (no.)**	**Leaves w/rust**	**Leaf area w/rust**	**Leaves w/spots**	**Leaf area w/ spots**
Calendar - 1st true leaf (1-4)	5	0.7 c[y]	0.08 b	26.7 a	5.3 a
Calendar - 1st true leaf + 7 d (2-4)	4	0.7 c	0.04 b	30.7 a	3.8 a
Calendar - 1st true leaf + 14 d (3,4)	3	4.0 c	0.19 b	19.2 a	3.3 a
Advisory - 1st true leaf (A1,A3)	2	1.5 c	0.16 b	29.0 a	4.6 a
Advisory - 1st true leaf + 7 d (A2)	1	3.2 c	0.25 a	27.5 a	5.3 a
Advisory - 1st true leaf + 14 d (A3)	1	26.7 b	4.81 b	26.0 a	5.6 a
Untreated check	0	62.5 a	16.17 a	35.0 a	6.2 a
LSD (P=0.05)[x]		13.8	4.98	NS	NS

[z] Spray timings 1 to 4 correspond to the spray dates of 1=16 Oct, 2=22 Oct, 3=29 Oct, 4=7 May for the calendar program; A1 to A3 correspond to the spray dates of A1=22 Oct, A2=30 Oct, A3=4 Nov made according to the advisory program.
[y] Values in a column followed by the same letter are not statistically different at P=0.05.
[x] Least significant difference, NS=treatment effect not significant.

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Preemergence Weed Control in Pepper

Research Results-2015
Lynn Brandenberger and Lynda Carrier
Oklahoma State University
In Cooperation with
Schantz Family Farms, Hydro, OK

Introduction: Oklahoma production of pepper includes both fresh market and peppers for processing. Crops are normally established with transplants following the last frost in the spring in different areas of the state. Depending upon the year, weather can be cool and the crop can be delayed or slow in developing. This slow start can easily cause problems due to weedy species that out-compete peppers. Several weed species including Palmer amaranth (Amaranthus palmeri), 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. Although some herbicides are labeled for this crop, many are not effective enough to be the sole means of control. Weed control with herbicides is 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 early in the season. The objective of this study was to screen herbicides that may have potential for weed control in commercial pepper production when applied early in the season as a preemergence application.

Methods and Materials: Plots for the Dual Magnum treatment were transplanted to the pepper cultivar ‘Okala’ on 4/30/15 prior to applying Dual Magnum and plots for all other treatments were transplanted on 5/01/15 following herbicide application. Row spacing was three feet between row centers with a transplant in-row spacing of 12 inches. The study included nine different herbicides Callisto (mesotrione), Devrinol (napropamide), Dual Magnum (S-metolachlor), Fierce (flumioxazin + pyroxasulfone), League (imazosulfuron), Outlook (dimethenamid-P), Reflex (fomesafen), Surflan (oryzalin), and Zedua (pyroxasulfone). All were applied pre-transplant except for Dual Magnum which was applied post-transplant on the same day. Treatments were applied to plots four rows wide (12 feet) by 20 feet in length in a randomized design with three replications on 5/01/15. Treatment applications were made with a tractor drawn sprayer with a 12 foot spray boom and a PTO driven centrifugal pump at an overall rate of 25 gallons of spray solution per acre. Crop plant counts and crop damage ratings were recorded on 5/15/15 for the middle two rows of each plot. Percent crop cover and the weight of five plants was recorded on 9/03/15.

Results and Discussion: The number of plants in the middle two rows of each plot varied significantly on 5/15/15 (Table 1). Callisto at 0.175 lbs. a.i. per acre had significantly lower numbers of plants per plot compared to most of the other treatments except for Callisto at 0.088 and League 0.094 lbs. a.i. per acre. These three treatments had plant numbers of 21 plants for Callisto at 0.175, 27 plants for Callisto at 0.088, and 28 plants for League per plot. Other treatments averaged 29 to 33 plants per plot. Crop injury ratings on 5/15/15 were highest for Callisto at 0.175 lbs. a.i. per acre which recorded 10% crop damage compared to 0 to 2% damage for all other treatments. Percent crop cover and weights for five plants did not vary between treatments. Although there were no differences the Callisto at 0.175 lbs. a.i. per acre treatment did have the lowest percentage of crop cover at 47% compared to the next lowest one at 65%.

Conclusions: Early season ratings did show differences between treatments. Callisto at the higher rate of 0.175 lbs. a.i. per acre did show a significant reduction in the number of plants and had higher levels of crop damage than a majority of the other treatments. Based on the results the authors would suggest further study of these herbicides regarding control of weedy species as this study did not provide the opportunity to record weed control.

Acknowledgements: The authors want to thank the Schantz family for their help and support in completing this study.

Table 1. 2015 Preemergence pepper herbicide study, Hydro, Oklahoma.

