2009 Vegetable Trial Report

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MP-164

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 2009.

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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www.seedway.com

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Hodges, SC 29653
www.twilleyseed.com

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www.willhiteseed.com

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Crop Culture

Spring 2009 Broccoli Variety Trial

Bixby, Oklahoma
Brian Kahn, Lynda Carrier, and Robert Havener

Introduction and Objectives: Broccoli is a minor crop in Oklahoma, but excellent quality heads can be produced in the fall. Recently, seed companies have developed cultivars with better heat tolerance. While large-scale commercial broccoli production during the spring in Oklahoma remains risky, these new cultivars are of particular interest to small-scale producers targeting local markets, as well as home gardeners. Objectives of this trial were to evaluate several hybrid broccoli cultivars for yield, quality, and adaptation under spring conditions.

Materials and Methods: Entries and their sources are shown in the table below. Entries 1-12 were grown in a transplanted trial using a randomized block design with 3 replications. All 17 entries were grown in a direct-seeded trial using a randomized block design with 2 replications. The soil was prepared with a broadcast, preplant-incorporated application of 50 lbs/A of N and trifluralin at 1 pint/A. Direct-seeding was done on March 9 using a research cone planter. Transplants were set in the field on April 3. Plots were on 3-foot centers. Each plot was a double row, with ≈ 1 foot between the two rows. Plots were 10 feet long. Transplants were set 12 inches apart in rows, with 8 plants per row (16 total plants per plot). Direct-seeded plots were intended to be thinned to similar stands, but stand establishment was too irregular. Both studies were topdressed with 50 lbs/A of N on May 7 and May 27.

Cultivar	Source	Cultivar	Source	Cultivar	Source
1 – Bay Meadows	Syngenta	7 – Green Magic	Sakata	13 – Imperial	Sakata
2 – Concord	Syngenta	8 – Gypsy	Sakata	14 – Diplomat	Seedway
3 – Destiny	Sakata	9 – Premium Crop	Seedway	15 – Emerald Crown	Sakata
4 – Emerald Pride	Sakata	10 – Santa Anita	Syngenta	16 – Major	Seedway
5 – Everest	Seedway	11 – Sarasota	Syngenta	17 – Packman	Seedway
6 – Greenbelt	Sakata	12 – Summerfield	Syngenta		

Results and Discussion: Despite the use of sprinkler irrigation, there were emergence issues in the direct-seeded trial, and subsequent early growth was poor due to excessive rainfall. The rainfall also delayed the date of transplanting beyond the target of March 25. Severe storms then raked the field in the two days following transplanting with flooding rain and high winds, resulting in considerable plant loss. As a result, stand establishment in both trials was so irregular that yield data could not be taken. However, observations were made and some heads were harvested. The first harvest (from the transplanted trial) was on May 27. Cultivars with marketable-size heads on May 27 (though not necessarily marketable quality) were: Destiny, Everest, Green Magic, Gypsy, and Premium Crop. Harvest ended on June 19, as unusually high temperatures were causing poor-quality heads.

The only conclusions that can be made relate to earliness. Many cultivars bred for adaptation to California are too late for reliable production in Oklahoma. Some early cultivars have relatively flat domes and large beads, making them undesirable for wholesale markets but still potentially marketable locally. ‘Premium Crop’ is a case in point here, with a long history of adaptation to Oklahoma conditions, but with heads that normally would not meet today’s wholesale standards. ‘Major’ and ‘Packman’ also fit the early-but-flat category. Other cultivars possibly early enough to warrant another trial include those harvested on May 27, plus Bay Meadows, Emerald Pride, and Summerfield. Those apparently too late include Concord, Santa Anita, and Sarasota. The overall most promising entry was Green Magic.

Diversifying Farm Enterprises with Cilantro Production-Fall 2008

Lynn Brandenberger, Niels Maness, and Lynda Carrier, Oklahoma State University
In Cooperation with: Shelby and Ross Farms, Muskogee County, Oklahoma

Introduction: Cilantro has potential to become a commercial crop in Oklahoma. Our project is concerned with determining if cilantro can be produced for processing using existing equipment and techniques currently used for growing commercial greens crops for canning. The objectives of the project were to demonstrate commercial production of cilantro for consumption as a dried condiment, produce adequate amounts of cilantro to test harvesting and drying equipment performance, develop the experience needed to commercially produce cilantro.

Materials and Methods: The demonstration included growing two one acre plots of cilantro using existing equipment available on the farm for growing commercial greens crops. Plot areas were prepared for planting by disking the plowed area three times with a disk-harrow, then finishing with a Do-All field cultivator. Following this, 60 inch wide beds were created with a bed shaper and firmed with a roller. Weed control used Prefar 4E herbicide applied at 5.5 pounds of active ingredient per acre pre-plant incorporated. Cilantro was direct seeded at a rate of 50 lbs of seed/acre using a planter normally used for planting leafy greens crops. The planter has 8 double disk openers on 6 inch row centers for a total width of 4 feet. The field was hand-hoed on two dates to control several cool season annual weeds and for control of palmer amaranth all of which was not controlled well with the Prefar. The crop was harvested on two different dates using a greens harvester.

Results and Discussion: Overall, the producer was able to grow cilantro with few changes to production methods utilized for leafy greens. Yields were 5,523 lbs of fresh cilantro for the first harvest on November 9 and 8,627 lbs fresh weight yield on November 18. The greens harvester worked well with cilantro and required no modifications to operate in this new crop.

There were some problems during the production period. First and foremost, weed control from Prefar was not very good and required two hand hoeing to clean up the field. Prefar is the only herbicide that was labeled for use on cilantro, but it did a very poor job of controlling weeds. We need a more effective herbicide for weed control in this crop. Hand hoeing cost can be very high and that’s if you can find a hoe crew, which is difficult to find.

Acknowledgements: The authors want to thank Shelby and Ross Farms for all their help and support in working with this new crop. We would also like to thank the Oklahoma Department of Agriculture Food and Forestry for their support of this effort.

Cilantro Production Field Demonstration Fall 2008

Lynn Brandenberger, Niels Maness, and Lynda Carrier, Oklahoma State University
In Cooperation with Schantz Farms, Blaine County, Oklahoma

Introduction: Cilantro has been shown to have potential as a commercial crop by researchers at Oklahoma State University. A major concern for us is labor which is in very limited supply and is expensive if available. Our project is really is about deciding if cilantro can be produced as a processing crop using existing equipment and techniques that are already used for growing commercial greens crops for canning. The objectives of our project were to demonstrate commercial production of cilantro for consumption as a dried condiment, produce adequate amounts of cilantro to test harvesting and drying equipment performance, develop the experience needed to commercially produce cilantro, and to find out if we can provide the quality and quantity of cilantro needed to warrant a processing plant in Oklahoma.

Methods and Materials: Our work with cilantro included growing two one acre plots of cilantro on our farm using the equipment that we already use for growing commercial greens crops. We prepared the ground for planting by spraying the previous crop residue with glyphosate to control existing weeds disking twice and finished with a mulch-treader. For weed control we used Prefar herbicide applied at five pounds of active ingredient per acre pre-plant incorporated, using the mulch-treader to incorporate the herbicide. Cilantro was direct seeded at a rate of 45 lbs of seed/acre using a grain drill with an in-row application of Ridimil fungicide. The field was hand-hoed on two dates to control several cool season annual weeds and for control of pigweed all of which was not controlled well with the Prefar. We harvested the crop on three different dates using our greens harvesting equipment.

Results and Discussion: Overall we felt that our experience with cilantro was not too bad. We were able to produce a crop that yielded 5,656 lbs of fresh cilantro for the first harvest on November 3 and 9,060 lbs fresh weight on November 11 and 3,168 lbs fresh weight on December 1st. We think that for fall produced cilantro we could expect 5,000 to 8,000 lbs as a potential yield in our area. We have plans to continue our work with cilantro this spring so we can find out what problems may occur and what the potential yield might be from spring production of this crop. Our greens harvester worked well with cilantro and required no modifications to operate in this new crop.

We did have some issues with this crop during the production period. First and foremost, we need a decent herbicide for controlling weeds. Prefar although it's labeled for cilantro did a very poor job of controlling weeds. What we really need is herbicide that could be used pre and post on this crop either as a tank-mix with Prefar or by itself. In addition to our production demonstration we also worked with OSU to take a look at using Lorox as a postemergence weed treatment and were encouraged by what we saw. As a result of this work we are hoping that there will be potential for getting a Lorox label for cilantro in the future.

Acknowledgements: The authors want to thank the Schantz family for all their help and support in experimenting with this new crop. We would also like to thank the Oklahoma Department of Agriculture Food and Forestry for their support of this effort.

Cilantro Production Field Demonstration Spring 2009

Lynn Brandenberger, Niels Maness, and Lynda Carrier, Oklahoma State University
In Cooperation with Schantz Farms, Blaine County, Oklahoma

Introduction: Following the first cropping study on cilantro in fall 2008 we decided to continue our efforts for this crop into the spring of 2009. Fall yields and production showed promise and we wanted to take a look at spring production. If successful this would allow us to produce cilantro twice a year during the spring and fall growing seasons. We did make some adjustments to our production practices as a result of what we learned in the fall. First, because of the poor weed control that was given by Prefar at the five pound rate we increased the rate to the highest labeled rate of six pounds per acre. Second, we reduced our seeding rate from 45 to 40 pounds of seed per acre. This adjustment was based on the crop stands that we had in our fall plantings in 2008.

Methods and Materials: The spring planting included two ½ acre plots planted on 3/20/09 and 3/27/09. Prior to planting the field it was prepared by disking twice, field cultivating once, and spring-toothing once (Table 1). Before planting we applied Prefar herbicide and incorporated it with two passes of a mulch-treader then planted using a grain drill. Approximately 125 pounds of nitrogen/acre was applied during the growing period, plus some phosphorus, potassium, and sulfur. On the average the plantings received 0.3 to 1.0 inches of water from irrigation and or rainfall per week. Weed control was better in the spring than in the fall, but we still needed to do one hand hoeing and used one application of a post herbicide for grassy weed control. Plots were harvested about two months after planting for the fresh cilantro crop. After the fresh harvest, the remainder of the crop that was not harvested was allowed to produce seed and the seed was harvested by combine in August about five months after planting.

Results and Discussion: Our spring yields for fresh averaged around 5,100 pounds/acre and the seed yielded around 350 pounds of seed per acre. Based on our experiences in both the fall and spring we are confident that cilantro can be produced commercially, but we still need more information about whether it will be a profitable enterprise. The real question is what will the crop be worth to a cilantro processor? Once we find that out we can then make decisions about the real potential of cilantro for Oklahoma.

Acknowledgements: The authors want to thank the Schantz family for all their help and support in experimenting with this new crop. We would also like to thank the Oklahoma Department of Agriculture Food and Forestry for their support of this effort.

Spring Brassica Greens Variety Trial

Lynn Brandenberger, Lynda Carrier, Robert Havener, Robert Adams
Department of Horticulture & Landscape Architecture

Consumers have become more conscious of the nutritional aspects of their diet and the effect that different foods have on it. Leafy brassicas such as collard, kale and mustard are an excellent source of vitamins and minerals. Increases in the consumption of these crops have prompted a need for improved cultivars that will help maintain the commercial production efficiency of these crops. Greens crops are grown by both processing and fresh market producers throughout the state of Oklahoma. The objective of this trial was to trial recently released cultivars of collard, kale, and mustard for yield and bolting resistance during the spring growing season.

Methods and Materials: Plots were arranged in a randomized block design with four replications, each plot consisted of 4 rows on 12 inch row centers 20 feet long. Seeding rate was approximately 490,000 seeds per acre. Plots were direct seeded on 4/07/09 using a research cone planter. Weed control included 0.5 lb ai/acre of Treflan (trifluralin) applied pre-plant incorporated on 4/07/09. No other pest control efforts were necessary. The study received a total of 100 lbs N/acre (50 lbs from 46-0-0 on 5/13/09 and 50 lbs from 46-0-0 on 5/27/09). Sixteen cultivars were included in the study, of these 16, eight were collard, three were Kale, four were mustard and one was turnip (Table 1). No disease infections were observed, but all cultivars were rated for bolting (flowering) at harvest. The rating scale that was used was a 0 to 100 scale where 0 represents no visible flowering and 100 represents 100% of plants having flower stalks present. Data recorded at harvest included overall plot yields and bolting.

Results and Discussion: Comparing overall yields for collard, kale, and mustard, yields averaged 12.9 tons/acre for collard, 11.9 tons/acre for kale, and 20 tons/acre for mustard (Table 1). The one turnip cultivar in the trial averaged 25.4 tons/acre. The highest yielding collards were Top Pick and Flash which yielded 20.7 and 14.4 tons/acre, respectively. Improved Dwarf Siberian kale yielded 16.2 tons/acre and was the highest yielding kale in the trial. Savanna and Southern Giant Curled were the two highest yielding mustards and had yields of 27.6 and 21.1 tons/acre, respectively. Tender Green turnip yielded 25.4 tons/acre.

Bolting (flowering) can be a serious concern in spring produced brassica greens. Ratings for bolting were taken at harvest time with a majority of the cultivars in the trial showing no bolting on 6/10/09 (Table 1). Florida Broadleaf mustard and Tendergreen mustard were the only two cultivars in the trial that had significant bolting. Bolting was 81 and 90%, respectively, for Florida Broadleaf and Tendergreen, all other cultivars showed no evidence of bolting.

In general, there were significant differences observed between different cultivars for yields with the highest yielding cultivars in the trial including Top Pick and Flash collard, Improved Dwarf Siberian kale, Savanna and Southern Giant Curled mustard, and Southern Green turnip. Only two cultivars bolted, Florida Broadleaf and Tendergreen mustard.

Acknowledgements: The authors wish to thank Allen Canning Company, Teddy Morelock of the University of Arkansas, and Alf Christianson Seed for their support of this study.

Table 1. 2009 Spring brassica greens trial, Bixby, OK.

Cultivar	Type	Company	% Bolting	Yield Tons /acre
Bulldog/Hybrid	Collard	Sakata	0 c	12.1 d
Champion/OP	Collard	Christianson	0 c	13.3 d
Flash/Hybrid	Collard	Sakata	0 c	14.4 cd
Georgia/OP	Collard	Christianson	0 c	11.2 d
Morris Heading/OP	Collard	Christianson	0 c	12.2 d
Ozark/OP	Collard	U of A	0 c	9.3 d
Top Pick/Hybrid	Collard	Sakata	0 c	20.7 bc
Vates/OP	Collard	Christianson	0 c	10.1 d
Blue Ridge/Hybrid	Kale	Sakata	0 c	9.5 d
Improved Dwarf Siberian/OP	Kale	Christianson	0 c	16.2 cd
Vates Blue Curled Scotch/OP	Kale	Christianson	0 c	10.0 d
Florida Broadleaf/OP	Indian Mustard	Christianson	81 b	15.0 cd
Southern Giant Curled/OP	Indian Mustard	Christianson	0 c	21.1 a-c
Savanna/Hybrid	Spinach Mustard	Sakata	0 c	27.6 a
Tendergreen/OP	Spinach Mustard	Christianson	90 a	16.4 cd
Southern Green/Hybrid	Turnip	Sakata	0 c	25.4 ab

[y] Bolting ratings and yield data on June 10, 2009

[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.

Fall Brassica Greens Variety Trial

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Department of Horticulture & Landscape Architecture
***Tulsa County OSU Extension**

Introduction: Greens crops are grown by both processing and fresh market producers throughout the state of Oklahoma. A spring brassica greens trial was completed during the spring of 2009 with results indicating cultivars that had bolting resistance and providing yield potential for 16 different cultivars. The objective of this trial was to repeat this trial during the fall growing season looking at yield potential, disease resistance and the quality of different cultivars for use in fall greens production.

Methods and Materials: Plots were arranged in a randomized block design with four replications, each plot consisted of 2 rows on 12 inch row centers 20 feet long. Seeding rate was approximately 490,000 seeds per acre. Plots were direct seeded on 9/28/09 using a research planter. Weed control included 0.5 lb ai/acre of Treflan (trifluralin) applied pre-plant incorporated on 9/28/09. No other pest control efforts were necessary. The study received a total of 100 lbs N/acre from 34-0-0 as split applications on 11/04/09 and 11/17/09. Fifteen cultivars were included in the study, of these, seven were collard, three were Kale, four were mustard and one was turnip (Table 1). No disease infections were observed, but all cultivars were rated for emergence on 10/19/09 and for stand survival prior to harvest on 12/10/09. A one row sub-plot (1 meter in length) was harvested in each plot due to stand variability caused by high rainfall during the trial. The remainder of each plot was rated on 12/11/09 for cold injury. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop emergence, stand, or cold injury and 100 represents complete emergence, full stand or 100% of a plants being dead from cold injury.

Results and Discussion: Emergence on 10/19/09 did not vary between treatments and ranged between 64 to 88% for the cultivars in the study (Table 1). Stand survival ratings were recorded on 12/10/09 and varied considerably for several cultivars in the trial ranging from a low of 35% to a high of 75%. Florida Broadleaf mustard had 35% stand survival while Southern Green turnip, Tendergreen spinach mustard, and Improved Dwarf Siberian kale had stand survival ratings of 75, 70, and 74%, respectively. Cold injury ratings were made on 12/11/09 and varied between cultivars within a crop group and between crop groups. In general, kales were the most tolerant of the 10-17^{o}F low temperatures that were recorded during the trial. Kale cultivars averaged 62% cold injury, collards averaged 73%, and the mustards had an average of 84% cold injury. The two most cold tolerant cultivars in the study were Vates Blue Curled Scotch kale and Flash collard which recorded 54 and 55% cold injury, respectively. Yields were highest overall for the mustards and the turnip cultivars included in the study. Overall this group averaged 11.2 tons/acre yield compared to 4.3 and 4.5 tons/acre, respectively, for collards and kale. The highest yielding cultivars of collard, kale, and mustard were Champion collard (6.0 tons/acre), Improved Dwarf Siberian kale (7.0 tons/acre), and Tendergreen spinach mustard (15.5 tons/acre).

Conclusions: In general this trial of brassica greens encountered several environmental challenges. First, during the trial period nearly 17.5 inches of rain was received at the trial site. This alone would account for the low emergence and stand survival ratings that were recorded. Second, the hard freezes that were recorded during the trial provided the opportunity to observe how cold tolerant these different greens crops are. Kale appears to have the most cold tolerance followed by collard and then the mustards and turnip. Additionally, these environmental stresses provide an excellent opportunity to observe the performance of brassica greens under less than ideal conditions which often occur in commercial production.

Acknowledgements: The authors wish to thank Allen Canning Company, Teddy Morelock of the University of Arkansas, and Alf Christianson and Sakata Seed for their support of this study.

Table 1. Fall 2009 Brassica greens variety trial, Bixby, OK.

Cultivar	Type/company[z]	% Emergence 10/19/09	% Stand survival 12/10/09	% Cold injury[x] 12/11/09	Yield Tons/acre 12/10/09
Bulldog/Hybrid	Collard/Sakata	68 a[y]	39 b-c	75 a-c	3.7 b
Champion/OP	Collard/Chris	76 a	54 a-c	83 a-c	6.0 b
Flash/Hybrid	Collard/Sakata	79 a	63 a-b	55 d	4.4 b
Georgia/OP	Collard/Chris	69 a	41 b-c	84 a-b	3.9 b
Morris Heading/OP	Collard/Chris	76 a	58 a-c	71 a-d	4.6 b
Ozark/OP	Collard/U of A	66 a	38 b-c	73 a-d	3.1 b
Vates/OP	Collard/Chris	80 a	50 a-c	73 a-d	4.6 b
Blue Ridge/Hybrid	Kale/Sakata	64 a	43 b-c	64 c-d	3.1 b
Improved Dwarf Siberian/OP	Kale/Chris	80 a	74 a	68 b-d	7.0 b
Vates Blue Curled Scotch/OP	Kale/Chris	69 a	49 a-c	54 d	3.5 b
Florida Broadleaf/OP	Indian Mustard/Chris	68 a	35 c	90 a	7.9 b
Southern Giant Curled/OP	Indian Mustard/Chris	75 a	49 a-c	85 a-b	6.6 b
Savanna/Hybrid	Spinach Mustard/Sakata	76 a	64 a-b	80 a-c	12.2 a
Tendergreen/OP	Spinach Mustard/Chris	83 a	70 a	80 a-c	15.5 a
Southern Green/Hybrid	Turnip/Sakata	88 a	75 a	85 a-b	13.8 a

[x]% Cold injury 0%= no injury, 100% died from freeze.
[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.
[z]Sakata = Sakata Seed USA, Chris = Alf Christianson Seed company, U of A = University of Arkansas.

Soil Improvement Study

Bixby, Oklahoma
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Introduction: Growers in the southern U.S. face serious problems due to low levels of organic matter in production soils. Organic matter levels in agricultural soils of Oklahoma commonly are less than 1%. Low organic matter can have serious effects upon production including poor stands, poor retention of water and plant nutrients, and generally poor tilth of production soils. The objectives of this study are to compare different means of increasing soil organic matter and the effects that increased organic matter may have on crop establishment and growth over a four year period.

Methods and Materials: Plots were arranged in a randomized block design with five replications. Treatments included a clean fallow check, cowpea (Victor) cover crop, sorghum/sudan cover crop (Hay Grazer BMR 6), sorghum/sudan + cowpea cover crop combination, and clean fallow + compost. Study treatments were initiated on 6/26/09 by direct seeding all cover crops in plots that were 12' x 26' which included 18 rows on six inch row centers. Plant populations are given in Table one. All cowpea seed were inoculated prior to planting with *Bradyrhizobium* species at a rate of 2.5 oz of inoculum per 50 lbs of seed. Clean fallow and compost plots were rototilled during the summer growth period on 7/24/09 and 8/6/09. Sorghum/sudan cover crop plots were mown with a rotary mower at a height of 4-6 inches on 8/06/09 and the entire study was mown on 8/25/09. On 9/01/09 all plots were rototilled once to a depth of 6-8 inches and this was repeated twice on 9/28/09 in preparation for planting on 9/29/09. Compost was applied on 9/29/09 to the clean fallow + compost plots at a rate of 8 tons of compost per acre and then rototilled to a depth of 3-4 inches for incorporation. All plots were direct seeded to the spinach cultivar 'Padre' on 9/29/09, eight rows per plot on one foot row centers at a seeding rate of 12 seed per row foot. All plots received 0.65 lbs ai/acre of Dual Magnum (S-metolachlor) as a preemergence herbicide application following direct seeding on 9/29/09. All plots received a total of 100 lbs of nitrogen per acre applied as a split application of 50 lbs per acre on two different dates (11/04/09 and 11/17/09). Emergence and stand coverage were rated on a 0 to 100 scale where 0% would indicate no emerged plants or coverage of the soil surface by crop plants in the plots and 100% would indicate a full stand and complete coverage of the soil surface by plants in the plots.

Results and Discussion: No differences were observed for emergence on 10/19/09 with emergence ranging from 46% for the fallow check to 53% for the sorghum x sudan + cowpea cover crop and the compost treatments (Table 1). Stand coverage was rated on 12/01/09 and differences between treatments were observed. The fallow check had 46% stand coverage while the compost treatment had 79% coverage, all other treatments did not vary from the lowest or highest ratings. In conclusion, the study was established during 2009 and although there were few differences between treatments observed, the authors are looking forward to continued efforts on the study and the potential improvement of soil conditions and related crop responses.

Table 1. 2009 Soil improvement study, Bixby, OK.

Treatment	% Emergence[z] 10/19/09	% Stand coverage 12/1/09
Fallow check	46 a	46 b
Cowpea cover crop	46 a	57 a-b
Sorghum x sudan cover crop	50 a	63 a-b
Sorghum x sudan + cowpea cover crop	53 a	66 a-b
Compost	53 a	79 a

[z] All plots were tilled and planted to 'Padre' spinach on 9/29/09
[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.

Southern Cooperative Cowpea Trial

Spring 2009, Bixby, Oklahoma

Lynda Carrier, Lynn Brandenberger, Robert Havener, and Robert Adams

Materials and Methods: The Southern Cooperative trials are an ongoing effort by scientists at 5 Land Grant Universities and the U.S.D.A to provide cowpea performance data from a wide variety of production environments. The Bixby trial provides Oklahoma producers with information on crop maturity and yield potential of breeding lines that may possibly become available in the near future. Plots consisted of one row 20 feet long with 36 inches between rows. Seed were spaced 5 seeds per foot and were planted on 6/17/09. A preemergence application of Dual Magnum at 1.0 lb ai/acre on 6/17/09 followed by an overhead irrigation of 0.5 inches of water. Supplemental water was supplied through overhead irrigation. Plots were fertilized on 7/9/09 with 25lbs N/acre. The trial included 4 replications for the 11 replicated lines and 2 replications for the 14 observational lines (Tables 1, 2). The trial was machine harvested on 10/7/09 dry yields were recorded subsequently. Data was analyzed using Duncan's multiple range test with comparisons made between varieties within a pea type (blackeye, cream, crowder, and pinkeye) compared only to other peas within that given type.

Results and Discussion: Peas were scheduled to harvest in September, due to extended rainfall in August and September, harvest was delayed. Because of the high rainfall, moisture readings were extremely high and many of the peas were moldy. Imbibed weights were not carried out due to the mold and high moisture. Visual plant growth habits were observed, it was noted that AR 01-821 and AR01-1293 (pinkeye type) were the most upright plants with most pod sets at the top of the plants. Peas were harvested on October 7th with a Wintersteiger plot combine. Yields had no significant differences; AR 01-821 was the highest yielding overall with 1773 lbs per acre in the replicated trial. LA 2-30 was the highest yielding in the observational study with 1735 lbs per acre.

Conclusions: Factors that should be considered when selecting a particular cowpea cultivar include plant growth habit, time to maturity, and of course, yield. The percentage of moisture in the harvested pea is an indicator of maturity with earlier maturing cultivars having a higher percentage dry pods and a lower percentage of moisture at harvest. Growth habit has a direct bearing on the ability to harvest the crop, both by machine and by hand. Cultivars that are more erect, particularly with pods set in the upper portion of the plant are essential for machine harvest, but are also desirable for hand harvesting of fresh market peas.

Acknowledgements: The authors would like to thank Bob Heister for combining the peas.

Table 1. Spring 2009 Southern Pea Trial, Bixby, OK. Replicated Trial.

Variety	Source	Shelled yield lbs./acre[z]
	Blackeye types	
TX2015-2-1-1-0BEgc	Texas A & M	1458 a[y]
TX2028-1-5-1-0BEgc/gt	Texas A & M	1555 a
ARK Blackeye #1	Industry Standard	1526 a
	Crowder types	
LA 2-119	Lousiana State	1643 a
Mississippi Silver	Industry Standard	1715 a
	Pinkeye types	
TX2044-5-1-0PEgc	Texas A & M	1372 a
LA 2-46	Louisiana State	1341 a
LA 2-52	Louisiana State	1434 a
AR01-821	U of Arkansas	1773 a
AR01-1293	U of Arkansas	1494 a
Coronet	Industry Standard	1559 a

[z] Dry shelled wt.=mechanically harvested on 10/7/09 yield in lbs./acre.
[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. Spring 2009 Southern Pea Trial, Bixby, OK. Observational Trial.

Variety	Source	Shelled yield lbs./acre
	Blackeye types	
TX2012-5-1-2-0BE	Texas A & M	1336 a
TX2028-1-3-1-0BEgc	Texas A & M	1231 a
ARK Blackeye #1	Industry Standard	1372 a
	Cream types	
AR01-1781	U of Arkansas	1967 a
Early Acre	Industry Standard	1706 a
	Pinkeye types	
TX2044-4-6-4-0PEgc	Texas A & M	1390 a
TX2044-5-2-0PEgc	Texas A & M	1459 a
LA 2-9 gc	Louisiana State	1289 a
LA 2-12	Louisiana State	1416 a
LA 2-16	Louisiana State	1242 a
LA 2-30	Louisiana State	1735 a
AR07-216	U of Arkansas	1699 a
AR07-1279	U of Arkansas	1532 a
Coronet	Industry Standard	1263 a

[z] Dry shelled wt.=mechanically harvested on 10/7/09 yield in lbs./acre.
[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.