	5/15/2015		9/3/2015	
Treatment (lbs. ai/acre)	**Number plants in 2 - 20' rows**	**% Injury to crop**	**% crop cover**	**Weight per 5 plants (lbs.)**
Untreated check	31 a[z]	0 b	85 a	3.2 a
Callisto Pre 0.088	27 ab	3 b	67 a	3.5 a
Callisto Pre 0.175	21 b	10 a	47 a	3.0 a
Devrinol Pre 3.0	29 a	2 b	65 a	2.9 a
Dual Magnum 0.75	29 a	0 b	85 a	3.5 a
Fierce Pre 0.414	29 a	2 b	65 a	3.4 a
League Pre T 0.094	28 ab	2 b	60 a	2.8 a
Outlook Pre 1.0	32 a	0 b	85 a	3.1 a
Reflex Pre 0.25	31 a	2 b	78 a	3.2 a
Surflan Pre 0.56	32 a	0 b	92 a	3.3 a
Zedua Pre 0.025	33 a	0 b	93 a	3.5 a
Zedua Pre 0.05	30 a	0 b	92 a	3.5 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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Watermelon Preemergence Weed Control Trial - Lane

Jim Shrefler and Merritt Taylor

The authors greatly appreciate the valuable assistance of Jim Vaughan, John Johnson and Shannon Reece of the Wes Watkins Agricultural Research and Extension Center, Harold Stephens and Casey Russell of the Oklahoma Cooperative Extension Service, Dr. Benny Bruton, USDA Agricultural Research Service (retired) and Marcos Montes (Exchange student from Mexico).

Effective weed control methods are needed for the successful and cost effective production of watermelon in Oklahoma. Although herbicides are approved for this crop, there are several common and important weed species that are not controlled by these products. Infestations of these weeds result in reduced yields, less effective management of insect pests and diseases and interference with harvest. Previous trials evaluated Reflex herbicide (fomesafen) for use in watermelon. In these trials the crop showed good tolerance to the herbicide when applied preemergence to direct seeded plantings and preplant to transplanted watermelon. Several Reflex application rates were used and excellent weed control was obtained at rates that did not have a negative impact on watermelon vine growth and yields. These trials were conducted on a fine sandy loam soil. The current trial was conducted on a nearby field that has a slightly sandier texture than fields used in previous studies.

Materials and Methods

This trial was conducted during 2015 at the Wes Watkins Agricultural Research and Extension Center at Lane, Oklahoma. The plot arrangement was a randomized complete block with four replications. In early June the field was disked and bedded. The beds were lightly tilled on July 1 and watermelon (Sugar Baby) sown on July 2 with a push planter to give a spacing of about 1 foot between seeds. Immediately after seeding herbicide experimental treatments were applied using a CO_2 pressurized hand held boom fitted with 8002VS flat fan nozzles, calibrated to apply 15 gal / acre and operated at 30 psi boom pressure. Plots consisted of a single planted row 6 feet wide and 40 feet long. Herbicide treatments were applied to a 6 foot wide swath centered on the crop row.

Herbicide treatments in this study included 1. PRE application of Reflex (fomesafen) at 1.5 pints per acre, 2. PRE application of Strategy (pre mix of ethalfluralin and clomazone) at 3 pints per acre and 3. An untreated check plot that was .

Soil moisture was adequate for rapid crop germination without supplemental watering due to a 1 inch rainfall event on July 3. Drip irrigation was used when deemed necessary. Weed control and crop response to treatments was evaluated on 7-18. On 7-19 weeds were removed from the untreated plots manually and Poast herbicide was applied to the entire study to remove grass weeds. An additional evaluation of weed control was made on 8-28.

Crop data collected included crop leaf stage (7-8) crop injury (7-8), stand reduction (7-8), vine condition (8-27) and fruit yield (8-28 and 9-1). Yield was determined by removing mature fruits from the field and weighing and counting. Weed control was evaluated visually on 7-18 and 8-27 for spiny amaranth, carpetweed (M*ullugo verticillata*), yellow nutsedge (*Cyperus esculentus*) and annual grasses, which was primarily crabgrass. Watermelon fruits were harvested, counted and weighed on August 28. On September 1 fruits that remained in the field were counted.

Results
Both herbicide treatments resulted in measureable crop injury as shown in Table 1. Injury in the form of stunting resulted from Reflex while Strategy injury included stunting and bleaching. Significant crop stand reduction compared to the untreated check was also detected for the Strategy treatment. Vine condition was on the decline at August 27 but was similar for all treatments.

Weed control evaluations on July 8 shown in Table 2 indicated a high degree of control of carpetweed, spiny amaranth and annual grasses. Reflex provided excellent control of yellow nutsedge. On August 27 weed control evaluations shown in Table 3 were made in comparison to untreated areas between plots. Reflex continued to provide a high degree of control for all weed species present in the trial. Control provided by Strategy did not differ from the untreated plots at this time.