Spring 2009 Sweet Corn Variety Trial

Bixby, Oklahoma
Brian Kahn, Lynda Carrier, Robert Havener, and Robert Adams

Introduction and Objectives: High quality sweet corn is a very popular vegetable in Oklahoma. Small scale production can be sold directly on the farm or at roadside stands, farmer's markets and local stores. Large scale production requires a considerable investment in harvesting equipment and packing facilities. Corn earworm is a serious insect pest, and sweet corn production should not be attempted without an adequate insecticide spray program during the silking to harvest stages.

The genetics of sweetness in corn have become increasingly complicated. For many years, varieties could be classified as either normal sweet (su_1), sugary-enhanced (se), or supersweet (sh_2). Now varieties with genetic combinations have been introduced to the market. Check with your seed company representative before planting a new variety to learn about isolation requirements.

Objectives of this trial were to evaluate 19 white varieties, all in the se isolation group, for yield, earliness, and overall quality.

Materials and Methods: Plots were direct seeded on April 23. Plots were 20 ft long with 3 feet between rows and 2 rows per plot. Varieties were replicated 3 times in a randomized block design. Plots were sprayed with S-metolachlor herbicide on April 24, at the rate of ¾ pint/acre. Plots were thinned to 20 plants per row on May 27. All plots had 100% stands after thinning, and overall early vigor was very good. Fertilizer was applied three times: April 23 at 50 lbs. N/acre; May 27 at 75 lbs. N/acre; and June 19 at 75 lbs. N/acre. Insecticide applications began in June (just before silking) and continued throughout the harvest period. Supplemental water was applied with overhead irrigation. Each variety was harvested one time at its peak maturity.

Results and Summary: Results are shown on the following page. An unusual period of prolonged high temperatures during silking caused severe quality problems in this trial and in commercial fields in the area. Most ears, regardless of variety, had irregular kernel fill and limited kernel development along the entire cob length. Still, a few conclusions can be made. 'Spring Snow' from Mesa Maize does not appear in the data table because it was too early and therefore unadapted. Ears set on 'Spring Snow' plants that were just 3 feet tall, and those ears never developed marketable size or quality. 'Frosty' plants also tasseled while small, but this variety managed to produce some marketable (although small) ears. 'Denali' ears looked good, especially in the husk, and this variety should be trialed again. 'Shasta' had relatively large, bright white kernels, and may have been nice in a year with better cob fill. 'Whiteout' showed some potential as a relatively early variety in the last white sweet corn trial at Bixby (in 2004), and again this year. Although some ears of 'Whiteout' had poor tip cover, shucked ear appearance ratings were relatively good. The experimental line W50371 was unimpressive, with very short ears. 'Avalon' was an enigma. Although billed as a relatively late cultivar, 'Avalon' plants tasseled while still small. The plants also set multiple ears (sometimes 3 to 5 per plant), but few of these ears ever developed, resulting in the lowest yield in the trial. 'Avalon' yields also had been below average in the 2004 trial. 'Argent' has been our standard of comparison for white sweet corn in the se group, and it still is recommended.

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

Table 1. Spring 2009 Sweet Corn Variety Trial, Bixby[z] .

Variety[y]	Company/ Source	Market yield (sacks/A)[y]	Yield (tons/A) Market	Yield (tons/A) Culls	Number days to harvest	In-shuck rating[x]	Shucked rating[x]	Avg ear dia. (inches)	Avg ear length (inches)	Corn earworm damage[v]
Group: se White varieties										
Denali	Mesa Maize	125	1.6	1.0	74	2.2	2.5	1.7	6.7	2.7
Frosty	Crookham	123	1.0	0.7	70	4.0	4.0	1.4	6.2	3.5
Whiteout	Mesa Maize	111	1.3	1.3	74	3.8	3.5	1.5	6.9	3.3
Silver Princess	Seedway	80	0.8	0.9	70	4.0	3.7	1.5	6.6	4.5
Argent	Crookham	78	0.9	1.5	77	3.0	3.3	1.6	6.9	3.5
Shasta	Mesa Maize	76	1.0	1.4	74	3.8	3.7	1.6	7.3	3.3
Chantilly	Mesa Maize	68	0.7	1.3	70	4.0	3.7	1.4	6.1	4.0
Mattapoisett	Mesa Maize	66	1.0	1.6	77	2.3	4.5	1.6	7.0	3.3
Augusta TSW	Mesa Maize	62	0.7	1.4	77	2.3	4.0	1.6	6.4	2.7
Celestial	Crookhama	62	0.7	1.6	81	2.5	4.0	1.6	7.0	2.7
W 50367	Mesa Maize	57	0.6	1.4	74	3.5	3.8	1.5	6.7	3.8
Sugar Pearl TSW	Mesa Maize	57	0.6	1.2	70	3.5	3.8	1.5	6.5	3.3
Captivate	Crookham	55	0.7	1.9	81	3.5	4.5	1.6	7.7	2.8
Silver King	Seedway	51	0.7	2.4	77	3.2	4.7	1.6	7.6	4.0
Cloud Nine	Mesa Maize	49	0.6	1.1	74	3.0	3.8	1.5	6.4	3.3
W 50371	Mesa Maize	41	0.4	0.9	81	3.7	4.5	1.5	5.8	3.3
Misquamicut	Mesa Maize	41	0.5	1.7	77	3.3	4.0	1.6	6.3	3.7
Avalon	Seedway	16	0.2	1.7	77	4.2	4.5	1.4	6.5	4.5
	Mean	68	0.8	1.4		3.3	3.9	1.5	6.7	3.5
	LSD $_{0.05}$	56	NS	0.7		0.6	0.7	0.1	0.5	1.1

[z]Seeded April 23, 2009; Plot size: 1.8m x 6.0m (2 rows/plot, 3 plots each variety, plots thinned to 20 plants/row.) Harvested 7/2/09 to 7/13/09

[y]One sack = 60 ears

[x]Rating: 1=best, 5=poorest

[x]Rating: 1=no damage, 2=earworm damage <½" from tip, 3=earworm damage <1" from tip, 4=earworm damage <1½" from tip, 5=earworm damage >1½" from tip.

[v]Earworm control: Pounce, Asana, Lannate & SpinTor were alternated and applied a total of 5 times between silking & harvest to entire planting.

Organic Tomato Transplant Production and Supplemental Fertilizers

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Lane, OK

Abstract: The consumer's perceptions that organic food tastes better and is healthier are two major factors driving the increasing demand for organically produced crops in the U.S. It was necessary to develop organic certification to provide consistent standards across the U.S. for the benefit of producers, processors, wholesalers, retailers, and consumers. All components entering into the organic crop production system must be approved for organic use, including the seed, soil media, and fertilizer used in transplant production.
Research was conducted to determine whether the addition of supplemental fertilizer to an organic soil medium enhance seedling growth. The factorial experiment included 4 fertilizer rates (5-4-4, 6-2-2, 7-3-7, and 0-0-0 N-P-K) added at 1% by weight prior to planting tomato (*Solanum lycopersicon* L.) seeds ('Florida 47') and 2 liquid fertilizer rates (0.4% and 0%) added at 3 weeks after planting (WAP) with 6 replications with 6 plants per replication. Adding fertilizer prior to planting produced significantly greater plant heights at 3 and 5 weeks (WAP) compared to the control (0-0-0). Although there were few height differences among 3 fertilizer treatments at 3 WAP, the addition of 0.4% solution of a fish and seaweed fertilizer at 3 WAP resulted in a significant height increase at 5 WAP for the 6-2-2 fertilizer treatment. To produce suitable tomato transplants supplemental fertilizer was required at a level of 1% by weight of a 6-2-2 N-P-K organic fertilizer, which was further enhanced by applying a 0.4% solution of a fish and seaweed fertilizer at 3 WAP. Further research should investigate additional organic soil media, fertilizer sources and rates, and crops.

Introduction: The consumer's perceptions that organic food tastes better and is healthier are two major factors driving the increasing demand for organically produced crops in the U.S. It was necessary to develop organic certification to provide consistent standards across the U.S. for the benefit of producers, processors, wholesalers, retailers, and consumers. All components entering into the organic crop production system must be approved for organic use, including the seed, soil media, and fertilizer used in transplant production.
Research was conducted to determine whether the addition of supplemental fertilizer to an organic soil medium enhance seedling growth.

Material and Methods: The factorial experiment included 4 pre-planting fertilizer[1,2] rates (5-4-4, 6-2-2, and 7-3-7 N-P-K and a 0-0-0 N-P-K control) added to a commercial organic soil medium[3] prior to planting tomato (*Lycopersicon esculentum* Mill.) seeds ('Florida 47') and two levels (2-3-1 N-P-K and a 0-0-0 control) of liquid fertilizer[4] applied at 3 weeks after planting (3 WAP) with 6 replications and 6 plants per replication.

Each dry pre-planting fertilizer was mixed thoroughly into 1.5 ft^3 organic soil media at the rate of 1% by weight. The 4 fertilized soil mixtures (5-4-4, 6-2-2, 7-3-7, and 0-0-0 N-P-K) were then added to 128-cell Speedling[5] trays and planted with tomato seeds and placed in the greenhouse. The tomato seedlings were thinned to 1 seedling per cell at 1 WAP. Plant heights were collected at 3 WAP.

Following the 3 WAP data collection, each pre-fertilized treatment received either an application of liquid fertilizer (0.4% v:v) or no additional fertilizer (control). At 5 WAP plant heights were collected. All data were subjected to ANOVA and mean separation using LSD with P=0.05 (SAS Inc., SAS, Ver. 9.0, Cary, NC).

Results and Discussion: Adding fertilizer prior to planting produced significantly greater plant heights at 3 and 5 weeks (WAP) compared to the control (0-0-0) (Table 1). Although there were few height differences among 3 fertilizer treatments at 3 WAP, the addition of 0.4% solution of a fish and seaweed fertilizer at 3 WAP resulted in a significant height increase at 5 WAP for the 6-2-2 fertilizer treatment. To produce suitable tomato

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[1] The mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.
[2] Barton Isle Fertilizer Company, LLC, 27415 Fairfax St., Southfield, MI 48076
[3] Organic Planting Mix, Sun Gro Horticulture Inc., 15831 N.E. 8th Street, Suite 100
Bellevue, WA 98008
[4] Neptune's Harvest, Fish and Seaweed Fertilizer (2-3-1), P.O. Box 1183, Gloucester, MA 01931-1183
[5] Speedling Inc., P. O. Box 7220, Sun City, FL 33586-7220

transplants supplemental fertilizer was required at a level of 1% by weight of a 6-2-2 N-P-K organic fertilizer, which was further enhanced by applying a 0.4% solution of a fish and seaweed fertilizer at 3 WAP. Further research should investigate additional organic soil media, fertilizer sources and rates, and crops.

Table 1. Influence of pre-planting fertilizer and supplemental fertilizers on tomato plant heights (cm) at 3 weeks after planting (WAP) and 5 WAP.

Pre-Planting Fertilizer[z] 1% by Weight N-P-K	Seaweed[y] 0.4% v:v	3 WAP Plant Height (cm)	5 WAP Plant Height (cm)
0-0-0 (Control)	No	2.64 d[x]	3.80 g
0-0-0 (Control)	Yes	2.76 d	4.67 f
5-4-4	No	4.06 b	5.73 e
5-4-4	Yes	3.79 c	7.10 cd
6-2-2	No	4.46 a	7.72 b
6-2-2	Yes	4.66 a	9.77 a
7-3-7	No	4.03 b	6.80 d
7-3-7	Yes	4.18 b	7.13 c

[z]Barton Isle Fertilizer Company, LLC, 27415 Fairfax St., Southfield, MI 48076
[y]Neptune's Harvest, Fish and Seaweed Fertilizer (2-3-1), P.O. Box 1183, Gloucester, MA 01931-1183
[x]Values in columns followed by the same letter are not significantly different at $P \leq 0.05$.

Acknowledgements: We would like to thank Buddy Faulkenberry (USDA, ARS Technician) and Will Baze (USDA Summer Worker) for technical assistance. Special thanks go to Wendell Minott, Barton Isle Fertilizer Company, LLC, for supplying the pre-plant organic fertilizers.

Disease Management

Control of Bacterial Leaf Spot on Mustard Greens - Spring Trial

Stillwater, 2009

John Damicone and Tyler Pierson, OSU Entomology and Plant Pathology

Introduction and Objective: Bacterial leaf spot (*Pseudomonas syringae* pv. *maculicola*; *Psm*) and Xanthomonas leaf spot (*Xanthomonas campestris* pv. *armoraceae; Xca*) are important bacterial leaf spots on leafy Brassica leafy greens (turnip, mustard, collards, kale, etc) in Oklahoma. Fungicides that are effective for the control of Cercospora leaf spot, the major fungal leaf spot disease in Oklahoma, are not effective on these bacterial leaf spots. Copper hydroxide (Kocide), copper sulfate (Cuprofix) and the plant defence activator acibenzolar-s-methyl (Actigard) have been previously evaluated for control of bacterial leaf diseases on turnip greens, but have not provided adequate control. The objective of this trial was to evaluate new products with reported activity on bacterial diseases (i.e. bactericides and plant defence activators) for control of bacterial leaf spot.

Materials and Methods: The trial was conducted at the Entomology and Plant Pathology Research Farm in Stillwater, OK in a field of Norge loam soil previously cropped to watermelons. Granular fertilizer (50-0-0 lb/A N-P-K) and the herbicide Treflan 4E at 1.0 pt/A were incorporated into the soil prior to planting the cultivar ‘Savannah’ on 16 Mar. Savannah is a spinach-mustard cultivar used by the processing industry as mustard greens. Plots were top dressed with additional granular fertilizer (50-0-0 lb/A N-P-K) on 7 Apr. Plots consisted of 4-row beds, 20-ft long, with rows spaced 12 inches apart. The experimental design was a randomized complete block with four blocks separated by a 5-ft-wide fallow buffer. Treatments were broadcast through flat-fan nozzles (8002vk) spaced 18 inches 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 when plants had 5 to 6 true leaves. Plots were inoculated by spraying a 3-ft section of the center two rows of each plot with a suspension of *Psm* and *Xcc* (10^7 cells/ml) on 28 April, 4 days after the first treatment application. Rainfall during the cropping period (16 Mar to 22 May) totaled 3.36 inches in March, 5.07 inches in April, and 3.23 inches in May. Plots received sprinkler irrigation that totaled 3 inches of water as needed to promote stand establishment and plant growth. Six, 1-ft row segments were harvested arbitrarily from the middle two rows of each plot on 22 May. The harvested leaves were bulked, mixed, and disease severity (diseased leaf area) was visually estimated on 30 blindly sampled leaves.

Results: Rainfall was near normal (30-yr average) in April but 2 inches below normal in May. Average daily temperature was near normal for April but was below normal for May. Conditions were generally favorable for foliar disease development but bacterial leaf spots only reached moderate levels which were variable within treatments. Plots receiving Kocide, Actigard, and Kocide+Actigard had reduced disease incidence (leaves with leaf spot) compared to the untreated check (Table 1). Other treatments had levels of disease similar to or greater that the check. While there were numerical trends for reduced disease incidence for treatments receiving Kocide and /or Actigard, differences were not statistically significant.

Conclusions: Treatments with Kocide and/or Actigard reduced incidence of bacterial leaf spot, but disease pressure was not sufficient to definitively assess the treatments.

Acknowledgements: Financial support from the IR4 Project and Allen Canning Co., and the assistance of Rocky Walker and staff at the OSU Entomology and Plant Pathology Research Farm in the trial establishment and maintenance are greatly appreciated.

Table 1. Control of bacterial leaf spot with bactericides and other products on "Savannah" spinach-mustard greens, Stillwater, Spring 2009.

Treatment and rate/A[1]	Leaves with leaf spot (%)[2]	Leaf area with leaf spot (%)[2]
Kocide 3000 0.75 lb………………….....	7.5 de[2]	0.6 a
Kasumin 2F 16 fl oz…………………....	21.6 bcde	4.4 a
KleenGrow 6.4 fl oz…………………….	39.0 abc	8.7 a
Agrimycin 17W 0.25 lb…………………	40.8 abc	9.3 a
Agrimycin 17W 0.25 lb + Champ DP 0.67 lb	26.5 bcde	8.7 a
Actigard 50WG 1.0 oz	7.5 de	1.5 a
Actigard 50WG 1.0 oz + Kocide 3000 0.75 lb	4.1 e	1.5 a
Oxidate 1 gal…………………..…….	30.8 bcd	7.4 a
KPX A2 8 fl oz………………………....	25.0 bcde	10.1 a
KPX A2 16 fl oz…………………..…….	57.5 a	20.3 a
Taegro 24W 3.5 oz………………….....	31.2 bc	7.3 a
MOI-10602 1 pt………………………....	29.8 bcd	11.2 a
Serenade 1.0 lb…………………………	41.6 ab	11.0 a
Omega Grow 2 qt……………………....	18.3 cde	5.0 a
Check……………………………..…….	40.0 abc	11.6 a
LSD (P=0.05)[4]…………….………….	22.7	NS

[1] Treatments were applied on 24 Apr, 1 May, 8 May, and 15 May.
[2] From 30 leaves per plot taken on 22 May.
[3] Means followed by the same letter are not statistically different at P=0.05 according to Fisher's Least Significant Difference test.
[4] Least significant difference. NS= treatment effect not significant at P=0.05.

Control of Bacterial Spot on Resistant and Susceptible Bell Pepper Cultivars

Stillwater, 2009

John Damicone and Tyler Pierson, OSU Entomology and Plant Pathology

Introduction and Objective: Bacterial spot is the most important foliar disease of peppers in Oklahoma. The disease causes defoliation and fruit spotting which can both reduce yield. Race specific-resistance to bacterial spot is available in bell peppers and in some other pepper types. The most effective resistance gene is *bs2* which confers resistance to three races and is sometimes termed "X3R" in cultivar names. Resistance from *bs2* may break down under hot temperature or where new races of the bacteria develop. Spray programs with copper or copper+maneb are also used in bacterial spot control. Copper-based spray programs generally require frequent (al least weekly) application and are only partially effective. The effectiveness of copper sprays is reduced where copper-resistant strains of the bacterium develop. Recently, regulations concerning the use of antibiotics in agriculture have been relaxed and new antibiotics are being developed by industry and the IR-4 minor use program. The objective of this field trial was to compare the performance of an antibiotic (Agrimycin), applied in alternation with copper, with recommended copper-based spray programs. The fungicide Tanos was included because it is reported to have activity on bacterial spot.

Materials and Methods: The trial was located at the OSU Entomology and Plant Pathology Research Farm in Stillwater in a field of Norge loam previous cropped to wheat. Granular fertilizer (46-0-0 lb/A N-P-K) and the herbicide Trifluralin 4E at 1.25 pt were incorporated prior to transplanting pepper seedlings on 21 May. The experimental design was a split plot with spray program as the whole plot treatment and pepper cultivar as the sub-plot treatment. The cultivars were Camelot (X3R), resistant to bacterial spot races 1 to 3, and Jupiter, susceptible to bacterial spot. Split plots consisted of single rows spaced 3 ft apart, each containing 6 plants spaced 1.5 ft apart within the row. Bactericides were applied as directed sprays through three flat-fan nozzles (8002vs) per row using a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 44 gal/A at 40 psi. Bactericides were applied on 7-day intervals from 12 June to 4 Aug. Sub-plots were inoculated on 15 June by spraying one plant to runoff with an aqueous suspension (10^7cells per ml) of a strain of the bacterial spot pathogen isolated from a vegetable farm in Payne Co. in 2007. Flea beetles and tomato hornworms were controlled with Baythroid 2 at 2.8 fl oz on 2 Jun and 10 July. Rainfall during the cropping period (1 June to 30 Aug) totaled 1.73 inches in June, 4.96 inches in July, and 7.5 inches in Aug. The trial received 32 applications of sprinkler irrigation that totaled 9.6 inches of water to promote plant growth and disease development. Disease incidence (percentage of leaves with bacterial spot or defoliated) and defoliation (percentage of leaves defoliated) was periodically estimated in three areas per subplot. Yield was determined by harvesting peppers from all plants in each sub-plot four times from 13 July to 31 Aug. Peppers were classified as healthy or diseased based on the presence or absence of bacterial spots.

Results: Rainfall was below normal (30-yr avg.) and average daily temperature was above normal in June. In July and August, rainfall was 6.7 inches above normal and temperatures were below normal. Bacterial spot appeared shortly after inoculation and conditions generally favored disease development. The disease increased to reach moderate levels in the susceptible cultivar Jupiter by the end of the trial (Table 1).

Overall, the resistant cultivar Camelot had lower levels of bacterial spot (Table 1) and higher yields (Table 2) than the susceptible cultivar Jupiter. Most of the treatments reduced bacterial spot on the resistant cultivar Camelot, but had little effect on disease levels in the susceptible cultivar Jupiter (Table 1). The Kocide/Penncozeb, Cuprofix, Cuprofix/Penncozeb, and Cuprofix/Agrimycin treatments increased yield of healthy peppers compared to the untreated check (Table 2). Yield of healthy peppers for the susceptible cultivar Jupiter were low and did not differ among treatments. A significant level of fruit with bacterial spot symptoms were observed on both cultivars and spray programs did not reduce levels of diseased fruit compared to the untreated check (Table 2). However, most of the bacterial spotting occurred on the fruit stems.

Conclusions: The X3R type of resistance from the *bs2* gene was effective against a local strain of bacterial spot. The effect of resistance was additive to spray program effects in increasing yield. Agrimycin (streptomycin sulfate) did not increase the performance of spray programs for bacterial spot compared copper and copper+ mancozeb treatments. Spray programs generally performed poorly on the susceptible cultivar.

Acknowledgment: The assistance of Rocky Walker and staff at the Entomology/Plant Pathology Research Farm in the establishment and maintenance of the trial is appreciated.

Table 1. Disease response of resistant (Camelot X3R) and susceptible (Jupiter) bell pepper cultivars to spray programs for control of bacterial spot.

Treatment and rate/A (timing)[1]	Bacterial spot (%)[2]		Defoliation (%)[3]	
	CX3R[4]	JUP[5]	CX3R	JUP
Check……………………………..….	32 a[6]	63 a	14 a	27 a
Kocide 3000 1.25 lb (1-8)…………..	13 b	53 a	4 bc	24 a
Kocide 3000 1.25 lb + Penncozeb 75DF 2 lb (1-8)……..…	7 b	58 a	3 c	25 a
Cuprofix Ultra 40DF 3 lb (1-8)…..…	8 b	55 a	1 c	21 a
Cuprofix Ultra 40DF 3 lb + Penncozeb 75DF 2 lb (1-8)…..……	6 b	68 a	2 c	27 a
Kocide 3000 1.25 lb (1,3,5,7) Agrimycin 17W 0.5 lb (2,4,6,8)…….	19 ab	60 a	6 bc	29 a
Cuprofix Ultra 40DF 3 lb (1,3,5,7) Agrimycin 17W 0.5 lb (2,4,6,8)…….	16 b	66 a	11 ab	33 a
Kocide 3000 1.25 lb (1,3,5,7) Tanos 50DF 8 oz (2,4,6,8)………....	14 b	57 a	4 bc	22 a
mean…………………………………	14	60	6	26
$LSD_{0.05}$[7]	15	NS	7	NS

1 Timings (1-8) correspond to the spray dates of 1=12 Jun, 2=19 Jun, 3=26 Jun, 4=2 Jul, 5=10 Jul, 6=17 Jul, 7=24 Jul, and 8=4 Aug
2 Percentage of leaves with bacterial spot including defoliation on 12 Aug.
3 Percentage of leaves defoliated by bacterial spot on 12 Aug.
4 Cultivar Camelot X3R.
5 Cultivar Jupiter.
6 Values in a column followed by the same letter are not statistically different.
7 Least significant difference; NS = treatment effect not significant at P=0.05.

Table 2. Yield response of resistant (Camelot X3R) and susceptible (Jupiter) bell pepper cultivars to spray programs for control of bacterial spot.

Treatment and rate/A (timing)[1]	Healthy yield (cwtA)[2]		Diseased yield (cwt/A)[3]	
	CX3R[4]	JUP[5]	CX3R	JUP
Check……………………………..….	104.1 d[6]	27.8 a	33.5 bc	12.9 bc
Kocide 3000 1.25 lb (1-8)…………..	148.8 cd	64.9 a	33.1 bc	42.7 a
Kocide 3000 1.25 lb + Penncozeb 75DF 2 lb (1-8)……..…	223.4 ab	48.8 a	32.7 bc	23.4 abc
Cuprofix Ultra 40DF 3 lb (1-8)…..…	252.9 a	48.0 a	30.2 bc	31.4 ab
Cuprofix Ultra 40DF 3 lb + Penncozeb 75DF 2 lb (1-8)…..……	257.3 a	64.9 a	18.1 c	27.0 ab
Kocide 3000 1.25 lb (1,3,5,7) Agrimycin 17W 0.5 lb (2,4,6,8)…….	161.3 bcd	43.2 a	53.2 ab	6.1 c
Cuprofix Ultra 40DF 3 lb (1,3,5,7) Agrimycin 17W 0.5 lb (2,4,6,8)…….	183.5 bc	45.6 a	33.5 bc	13.3 bc
Kocide 3000 1.25 lb (1,3,5,7) Tanos 50DF 8 oz (2,4,6,8)………....	162.1 bcd	78.6 a	64.1 a	16.9 bc
mean…………………………………	186.7	52.7	37.3	21.8
$LSD_{0.05}$[7]	68.2	NS	25.2	19.0

[1] Timings (1-8) correspond to the spray dates of 1=12 Jun, 2=19 Jun, 3=26 Jun, 4=2 Jul, 5=10 Jul, 6=17 Jul, 7=24 Jul, and 8=4 Aug
[2] Yield of marketable fruit with no bacterial spots.
[3] Yield of fruit with bacterial spot.
[4] Cultivar Camelot X3R.
[5] Cultivar Jupiter.
[6] Values in a column followed by the same letter are not statistically different.
[7] Least significant difference; NS = treatment effect not significant at P=0.05.

Evaluation of Fungicides for Control of Pumpkin Powdery Mildew

Perkins, 2009

John Damicone and Tyler Pierson, Entomology and Plant Pathology

Introduction and Objective: Powdery mildew, caused by the fungus *Sphaerotheca fuliginae*, is the most important foliar disease of pumpkin in Oklahoma. The disease is favored by moderate temperatures (<95F), cloudy conditions, and high humidity. Rainfall is not necessary for powdery mildew development. The disease can be controlled with spray programs that use the registered fungicides sulfur (e.g. Microthiol), Quintec, DMI fungicides (Nova, Procure), strobilurin fungicides (e.g. Flint), and chlorothalonil (e.g. Bravo). Resistance to DMI and strobilurin fungicides in the powdery mildew fungus can develop quickly. For example, control of powdery mildew with strobilurin fungicides on cucurbits has declined in recent years. Therefore, it is important to evaluate new fungicides for powdery mildew. Quintec and Folicur (a DMI) are new fungicides recently registered on cucurbits. The objective of this trial was to evaluate powdery mildew control with the experimental fungicides Quadris Top and A16001A in comparison to registered fungicides. Microthiol and Bravo were applied full-season while the other fungicides (Quintec, Flint, Nova, Procure, Folicur, Quadris Top, and A16001A) were alternated with Bravo.

Materials and Methods: The trial was located at the OSU Cimarron Valley Research Station in Perkins. The susceptible pumpkin cultivar ‘Small Sugar Pie’ was direct seed on 7 July. Granular fertilizer (46-0-0 N-P-K at 100 lb/A) was top dressed; and the herbicides Touchdown 3S at 3 pt/A, Sonalan 3E at 3 pt/A, and Permit 75WG at 0.75 oz/A were broadcast after planting on 8 July. The herbicide Clethodim 2E at 8 fl oz/A plus 1% crop oil concentrate was broadcast for additional weed control on 24 Aug. Squash bugs were controlled with Ambush 2E at 12.8 fl oz/A on 17 Aug, 4 Sep, and 18 Sep, and with Assana XL at 9.6 fl oz on 24 Aug. Treatments were arranged in a randomized complete block design with four replications. Plots were single, 25-ft-long rows spaced 15 ft apart with a 2-ft within row spacing between plants. Fungicides were broadcast through flat-fan nozzles (8002vk) spaced 18 inches apart using a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 25 gal/A at 40 psi. Fungicides were applied six times on 7-day intervals beginning on 17 Aug. Disease was assessed twice by visually estimating the percentage of leaves with powdery mildew (including defoliation) and defoliation alone in three areas of each plot on 15 Sep and 30 Sep. Yield was taken on 15 Oct.