Watermelon fruit yields at ranged from 5243 lbs / acre for the untreated check to 3832 lbs / acre for the Reflex treatment. Total fruit numbers, which includes numbers of mature fruit at harvest plus those maturing over the next week, ranged from 2339 fruits / acre for the untreated check to 2517 fruits / acre for the Reflex treatment. There were no significant differences across treatments for any of the yield parameters.

Conclusions
These results provide additional evidence that Reflex herbicide applied at 1.5 pints per acre would be a safe and effective product for use in direct seeded watermelon production. Although some injury was detected it was similar to that caused by the currently approved product Strategy.

Table 1. Watermelon plant response to weed control treatments in 2015 at Lane, OK.

Treatment (pints of product /acre)	Crop leaf stage July 18	Injury (%, 0=none) July 18	Stand reduction (%) July 18	Vine condition (% where 0=dead and 100= excellent) August 27
1 Untreated check	4.0	0 b[z]	0 b	47
2 Strategy (3)	3.7	25 a	27 a	45
3 Reflex (1.5)	3.4	27 a	11 ab	42

[z] Numbers in a column followed by the same letter do not differ using Duncan's Multiple Range Test P=0.05.

Table 2. Weed control visual evaluations on July 18 in the 2015 watermelon weed trial at Lane, OK.

Treatment (pints of product /acre)	Carpetweed	Spiny amaranth	Annual grass (mostly crabgrass)	Yellow nutsedge
	---------------------------% control			------------------------------
1 Untreated check	0 c[z]	0 c	0 b	0 b
2 Strategy (3)	86 b	85 b	99 a	0 b
3 Reflex (1.5)	99 a	100 a	100 a	100 a

[z] Numbers in a column followed by the same letter do not differ using Duncan's Multiple Range Test P=0.05.

Table 3. Weed control visual evaluations on August 27 in the 2015 watermelon weed trial at Lane, OK.

Treatment (pints of product /acre)	Carpetweed	Spiny amaranth	Annual grass (mostly crabgrass)	Yellow nutsedge
	---------------------------% control			------------------------------
1 Untreated check	57 b[z]	44	55	25 b
2 Strategy (3)	60 b	49	76	17 b
3 Reflex (1.5)	99 a	99	99	99 a

[z] Numbers in a column followed by the same letter do not differ using Duncan's Multiple Range Test P=0.05.

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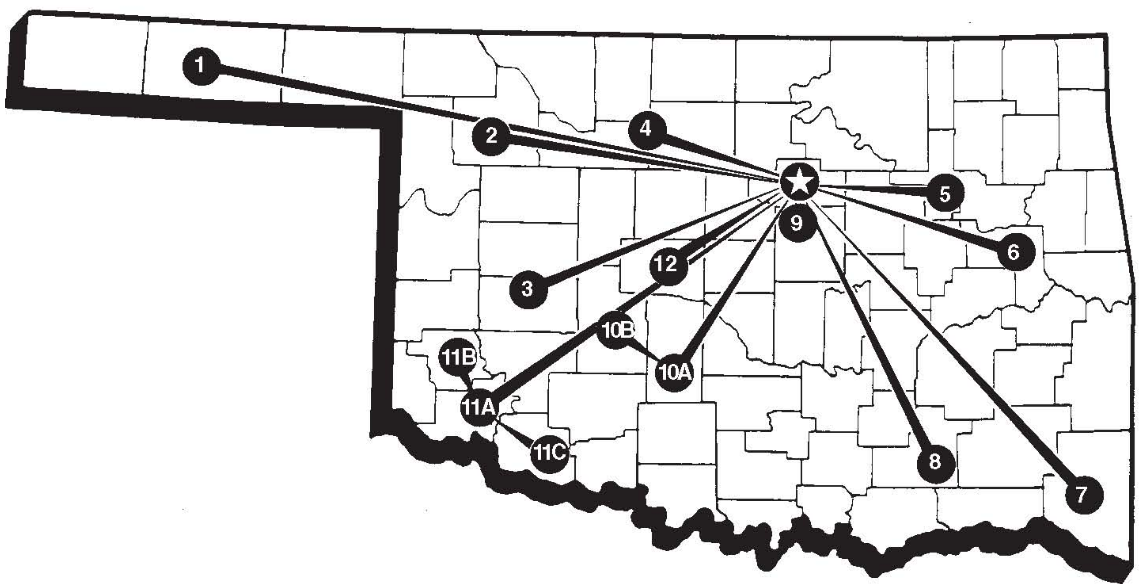
SI (METRIC) CONVERSION FACTORS

Symbol	When you know	Multiply by	To Find	Symbol	Symbol	When you know	Multiply by	To Find	Symbol
Approximate Conversions to SI Units					*Approximate Conversions from SI Units*				
		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***
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