Results: Weather conditions generally favored crop and disease development. Rainfall during the cropping period (15 Jul to 22 Oct) was 7.9 inches above normal (30-yr average) and average daily temperature was below normal each month. Powdery mildew appeared in late August and reached severe levels in untreated check plots during Sept. All fungicide programs reduced levels of powdery mildew compared to the untreated check (Table 1). Procure, Quintec, Nova, and A16001A generally provided the best disease control while the full-season Bravo and Microthiol treatments were least effective. All treatments had numerically higher yields than the untreated check, but yields were variable and differences were not statistically significant.

Conclusions: All of the fungicides applied in alternation with Bravo were generally better than either Bravo or Microthiol alone. Quintec continues to provide excellent powdery mildew control. Microthiol did not perform as well as in previous trials. Frequent rains may have reduced the effectiveness of this sulfur formulation. Folicur was less effective than the other DMI fungicides (Nova and Procure). The experimental fungicides Quadris Top and A16001A are fungicide mixtures that are effective on powdery mildew. Yield responses to fungicide programs for powdery mildew control have not been consistent.

Acknowledgements: The financial support of Syngenta Crop Protection and the assistance of Gerry Moore and Josh Massey at the Cimarron Valley Research Station in the maintenance of the field trial are greatly appreciated.

Table 1. Effects of fungicides on control of powdery mildew of pumpkin ('Small Sugar Pie'), Perkins - 2009.

Treatment and rate/A (timing)[1]	15 Sep leaves w/ mildew (%)[2]	30 Sep leaves w/ mildew (%)[2]	30 Sep defoliation (%)[3]	Yield (cwt/A)[3]
Procure 4SC 6 fl oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	5.2 f[4]	30.4 e	12.5 cde	202.2 a
Quintec 2.08F 6 fl oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	2.1 f	11.7 f	7.5 e	174.4 a
Flint 50WG 2.0 oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	20.4 bcd	65.9 c	20.4 de	183.3 a
Nova 40W 5 oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	17.9 cde	40.0 de	14.2 cde	193.8 a
Folicur 3.6F 6 fl oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	26.7 bc	68.3 c	24.2 bc	176.5 a
Quadris Top 2.7F 10 fl oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	13.5 def	47.5 d	19.2 cde	180.3 a
A16001A 2.8E 20 fl oz (1,3,5) Bravo 6F 2 pt (2,4,6)……………..	8.8 def	48.3 d	9.6 de	162.5 a
Microthiol 80DF 5 lb (1-6)……….	31.7 b	80.9 b	35.0 b	188.4 a
Bravo 6F 2 pt (1-6)……………….	45.8 a	77.5 bc	35.0 b	159.4 a
Check……………………………....	56.7 a	97.9 a	65.0 a	157.4 a
LSD (P=0.05)[5]	13.1	12.4	12.3	NS

[1] Numbers 1 to 6 corresponds to the spray dates of 1=17 Aug, 2=27 Aug, 3=4 Sep, 4=11 Sep, 5=18 Sep, and 6=25 Sep.
[2] Percentage of leaves with powdery mildew (includes defoliated leaves).
[3] Percentage of leaves defoliated from powdery mildew.
[4] Values in a column followed by the same letter are not statistically different according to Fishers Least Significant Difference Test.
[5] Least significant difference. NS= treatment effect not significant at P=0.05.

Control Pod Decay on Snap Bean Cultivars with Fungicides

Bixby – 2009

John Damicone and Tyler Pierson, OSU Entomology and Plant Pathology

Objective: Pod decay is a disease problem in the production of snap beans for processing in Oklahoma and surrounding states. Lower pods, particularly those in contact with the soil, develop a wet rot with profuse growth of white, fluffy mold (mycelium). The disease appears to increase within the canopy through direct contact of diseased pods with adjacent, healthy pods and leaves. Plants in areas with dense foliar growth appear to be most severely affected. Pod decay from *Pythium aphanidermatum* and *P. ultimum* which cause "cottony leak" on numerous vegetable crops, have been the primary causes of pod decay in previous field trials. The objective of this study was to screen various fungicide for pod decay control on snap bean cultivars with round and flat pods.

Materials and Methods: The trial was conducted at the Oklahoma Vegetable Research Station in Bixby, OK in a field of Wynona silty clay loam previously cropped to soybeans and where pod decay has been a previous problem. The field received 150 lb/A of 18-46-0 N-P-K granular fertilizer prior to planting on 22 April. Plots were top-dressed with additional granular fertilizer at 46-0-0 lb/A N-P-K as urea on 26 May. Weeds were controlled by a post-emergence application of Basagran (1 pt/A), Fusilade DX (12 fl oz/A), Reflex (0.75 pt/A), and NIS (0.5 pt/A) on 26 May. The experimental design was a split plot with four replications. The whole-plot treatment was fungicide while the sub-plot treatment was cultivar. Whole plots consisted of four 20-ft-long rows spaced 3 ft apart. Sub-plots consisted of two rows of either the cultivar Nelson (round pods) or Herrera (flat pods). The fungicides were applied three times on 7-day intervals beginning when pin-sized pods first appeared on 9 June. Fungicide sprays were directed through three flat-fan nozzles (8002vs) per row using a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 34 gal/A at 40 psi. Rainfall during the cropping period (22 Apr to 29 June) totaled 4.59 inches in May and 2.23 inches in June. The trial was sprinkler irrigated as necessary to promote crop development. In-field rating of pod decay incidence was not possible due to low disease pressure. Yield was taken on 29 June when pods were stripped from 1 m of row from each sub-plot and classified as either diseased or healthy. A 1-lb sample of pods from each sub-plot was enclosed in a plastic bag and incubated for 7 days at 72^{o}F to simulate bulk storage prior to processing when pod decay fungi increase to cause nested areas of moldy pods. The percentage of pods with moldy decay was determined and representative moldy pods were cultured on water agar to identify the pathogen.

Results: Rainfall and average daily temperature were near normal (30-year average) in May, but rainfall was 50% below normal and temperature was 4^{o}F above normal for June. There were 18 days above 90^{o}F and temperatures were in the upper 90's the week before harvest. The high temperatures were not favorable for disease development and pods were over mature at harvest. Levels of diseased pods were very low at harvest and did not differ among fungicide treatments (Table 1) or cultivars (Table 2). Most of the decayed pods at harvest had a dry, red-colored decay of pod tips typically caused by *Rhizoctonia solani*.

High levels of nesting (moldy pods) developed following incubation of pod samples in plastic bags at room temperature. The Quadris/Catamaran treatment was the only treatment that reduced levels of nesting compared to the untreated check (Table 1). Nesting levels did not differ among cultivars (Table 2). *Fusarium* spp. was the only pathogen isolated from nested pods.

Conclusions: Cottony leak caused by the watermolds *Pythium* and *Phytophthora* has been a primary cause of pod decay in snap beans. However, cottony leak was not present at harvest or in pod samples incubated in plastic bags to simulate post-harvest disease development.

Acknowledgements: Financial support from Allen Canning Co. and the IR-4 efficacy program, and assistance in the maintenance of the trial by the staff at the Oklahoma Vegetable Research Station is appreciated.

Table 1. Main effects of fungicide on control of pod decay of snap bean, Bixby - 2009.

Treatment and rate/A[1]	**Diseased pods (%)**[2]	**Yield (cwt/A)**	**Nested pods (%)**[3]
Kocide 3000 1.25 lb…………………………………	0.39 a[4]	73.2 a	60.2 abc
Ridomil Gold Copper 65W 2.5 lb…………………..	0.19 a	57.6 a	60.1 abc
Ranman 400F 2.75 fl oz + Silwet L77 2 fl oz…….	0.98 a	59.2 a	68.4 ab
Reason 4.17F 8.2 fl oz…………………………...	0.91 a	66.3 a	74.7 ab
Phostrol 4.08L 5 pt………………………………….	0.07 a	63.1 a	54.4 bcd
K-Phite 4.4L 3 qt ……………………………………	0.00 a	57.6 a	62.8 abc
Quadris 2.08F 10 fl oz + Catamaran 5.27F 4 pt…	0.07 a	65.5 a	36.7 d
Curzate 60DF 5 oz………………………………….	0.17 a	60.4 a	47.2 cd
Presidio 4F 4 fl oz…………………………………...	0.08 a	65.9 a	77.1 a
Revus 2.08F 8 fl oz…………………………………	1.10 a	60.8 a	58.3 abc
Check…………………………………………………	1.60 a	54.7 a	65.7 abc
LSD (P=0.05)[5]……………………….…….…………..	NS	NS	20.8

[1] Fungicides were applied 3 times on 7 day intervals beginning 9 June when pods were first observed.
[2] Percentage of harvested pods with decay on 29 June. Most diseased pods had a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*.
[3] Percentage of pods with moldy decay from a 1-lb sample incubated in a plastic bag at room temperature for 7 days. Isolations from decayed pods yielded mostly *Fusarium* spp.
[4] Values in a column followed by the same letter are not statistically different.
[5] Least significant difference; NS = treatment effect not significant at P=0.05.

Table 2. Main effects of snap bean cultivar on control of snap bean pod decay, Bixby - 2009.

Cultivar	**Diseased pods (%)**[1]	**Yield (cwt/A)**	**Nested pods (%)**[2]
Nelson……………………………………………..	0.31 a[3]	64.6 a	58.4 a
Herrera…………………………………………….	0.70 a	59.8 a	62.6 a
LSD (P=0.05)[4]	NS	NS	NS

[1] Percentage of harvested pods with decay on 29 June. Most diseased pods had a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*.
[2] Percentage of pods with moldy decay from a 1-lb sample incubated in a plastic bag at room temperature for 7 days. Isolations from decayed pods yielded mostly *Fusarium* spp.
[3] Values in a column followed by the same letter are not statistically different.
[4] Least significant difference; NS = treatment effect not significant at P=0.05.

Evaluation of Fungicides for Spinach White Rust

Stillwater, 2009
John Damicone and Tyler Pierson, Entomology and Plant Pathology

Introduction and Objective: White rust, caused by the fungus *Albugo occidentalis*, is the most important foliar disease of spinach in Oklahoma. Multiple fungicide applications are generally required to effectively manage white rust. The strobilurin (Group 11) fungicides azoxystrobin (Quadris), pyraclostrobin (Cabrio), and fenamidone (Reason) are highly effective against white rust. However, these group 11 (strobulurin) fungicides have been prone to resistance problems with several diseases of other crops. Therefore, resistance management guidelines have been developed and labelled which require the alternation of Quadris and Cabrio with fungicides that have a different mode of action. Unfortunately, there are few fungicides registered for use on spinach with non-group 11 modes of action. These include Presidio (fluopicolide), phosphorous acid (K-Phite) copper (Kocide), cyazofamid (Ranman), phosetyl Al (Aliette), and dimethomorph (BAS 651). The objective of this study was to evaluate fungicides and fungicide programs that use alternating modes of action for control of white rust.

Materials and Methods: The trial was conducted at the OSU Entomology and Plant Pathology Research Research Station Stillwater in a field of Norge loam with a history of white rust and previously fallow. Granular fertilizer (50-0-0 lb/A N-P-K) was incorporated into the soil prior to seeding on 5 March. The herbicide Dual Magnum II 7.6E at 0.67 pt/A was broadcast immediately after seeding. Plots were top-dressed with additional granular fertilizer (46-0-0 lb/A N-P-K) on 7 Apr. 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 blocks separated by a 5-ft-wide fallow buffer. Treatments were broadcast through flat-fan nozzles (8002vk) spaced 18 inches 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 were irrigated lightly (about 0.1 inches water) each day after planting until stand establishment on 22 March. Plots received 0.45 inches of sprinkler irrigation on 24 Apr. Rainfall (inches) during the cropping period (5 Mar to 12 May) totaled 3.63 in Mar, 5.07 in Apr, and 2.01 in May. Disease incidence (percentage of leaves with rust) and severity (percentage of leaf area with rust) were assessed on 12 May. Six, 1-ft row segments were harvested arbitrarily from the middle two rows of each plot. The harvested leaves were bulked, mixed, and disease severity was visually estimated on 30 blindly sampled leaves.

Results: Rainfall was 0.5 and 1.7 inches above normal (30-yr average) and in April and May. Average daily temperature was near normal for March and May. White rust appeared in late March when the spinach was small but did not increase to high levels in the untreated check until May. Disease levels in the untreated check were severe compared to previous trial at this site. All treatments reduced levels of white rust compared to the untreated check (Table1). Cabrio and Presidio provided the best disease control. BAS 651 and Quadris alone did not provide adequate disease control. The relatively poor disease control with Quadris alone resulted from an unexplainably high level of disease in one of the blocks.

Conclusions: Ranman, Presidio, and phosphonate fungicides (Aliette, K-Phite) appear to be effective non-group 11 fungicides, suitable for use in alternation with Quadris, Cabrio, and Reason in fungicide programs targeting white rust.

Acknowledgements: Funding from Allen Canning Co. and the IR-4 Efficacy Program, and the assistance of Rocky Walker and staff at the Entomology and Plant Pathology Farm, in the establishment and maintenance of the trial at Stillwater is acknowledged.

Table 1. Evaluation of fungicides for control of white rust on spinach ('Melody'), Stillwater - 2009.

Treatment and rate/A (Timing[1])	White Rust (%)	
	Leaves[2]	Leaf area[2]
Quadris 2.08F 12.3 fl oz (1-4)…………………………….	21.8 cd[4]	7.4 b
Cabrio 20WG 0.75 lb (1-4)…………………….…………	0.0 e	0.0 b
Ranman 3.3F 2.75 fl oz + Silwet-L77 2 fl oz (1-4)….….	10.0 de	0.6 b
Quadris 2.08F 12.3 fl oz (1,3) Aliette 80WG 3 lb (2,4)…	17.5 cde	1.3 b
Presidio 4F 4 fl oz (1-4)…………………………..………..	0.8 e	0.1 b
K-Phite 7L 4 pt (1-4)……….………………….……………..	31.8 cb	3.9 b
K-Phite 7L 2 pt + Quadris 2.08F 6 fl oz (1-4)…………..	12.5 de	0.7 b
BAS 651 00F 13.7 fl oz + Silwet-L77 2 fl. oz. (1-4)…....	43.3 b	6.0 b
Check……………………………………….…………………	80.8 a	30.7 a
LSD($P \leq 0.05$)[5]……………………………………………..	17.8	10.0

[1] The numbers (1-4) correspond to the spray dates of 1=16 April, 2=23 April, 3=30 April, 4=7 May.
[2] The percentage of leaves with white rust from 30 leaves on 12 May.
[3] The percentage of leaf area with white rust from 30 leaves on 12 May.
[4] Means in a column followed by the same letter are not statistically different according to Fisher's least significant difference test.
[5] Least significant difference.

Effect of Fungicide Application Timing On Control of Spinach White Rust

Stillwater, 2009

John Damicone and Tyler Pierson, Entomology and Plant Pathology

Introduction and Objective: White rust, caused by the fungus *Albugo occidentalis*, is the most important foliar disease of spinach in Oklahoma. Applications can be timed according to the calendar or the Spinach White Rust Advisor (http://agweather.mesonet.org/), a program that predicts white rust risk based on weather. Current recommendations are that fungicide programs begin when the first true leaves are fully expanded. However, it may be possible to delay the start of fungicide programs without sacrificing disease control. 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 disease control.

Materials and Methods: The trial was conducted at the Oklahoma State University Plant Pathology Research Farm in Stillwater in a field of Norge loam with a history of white rust and previously fallow. Granular fertilizer (50-0-0 lb/A N-P-K) was incorporated into the soil prior to seeding the susceptible cultivar 'Melody' on 5 March. The herbicide Dual Magnum II 7.6E at 0.67 pt/A was broadcast immediately after seeding. Plots were top-dressed with additional granular fertilizer (46-0-0 lb/A N-P-K) on 7 Apr. Plots consisted of 4-row beds, 20-ft long, with rows spaced 14 inches apart. The experimental design was a randomized complete block with four blocks separated by a 5-ft-wide fallow buffer. Treatments were broadcast through flat-fan nozzles (8002vk) spaced 18 inches apart with a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 25 gal/A at 40 psi. The first spray for the calendar (7-day) program, and monitoring of the advisory program 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 advisory program were made within 3 days of a spray recommendation. Following each advisory application, plots were considered protected for the next 7 days during which time the advisory program was not consulted. For each program and starting point, the fungicides Cabrio 20WG at 0.75 lb/A and Aliette 80WG at 3 lb/A were alternated with Cabrio applied first. Plots were irrigated lightly (about 0.1 inches water) each day after planting until stand establishment on 22 March. Plots received 0.45 inches of sprinkler irrigation on 24 Apr. Rainfall (inches) during the cropping period (5 Mar to 12 May) totaled 3.63 in Mar, 5.07 in Apr, and 2.01 in May. Disease incidence (percentage of leaves with rust) and severity (percentage of leaf area with rust) were assessed on 12 May. Six, 1-ft row segments were harvested arbitrarily from the middle two rows of each plot. The harvested leaves were bulked, mixed, and disease severity was visually estimated on 30 blindly sampled leaves.

Results: Rainfall was near normal (30-yr average) in April but 2 inches below normal in May. Average daily temperature was near normal for April but was below normal for May. White rust appeared in late March when the spinach was small but did not increase to high levels in the untreated check until May. Disease levels in the untreated control were severe compared to previous trial at this site. All treatments (programs and starting points) reduced levels of white rust compared to the untreated check (Table1). Usage of the advisory program resulted in 1-2 fewer sprays per season compared to respective calendar programs. Only two applications were made according to the advisory program at the late starting point. Levels of disease incidence (leaves with rust) were similar among all treatments except that the late calendar program was greater than the early calendar program. Levels of disease severity were similar among all treatments.

Conclusions: Starting points for both calendar and advisory spray programs could be delayed until 14-days after the first true leaf stage without sacrificing disease control. However, disease levels for the calendar program started late were the highest and approached being unacceptable. In previous trials, the late starting point sometimes resulted in higher levels of disease compared to the early date. Results of this and previous trials support the idea of delaying fungicide programs at least 7 days after the first true leaf stage.

Acknowledgements: Funding from Allen Canning Co. is gratefully appreciated. The assistance of Rocky Walker and staff at the OSU Plant Pathology Farm in the establishment and maintenance of the trial also is appreciated.

Table 1. Comparison of starting points for calendar and advisory fungicide programs to control white rust on spinach ('Melody'), Stillwater - 2009.

Program - Starting point (timing)[1]	**Number of sprays**	**Leaves w/rust (%)**[2]	**Leaf area w/rust (%)**[2]
Calendar - 1st true leaf (1-5)……………….….	5	12.5 c[3]	0.3 b
Calendar - 1st true leaf + 7 d (2-5)…………	4	14.2 bc	1.3 b
Calendar - 1st true leaf + 14 d (3-5)……….	3	32.5 b	4.1 b
Advisory - 1st true leaf (A1, A3, A4)……….	3	30.7 bc	1.7 b
Advisory - 1st true leaf + 7 d (A2, A3, A4)…	3	21.7 bc	1.1 b
Advisory - 1st true leaf + 14 d (A3, A4)……	2	16.0 bc	1.5 b
Untreated check……………………….……….	0	80.4 a	41.7 a
LSD($P \leq 0.05$)[4]……………………….……..		9.3	7.3

[1] The timings 1 to 5 correspond to the spray dates of 1=10 April, 2=16 April, 3=23 April, 4=30 Apr, and 5=7 May for the calendar program; and the timings A1 to A4 correspond to the spray dates of A1=14 Apr, A2=20 Apr, A3=30 Apr, and A4=8 May for the advisory program.

[2] From 30 leaves on 12 May.

[3] Values in a column followed by the same letter are not statistically different according to Fisher's least significant difference test.

[4] Least significant difference.

Evaluation of Fungicides for Control of Watermelon Anthracnose Diseases

Stillwater, 2009
John Damicone and Tyler Pierson, OSU Entomology and Plant Pathology

Introduction and Objective: Anthracnose, caused by the fungus *Colletotrichum obiculare*, is the most important foliar disease of watermelon. The disease attacks leaves, stems, and fruit and is favored by warm, rainy weather. Because varieties with effective resistance are not available, fungicide programs are needed to manage the disease. Fungicide programs using cholorthalonil (e.g. Bravo), mancozeb (e.g. Dithane), thiophanate-methyl (e.g. Topsin), and strobilurins (Quadris, Cabrio) are highly effective on foliage infections. Fruit infections, which are problematic in marketing, have proven more difficult to control in experimental plots that are artificially inoculated. New fungicides have recently been registered or are in development for use on cucurbits. However, little information is available on their activity against anthracnose. New fungicides (Folicur, A16001A, and Quadris Top) were evaluated in fungicide programs with Bravo in comparison to a full-season Bravo program.

Materials and Methods: The trial was located at the OSU Entomology/Plant Pathology Research Farm in Stillwater in a field of Norge loam previous cropped to mustard greens. The variety 'Sunsugur' was direct-seeded on 16 June. The herbicides Curbit 3E at 3.5 pt/A and Sandia 75DF at 0.75 oz/A were broadcast after planting to control weeds. Plots were top-dressed with granular fertilizer (46-0-0 lb/A N-P-K) on 13 July. Plots were single, 20-ft-long rows spaced 15 ft apart. Plots were thinned to a 2-ft within row spacing. Squash bugs were controlled Ambush 2E at 12.6 fl oz/A on 1 Sep and 18 Sep. Treatments were arranged in a randomized complete block design with four replications. Fungicides were broadcast through flat-fan nozzles (8002vk) spaced 18 inches apart using a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 24 gal/A at 40 psi. Fungicides were applied on 12 Aug, 24 Aug, and 31 Aug. Plots were inoculated by sprinkling oat kernels colonized by the anthracnose fungus over each plot after the first fungicide application on 12 Aug. Rainfall during the cropping period (15 June to 30 Sep) totaled 0.61 inches for June, 4.96 inches for July, 7.5 inches for Aug, and 3.07 inches for Sep. Plots received 17 applications of sprinkler irrigation that totaled 4.6 inches of water. Disease was assessed by visually estimating the percentage of leaves with symptoms and leaves defoliated in three areas of each plot. Yield of marketable melons weighing 12 or more lb was taken on 4 Sep.

Results: Rainfall was above normal and average daily temperature was below normal from July to Sept. Fungicide programs were initiated later in crop development than in previous trials. In addition, the trial received four inches of rainfall after inoculation in August and it was not possible to maintain a 7-day schedule because of the muddy conditions. Anthracnose became severe by harvest on 4 Sep. The full-season program with Bravo alone was the only treatment that reduced levels of foliar anthracnose and defoliation compared to the untreated check (Table 1). Other treatments were generally not effective. Yields were low and variable for plots within the same treatments, and levels of fruit infection were high.

Conclusions: Excessive rainfall in Aug resulted in heavy disease pressure. None of the new fungicides appeared to be effective against anthracnose. While the full-season program with Bravo alone was better than the other treatments, levels of disease fruit were high and none of the treatments provided adequate disease control. Preventive spray programs based on using broad-spectrum fungicides such as Bravo are recommended for foliar disease control in Oklahoma. However, fungicide programs may not be effective when rainfall is excessive and timely application schedules can't be kept.

Acknowledgements: Financial support from Syngenta Crop Protection and the assistance of Rocky Walker and staff at the Entomology/Plant Pathology Research Farm in the establishment and maintenance of the trial are greatly appreciated.

Table 1. Effects of fungicide programs on control of anthracnose of watermelon (‘Sunsugur’), Stillwater - 2009.

Treatment and rate/A (timing)[1]	Anthracnose (%)[2]	Defoliation (%)[3]	Yield (cwt/A)	
			Healthy[4]	Diseased[5]
Check……………………………	81.6 ab[6]	54.1 ab	0.0 a	8.7 a
A16001A 2.8E 20 fl oz (1,2) Bravo 6F 2 pt (3)………………..	79.1 ab	49.1 abc	10.1 a	10.7 a
Quadris Top 2.7F 10 fl oz (1,3) Bravo 6F 1.5 pt (2)……………..	65.8 b	32.5 cd	13.5 a	11.3 a
Actigard 50WG 0.25 oz + A16001A 20 fl oz (1,2) Bravo 6F 2 pt (3)……………….	75.0 ab	38.3 bc	31.2 a	10.4 a
Folicur 3.6F 8 fl oz (1,3) Bravo 6F 2 pt (2)……….……...	84.9 a	58.3 a	1.9 a	10.2 a
Bravo 6F 2 pt (1,2,3)…….……..	39.1 c	14.1 d	50.8 a	8.1 a
LSD (P=0.05)[7]…………………..	17.5	19.9	NS	NS

[1] Timing numbers 1 to 3 correspond to the spray dates of 1=12 Aug, 2=24 Aug, and 3=31 Aug.
[2] Plot foliage with anthracnose (including defoliation).
[3] Leaves defoliated from anthracnose.
[4] Marketable melons weighing 12 lb or more harvested on 4 Sep.
[5] Melons weighing 12 lb or more with anthracnose harvested on 4 Sep.
[6] Values in a column followed by the same letter are not statistically different.
[7] Least significant difference. NS=treatment effect not significant.

Evaluation of Fungicides for Control of Watermelon Foliar Diseases

Stillwater, 2009

John Damicone and Tyler Pierson, OSU Entomology and Plant Pathology

Introduction and Objective: Downy mildew is one of several foliar disease of watermelon that can lead to reduced yield and crop failure. In Oklahoma, downy mildew does not overwinter and is a sporadic problem that arises from airborne spores transported from distant diseased cucurbit fields that are rained out of the air into healthy fields where new disease epidemics can begin. The disease is sporadic apparently because of the complex interactions among weather conditions near the source fields and along the wind trajectories that carry the downy mildew spores long distances. Rapid defoliation occurs where the disease develops and fields are not protected with fungicide. Broad-spectrum protectant fungicides like chlorothalonil (e.g. Bravo) and mancozeb (e.g. Dithane) have generally been effective in fungicide trials in Oklahoma, but based on trial results from other states, may not provide adequate disease control under severe downy mildew pressure. Fungicides including Ranman, Presidio, Revus, and Tanos have been registered over the last five years that have specific activity on downy mildew. These have not been evaluated in Oklahoma under severe downy mildew pressure. Therefore the objective of this trial was to compare downy mildew-specific fungicides applied in alternation with Bravo to a full-season program with only Bravo.

Materials and Methods: The trial was located at the OSU Entomology/Plant Pathology Research Farm in Stillwater in a field of Norge loam previous cropped to mustard greens. The variety 'Sunsugur' was direct-seeded on 16 June. The herbicides Curbit 3E at 3.5 pt/A and Sandia 75DF at 0.75 oz/A were broadcast after planting to control weeds. Plots were top-dressed with granular fertilizer (46-0-0 lb/A N-P-K) on 13 July. Plots were single, 20-ft-long rows spaced 15 ft apart. Plots were then thinned to a 2-ft within row spacing. Squash bugs were controlled Ambush 2E at 12.6 fl oz/A on 1 Sep and on 18 Sep. Treatments were arranged in a randomized complete block design with four replications. Fungicides were broadcast through flat-fan nozzles (8002vk) spaced 18 inches apart using a CO_2-pressurized wheelbarrow sprayer. The sprayer was calibrated to deliver 24 gal/A at 40 psi. Fungicides were applied six times beginning on 12 Aug. Rainfall during the cropping period (15 June to 30 Sep) totaled 0.61 inches for June, 4.96 inches for July, 7.50 inches for Aug, and 3.07 inches for Sep. Plots received 17 applications of sprinkler irrigation that totaled 4.6 inches of water. Disease was assessed by visually estimating the percentage of leaves with symptoms and defoliation in three areas of each plot. Yield of marketable melons weighing 12 or more lb was taken on 4 Sep.

Results: Rainfall was above normal (30-yr average) and average daily temperature was below normal from July to Sept. Downy mildew did not develop in the trial. Powdery mildew appeared in August and anthracnose spread into the plots during September from an adjacent trial that was inoculated with the anthracnose fungus. Foliar disease became severe by 22 Sep when the untreated check plots were completely defoliated. All fungicide programs reduced disease incidence and defoliation compared to the untreated check on 22 Sep (Table 1). Treatments did not affect yield as most of the foliar disease developed after the melons were harvested on 4 Sep. Melons were not produced for a second harvest.

Conclusions: Downy mildew did not develop in this study, but other foliar disease developed. Preventive spray programs using broad-spectrum fungicides such as Bravo are recommended for foliar disease control in Oklahoma. In this trial, downy mildew fungicides were evaluated in tank-mixes and/or alternation with Bravo in spray programs and generally provided adequate control of anthracnose and powdery mildew.

Acknowledgements: Financial support from Syngenta Crop Protection and Valent Biosciences, and the assistance of Rocky Walker and staff at the Entomology/Plant Pathology Research Farm in the establishment and maintenance of the trial are greatly appreciated.

Table 1. Effects of fungicide programs on control of anthracnose and powdery mildew on watermelon ('Sunsugur'), Stillwater - 2009.

Treatment and rate/A (timing)[1]	Diseased leaves (%) [2]		Defol. (%)[3]	Yield (cwt/A)[4]
	31 Aug	22 Sep	22 Sep	
Check……………………………	11.6 a	100.0 a	100.0 a	182.9 a
Bravo 6F 2 pt (1-7)……………..	14.5 a	25.0 b	5.8 b	234.1 a
Presidio 4F 4 fl oz + Gavel 75DF 1.5 lb (1,3,5) Bravo 6F 1.5 pt + Tanos 50DF 8 oz (2,4,6)………	15.4 a	46.6 b	23.3 b	228.9 a
Bravo 6F 2 pt (1,3,5) Bravo 6F 1.5 pt + Ranman 3.3F 2.75 fl oz (2,4,6).	9.1 a	23.8 b	5.0 b	174.2 a
Bravo 6F 2 pt (1,3,5) Bravo 6F 1.5 pt + Presidio 4F 4 fl oz (2,4,6)……..	13.3 a	45.8 b	22.9 b	256.4 a
Bravo 6F 2 pt (1,3,5) Bravo 6F 1.5 pt + Revus 2.08F 8 fl oz (2,4,6)…….	8.3 a	33.7 b	10.0 b	182.3 a
LSD (P=0.05)[5]…………………..	NS	24.6	19.1	NS

[1] Timing numbers 1 to 6 correspond to the spray dates of 1=12 Aug, 2=24 Aug, 3=31 Aug, 4=8 Sep, 5=18 Sep, 6=25 Sep.
[2] Leaves with symptoms of anthracnose and powdery mildew (including defoliation).
[3] Leaves defoliated from anthracnose and powdery mildew.
[4] Marketable melons weighing 12 lb or more harvested on 4 Sep.
[5] Least significant difference. NS=treatment effect not significant.

Watermelon Foliar Fungicide Timing

2009 - Lane

Jim Shrefler, Tony Goodson, Benny Bruton and John Damicone

Foliar diseases represent a constant threat to watermelon production in Oklahoma. Any of several diseases including Anthracnose, Downy Mildew and Powdery Mildew can result in yield and fruit quality loss when foliage is damaged. Although fungicides are available for the control of these diseases growers are faced with the challenges of determining which fungicide products to use and when to apply fungicides to obtain maximum effectiveness. Several options available for determining fungicide application timing include using preset scheduled (for example, weekly), making applications based on general weather forecasts, or applying fungicides when disease symptoms appear. Each of these has benefits and downsides. The last, although most often used, is a particularly poor choice because fungicides are most effective when used as a preventive treatment rather than a "cure". An additional means of determining when to apply fungicides is an Anthracnose Forecaster that was developed for Oklahoma watermelon production. The forecaster is available on the Oklahoma Mesonet system at http://agweather.mesonet.org/models/watermelon/default.html and it is recommended that the forecaster be used on a trial basis until its dependability is be verified. One concern is that the forecaster is specific for anthracnose. Consequently, forecasts obtained with the forecaster do not consider watermelon infection by other diseases. This trial was conducted to compare the efficacy of two broad spectrum fungicide treatments for foliar disease control using application timings based on a preset schedule and the anthracnose forecaster.

Materials and Methods: The trial was conducted at Lane, Oklahoma at the Wes Watkins Agricultural Research and Extension Center on a sandy loam soil. Beds four feet wide were constructed on 24-foot centers. A single row of watermelon c.v. "Legacy" was seeded July 2, 2009 at the center of beds and thinned to 1 plant per 3 feet of row following emergence. Preemergence herbicides (Curbit @ 3 pts/acre and Sandea @ ½ ounce / acre) were applied after seeding. Drip irrigation was used once the crop was established.

Experimental treatments included an untreated check and fungicide treatments of 1. a tank mix of Dithane F-45 and Topsin 70WP and 2. Bravo Weatherstick. Each of these was scheduled to be applied using one of two decision-making options: 1. apply at first flowering and then every two weeks thereafter or 2. apply at first flowering and then based on recommendation by the Mesonet anthracnose forecaster. For all applications, treated acre rates were Dithane at 1.6 quart, Topsin at ½ lb. and Bravo Weatherstick at 1 quart. All applications were made using 21 gallons per acre of spray mixture. The sprayer consisted of a tractor mounted boom fitted with 8003 flat fan nozzles, spaced 20 inches on a straight boom, which were connected to a closed tank system that uses pressurized air to deliver the spray mixture. Spray mixtures were prepared in 3 to 5 gallon tanks and agitated immediately before spray application. Fungicide application was initiated at early flowering on August 14. Subsequent applications were made to the calendar treatments on 8-21 and 9-4 and to the forecaster treatments on 8-26, 9-9, and 9-18.

The experimental design was a randomized complete block with four replications. Individual plots consisted of a 40 foot long section of a single watermelon row. Treatment applications covered an expanse of 24 feet that was centered on the plot row. The tractor on which the spray boom was mounted traveled with wheels centered on the adjacent row and did not drive over the vines of plot rows. Visual evaluations of disease symptoms on watermelon foliage and defoliation were made beginning on September 17. Fruits were harvested and weighed on Sept. 28 and data for fruits 8 lbs and greater were used for analysis.

Results and Discussion: Field conditions were good during early crop establishment. However, there were two prolonged wet periods during the crop cycle, the first during late July - early August and the second in mid September. During each period saturated soil conditions were present for several days. Watermelon vines survived these conditions but vine growth never became extensive.

Visible symptoms of foliar disease became evident in mid September and foliage injury and/or disease symptoms were evaluated on Sept. 17, 18, and 24 (Table 1). On Sept. 17 anthracnose lesions were found to affect all treatments. Anthracnose severity was as great as about 20% but no treatment effects were detected. Overall injury to foliage was found in all treatments on Sept. 18 and was likely due to a combination of foliar disease (primarily anthracnose), wilting (likely due to waterlogged conditions) and other non-specific leaf damage. Soon after initial observation of disease symptoms defoliation was evident in all treatments.

Defoliation was most severe (60%) in the untreated check plots and the Bravo treatment that was based on the forecaster. There was significantly less defoliation in each of the Dithane + Topsin treatments (9-30 %) compared to the untreated plots. These symptoms were found to be primarily anthracnose. Anthracnose was again evaluated on 9-24 with no differences detected across treatments.

Watermelon yields were measured on Sept. 28 and yields data are presented in Table 2. Yields were low and no differences were detected across treatments. Low yields are due to the excessively wet field conditions and vine growth that was much less than normally expected for a watermelon crop.

Foliage loss in untreated plots of this trial was rapid with anthracnose being the major disease that was identified. Anthracnose was not uniform throughout the field which may have influenced the ability to detect treatment differences. It does appear that the Dithane and Topsin treatments were somewhat more effective than Bravo in protecting foliage. However, this did not impact yield.

Table 1. Evaluation of foliar diseases in watermelon at Lane in 2009.

		Visual Disease Evaluation[1]				
				Anthracnose[4]		
				Foliage		Fruit
Fungicide Treatment	**Application timing**	**Foliar Injury[2] 9-18**	**Defoliation[3] 9-24**	**9-17**	**9-24**	**9-24**
Untreated	-	17	61	19	42	50
Dithane + Topsin	Calendar	5	9	3	27	0
Dithane + Topsin	Forecaster	7	30	15	24	0
Bravo	Calendar	16	45	21	50	0
Bravo	Forecaster	16	61	14	39	30
lsd (alpha=0.05)		NS	28.4	NS	NS	NS

[1] Visual evaluations: 0 = no disease, injury or defoliation and 100 = all leaves or fruits affected.
[2] Percent injury refers to combined disease and discoloration of foliage.
[3] Percent defoliation refers to the portion of foliage lost from a complete canopy.
[4] Percent of foliage or fruits having anthracnose lesions.
[5] NS indicates no significant statistical difference.

Table 2. Fruit yield in the 2009 watermelon foliar fungicide timing trial at Lane.

Fungicide Treatment	**Application Timing**	**Yield (lbs. per acre)[1]**	**Individual fruit weight (lbs)**	**Number of fruit per plot**
Untreated	---	4943	9.4	5.2
Dithane + Topsin	Calendar	6003	10.9	5.5
Dithane + Topsin	Forecaster	5346	9.7	5.5
Bravo	Calendar	5885	10.0	6.2
Bravo	Forecaster	7350	10.6	6.7
		NS[2]	NS	NS

[1] Fruits harvested Sept. 28. Lowest fruit weight included is 8 lbs.
[2] NS indicates no statistical differences within a column.

Weed Management

Brassica Greens Herbicide Screening

Lynn Brandenberger, Lynda Carrier, Robert Havener, Robert Adams
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Leafy greens crops are grown by both processing and fresh market producers throughout the state of Oklahoma. Weed control in leafy greens is critical because of the need for weed-free product at harvest. Much of the greens crop in Oklahoma is machine harvested and product adulterated with weedy species can render a crop unmarketable. The objective of this study was to screen several herbicides for their potential for use in brassica greens production in Oklahoma.

Materials and Methods: Plots were arranged in a randomized block design with four replications, each plot consisted of 2 rows on 24 inch row centers 20 feet long. Seeding rate was approximately 272,000 seeds per acre of Savanna mustard. Plots were direct seeded on 5/19/09 using a research cone planter. Treatments included six different compounds (Treflan, Dacthal, Bolero, Nortron, Command 3ME, Barricade) alone and in combination for a total of six treatments and an untreated check (Table 1). Treflan was applied preplant incorporated Dacthal and all other compounds were applied preemergence following planting. The study received a total of 50 lbs N/acre (from 46-0-0 on 6/18/09). Treatment ratings were recorded for phytotoxicity and crop emergence on 6/02/09, phytotoxicity and efficacy on 6/17/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop damage, weed control or plant stand and 100 represents 100% of the crop or weed species being dead or non-existent or 100% of crop being emerged. Data recorded at harvest included overall plot yields.

Results and Discussion: No differences were observed for crop emergence on 6/02/09 with emergence ranging from 78 to 97% complete at that time (Table 1). Crop injury was highest on 6/02/09 and 6/17/09 for Command 3ME at 0.5 lbs ai/acre. Crop injury on 6/02/09 ranged from 0 for the untreated check to 60% injury for the Command 3ME treatment. On 6/17/09 crop injury ranged between 0 to 33%. Command 3ME and Nortron had crop injury ratings of 33 and 30%, respectively. Control of Palmer amaranth (Amaranthus palmeri S. Wats) on 6/17/09 ranged from 0 for the untreated check to 100% for Treflan + Dacthal at 6 lbs ai/acre. Other treatments ranged between 75 to 99% control. Treflan + Dacthal at 4 lbs ai/acre, Bolero, Nortron, Command 3ME, and Barricade had efficacy ratings of 99, 86, 75, 94, 99%, respectively, on 6/17/09. Yields on 7/02/09 did not vary significantly. Recorded yields were 8.8, 8.0. 7.7, 8.5, 6.3, 5.7, and 7.9 tons/acre, respectively, for the untreated check, Treflan + Dacthal at 4 lbs ai/acre, Treflan Dacthal at 6 lb ai/acre, Bolero, Nortron, Command 3ME, and Barricade. Although there were no differences observed for yield, there was a tendency for yields to reflect to some extent both the level of crop injury and weed control that each recorded. Of the treatments included in this study the authors would recommend more study be undertaken for the Treflan + Dacthal treatments and Bolero at different rates.

Acknowledgements: The authors wish to thank Allen Canning Company for their support of this study.

Table 1. 2009 Mustard greens herbicide trial, Bixby, OK.

Treatment/ acre	% Stand 6/2/09	% Injury 6/2/09	% Injury 6/17/09	Pigweed 6/17/09	Yield Tons /acre 7/2/09
Untreated-weeded check	97 a	0 c	0 b	0 b	8.8 a
Treflan PPI 20 oz. + Dacthal pre 4 lbs.	78 a	6 bc	20 ab	99 a	8.0 a
Treflan PPI 20 oz. + Dacthal pre 6 lbs.	93 a	6 bc	19 ab	100 a	7.7 a
Bolero pre 1 lb.	91 a	3 bc	13 ab	86 a	8.5 a
Nortron pre 1 lb.	88 a	9 b	31 a	75 a	6.3 a
Command 3 ME pre 0.5 lbs.	89 a	60 a	33 a	94 a	5.7 a
Barricade pre 0.66 lbs.	89 a	3 bc	18 ab	99 a	7.9 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.

Cilantro Preemergence and Postemergence Herbicide Trials

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Introduction: Cilantro has the potential to become a commercially produced vegetable crop within the state of Oklahoma. One challenge that potential producers face is adequate weed control for this cool season crop. Currently there are few herbicides labeled for use in cilantro production. Prefar (bensulide) is labeled for cilantro weed control as a preplant incorporated herbicide. Past experiences have shown that Prefar alone is not capable of providing the level of weed control that is needed for commercial cilantro production in Oklahoma. The objective of this study was to compare different preemergence and postemergence treatments to determine the level of crop safety and efficacy of several different pre and post herbicides.

Materials and Methods: The study included both pre and postemergence treatments and a weeded check. There were seven different compounds alone and in combination for a total of 19 treatments (Tables 1 and 2). All plots were arranged in a randomized block design with four replications. Plots included four rows of the Santo variety of cilantro planted on one foot row centers with a 20 foot plot length. Plant populations were approximately 0.5 million seeds/acre. Plots were planted on 3/25/09 with pre and preplant incorporated treatments being applied the same day with a CO_2 sprayer using a hand-boom with a six foot wide spray pattern. Postemergence treatments were applied with the same sprayer on 5/22/09. The overall spray rate was 25 gallons of spray material per acre for both pre and postemergence treatments. Plots received a total of 82 lbs of nitrogen per acre spread over two applications on 5/13/09 and 5/27/09. Emergence, crop injury and efficacy ratings were recorded on 5/22/09 for the preemergence treatments. Emergence ratings were also recorded for the postemergence treatments on 5/22/09 with crop injury and efficacy ratings recorded on 6/10/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop emergence, weed control or crop injury and 100 represents 100% emergence of the crop, control and or death of the weed species or the crop.

Results and Discussion: Emergence ranged from 15 to 78% for all treatments and the weeded check (Tables 1 and 2). All preemergence treatments had similar crop emergence ratings with Lorox (linuron) recording the highest emergence at 78%. A majority of postemergence treatments had significantly lower emergence ratings although no treatments had been applied at the time of rating. This was due to the post treatments being in a lower area of the field during an extremely wet spring season. Crop injury was observed as reduced crop growth (stunting). Low levels of crop injury were observed for both pre and postemergence treatments (no differences recorded) with Dual Magnum (S-metolachlor) at 0.975 lbs ai/acre pre recording the highest injury at 11%. Efficacy of different treatments varied significantly for both the preemergence and postemergence treatments. Prowl H_2O (Pendimethalin) at 0.75 lbs ai/acre provided the highest level of preemergence control for lambsquarter (*Chenopodium album* L.) on 5/22/09 (Table 1). Prefar PPI + Lorox post provided the highest level of Lambsquarter control for either pre and or postemergence treatments on 6/10/09 (Table 2) with 100% control of this weed species. Preemergence henbit (*Lamium amplexicaule* L.) control was highest on 5/22/09 for Prowl H_2O at 0.75 lbs ai/acre, Dual Magnum at 0.975 lbs ai/acre, Define DF, and Dual Magnum at 0.65 lbs ai/acre that recorded 89, 86, 79, and 78% control, respectively (Table 1). Postemergence henbit control was highest on 6/10/09 for Lorox post at 1.5 lbs ai/acre, Lorox post at 1.0 lbs ai/acre, and Prefar PPI + Lorox post that recorded 100, 94, and 90% control, respectively (Table 2).

Conclusions: First, there are several preemergence herbicides that warrant further investigation for use in commercial cilantro production. These materials include Prowl H_2O, Dual Magnum and Define because of their reasonable levels of crop safety and efficacy. Prefar which is labeled for use in cilantro proved to be safe for use in the crop, but control of henbit was less than needed. When combined with a postemergence application of Lorox, the combination provided good control of both lambsquarter and henbit. Second, Lorox at the rates used in the study was shown to be safe for use in cilantro and provided high levels of control of henbit as a postemergence treatment.

Acknowledgements: The authors would like to acknowledge the support and assistance of Rodney Farris, Robert Havener, and Robert Adams, who supervise the Oklahoma State University Vegetable Research Station at Bixby.

Table 1. Spring 2009 Cilantro weed control pre and pre + post emergence treatments crop safety and efficacy, Bixby, OK

Treatment lbs.ai/acre	Emergence 5/22/09	Stunting 5/22/09	Weed Control: Lambsquarter 5/22/09	Weed Control: Henbit 5/22/09
Weeded check	68 a[z]	0 a	0 d	0 e
Dual Magnum 0.65 pre	77 a	0 a	83 b-c	78 a
Dual Magnum 0.975 pre	58 a	11 a	93 a-c	86 a
Define DF 0.6 pre	49 a-b	8 a	90 a-c	79 a
Prowl H2O 0.5 pre	74 a	0 a	93 a-c	71 a-b
Prowl H2O 0.75 pre	60 a	9 a	97 a	89 a
Spartan 0.05 pre	74 a	3 a	93 a-c	33 c-d
Lorox 0.1 pre	68 a	0 a	81 c	16 d-e
Lorox 0.2 pre	78 a	0 a	89 a-c	26 c-e
Lorox 0.3 pre	78 a	0 a	91 a-c	48 b-c
Prefar 6.0 PPI	74 a	3 a	95 a-b	14 d-e
Prefar 12.0 PPI	48 a-c	5 a	93 a-c	34 c-d
Prefar 6.0 PPI + Lorox 0.3 post	61 a	4 a	91 a-c	4 e

[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. Spring 2009 Cilantro weed control post and pre + postemergence treatments crop safety and efficacy, Bixby, OK.

Treatment lbs.ai/acre	Emergence 5/22/09	Stunting 6/10/09	Weed Control: Lambsquarter 6/10/09	Weed Control: Henbit 6/10/09
Prefar 6.0 PPI + Lorox 0.3 post	61 a[z]	3 a	100 a	90 a-b
Poast 0.28	21 b-d	1 a	7 c	79 c
Lorox 0.1	18 d	1 a	8 c	85 b-c
Lorox 0.2	19 c-d	3 a	5 c	85 b-c
Lorox 0.3	19 c-d	1 a	. .[y]	86 b-c
Lorox 0.5	15 d	1 a	. .	84 b-c
Lorox 1.0	19 c-d	0 a	25 b	94 a-b
Lorox 1.5	15 d	0 a	. .	100 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.
[y] "." In a column indicates that a particular weed species was not present in the plots of a given treatment, therefore no data was recorded for that treatment.

Grape Herbicide Screening

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Grape production in the state of Oklahoma is a growing industry with production being utilized for wine, juice, and fresh table grapes. Weed control for a perennial crop such as grape is particularly important during the establishment period when newly planted vines are small and competing with weedy species for light, water and nutrients. Currently there are several preemergence herbicides that have shown potential for season long control for several weed species. The objective of this study was to screen three preemergence herbicides for their potential for weed control in Oklahoma grapes.

Methods and Materials: Plots were arranged in a randomized block design with five replications, each plot consisted of 5 vines on 12 foot row centers with 6 feet between vines in the row. Plant population was approximately 605 plants per acre of 'Chambourcin' grape on 101-14 Mgt. rootstock. Plots were transplanted on 4/16/09 by hand. Treatments included three different compounds (Callisto mesotrione-pre, Sandea halosulfuron-pre, Spartan sulfentrazone-pre) at two rates for a total of six pre treatments and a glyphosate-post check (Table 1). Pre treatments were applied on 5/18/09 and all plots including the glyphosate check were sprayed with glyphosate (2% solution) on 5/19/09. Treatment ratings were recorded for phytotoxicity on 6/02/09 and phytotoxicity and efficacy on 8/04/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop damage or weed control and 100 represents 100% of the crop or weed species being dead or non-existent.

Results and Discussion: There were no differences in crop injury observed on either day that ratings were recorded (Table 1). All ratings on 6/02/09 were less than 10% injury with the highest rating being 7%. Weed control varied for each of the four weed species that were observed in the study (Table 1). Control of Palmer amaranth (*Amaranthus palmeri* S. Wats.) ranged from 0 for the glyphosate check to 100% for the highest rate of Spartan. The three treatments with the highest level of control were Spartan at 0.375, 0.1875, and Callisto at 0.24 lbs ai/acre these had recorded ratings of 100, 99, and 77% control respectively. Carpetweed (*Mollugo verticillata* L.) control was highest for Callisto at 0.24 lb ai/acre and Spartan at 0.1875 and 0.375 lbs ai/acre. Carpetweed control for these treatments was 93, 87, and 99% control, respectively. Control of goosegrass (*Eleusine indica* L.) ranged from 0 to 75% control, with Spartan 0.1875 and Callisto 0.24 lbs ai/acre having recorded ratings of 75 and 69% control respectively. There were no differences observed in the study for control of crabgrass (*Digitaria* sp.) which ranged from 0 to 51%.

In conclusion, very low levels of crop damage to grape were observed for any of the treatments included in the study, but there were significant differences between treatments for weed control. Both Spartan and Callisto provided significantly higher levels of weed control for Palmer amaranth, carpetweed, and goosegrass compared to the glyphosate check and Sandea. Although levels of crabgrass control ranged widely between treatments there no differences observed, this was likely due to variability in this weed species naturally occurring population within the test area.

Acknowledgements: The authors wish to thank the USDA IR-4 project for their support of this study.

Table 1. 2009 Grapes Herbicide trial, Bixby, OK.

	% Injury		% Control on 8/4/09			
Treatment/ acre	**6/2/09**	**8/4/09**	**Palmer amaranth**	**Carpet weed**	**Goose grass**	**Crab grass**
glyphosate check	1 a[z]	0 a	0 d	0 d	0 c	0 a
Callisto 0.12 pre	1 a	0 a	46 c	47 b	25 bc	32 a
Callisto 0.24 pre	6 a	0 a	77 ab	93 a	69 a	48 a
Sandea 0.024 pre	2 a	4 a	54 bc	20 c	43 ab	34 a
Sandea 0.048 pre	6 a	0 a	65 bc	37 bc	58 ab	38 a
Spartan 0.1875 pre	6 a	0 a	99 a	87 a	75 a	51 a
Spartan 0.375 pre	7 a	0 a	100 a	99 a	58 ab	46 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.

Impact of Over-the-Top Broadcast Applications of Racer® on Onion Weed Control

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[b]Oklahoma State University, Lane, Oklahoma
[c]Oklahoma State University, Stillwater, Oklahoma

Introduction: The weed control challenges for onion production are formidable; however, these challenges are even greater for those considering organic crop production. Organic weed control methods include crop rotations, cover crops, planting systems, mechanical methods, and organic herbicides. Although mechanical weed control through cultivation is useful for controlling weeds between rows, it is ineffective for controlling weeds between plants within rows. Corn gluten meal is a potential alternative to hoeing or hand removal of weeds from rows in organic crops. Although corn gluten meal has shown promise as an early-season pre-emergent organic herbicide in sweet onion production (Webber et al., 2006), uncontrolled weeds can inflict serious yield reductions by the end of the growing season. Organic onion producers need organic herbicides that can effectively provide post-emergent weed control.

Racer®[6,7] has been labeled as a herbicide for food use and cleared as an organic herbicide for organically grown food crops. The main component (40%) of Racer® is ammonium nonanoate (ammonium pelargonate), which occurs in nature and is primarily formed from biodegradation of higher fatty acids. Although previous studies provided important information concerning use of Racer® as an organic herbicide, further research is indicated in order to increase the understanding of the relationship among application rates, weed species, and weed maturity on herbicidal efficacy and crop injury. In order to address these issues, field research was conducted in southeast Oklahoma (Atoka County, Lane, OK) to determine the effect of application rates and broadcast application of Racer® on weed control efficacy, crop injury, and yields.

Materials and Methods: The experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) soil at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2009 into 2 rows per 6 ft-wide raised beds. Each plot consisted of two onion rows per 10 ft length of bed. The experiment included 8 weed control treatments (3 application rates at 2 hand-weeding levels, plus an untreated weedy-check and an untreated weed-free) with 4 replications. Nutsedge (*Cyperus esculentus* L.) and grass weeds were removed from all plots, including the weedy-check, to investigate the impact of ammonium nonanoate on the broadleaf weeds. Racer® (40% ammonium nonanoate) at three rates, 7.5, 10, and 15% v/v, over-the-top broadcast was applied on May 22, 2009, 63 days after transplanting (DATr) using a tractor mounted CO_2 sprayer equipped with four extended range, stainless steel, 0.30 gallons/min nozzles[8] on 20-inch spacings at a spraying height of 19 inches at 35 gpa. The two weed control treatments within each application rate (7.5, 10% and 15% v/v) involved no hand-weeding, where the uncontrolled weeds were allowed to grow, or a season-long hand-weeding, where all weeds were removed.

Data Collection
Weed control and injury (phytotoxicity) ratings were collected at 3, 10, 18, and 33 days after treatment (DAT). Weed control ratings represent the percent broadleaf weed control for a treatment compared to the weedy-check. A 0 to 100% visual rating system was used in which 0% represented no weed control, while 100% represented complete weed control. The data were converted using an arcsine transformation to facilitate statistical analysis and mean separation. A 0 to 100% visual rating system was used in which 0% represented no crop injury, while 100% represented crop death. Weed control and crop injury data were converted using an arcsine transformation to facilitate statistical analysis and mean separation

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[6] Racer®, 40% Ammonium Nonanoate, Falcon Lab LLC, Wilmington, Delaware

[7] The mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

[8] XR TeeJet, XR8003VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

Onions were harvested on June 25, 2009, 97 days after transplanting, sorted by size, counted, and weighed. The sorted onion grades included “small” (< 2.0 in.), “medium” (>2.0 to 3.0 in.), “large” (>3.0 to 3.75 in), and “colossal” (> 3.75 in.) for marketable size. Split and decomposed onions were placed in the unmarketable group. All data were subjected to ANOVA[9] and mean separation using LSD with P=0.05.

Results and Discussions

Rainfall

Rainfall during the 2009 growing season, from transplanting to harvest (97 days), was 18.40 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 25) is 16.01 inches.

Weed Control

The experiment had very high weed densities with multiple broadleaf species. Weeds present at spraying included spiny amaranth (*Amaranthus spinosus* L.), cutleaf ground-cherry (*Physalis angulata* L.), cutleaf evening primrose (*Oenothera laciniata* Hill), and carpetweed (*ollugo verticillata* L.). At the time of spraying, spiny amaranth, cutleaf ground-cherry, and cutleaf evening primrose averaged 2-5 leaves and were less that 1 inch tall. Carpetweed seedlings were no more than 1 inch wide with 3 or 5 leaves. No other weed species contributed more than 5% to the weed cover. Grass weed species and nutsedge (*Cyperus esculentus* L.) were removed after spraying Racer® and were kept hand-weeded throughout the remainder of the growing season. Only data for the combined ratings for total broadleaf weed control are reported.

Total broadleaf weed control for Racer® increased as the percentage of Racer® increased (Table 1). Within application rates, Racer maintained consistent weed control through 10 DAT. Racer® at 10 and 15% provided excellent (≥90%) weed control. while Racer® at 7.5% peaked at 10 DAT with only 69% total broadleaf weed control.

Table 1. Total broadleaf weed control percentage at 2, 10, 18, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer® 7.5%*	No	69 c**	69 c**	40 d**	6 d**
Racer® 7.5%	Yes	100 a	100 a	100 a	100 a
Racer® 10%	No	91 b	91 b	61 c	14 c
Racer® 10%	Yes	100 a	100 a	100 a	100 a
Racer® 15%	No	97 a	97 a	73 b	21 b
Racer® 15%	Yes	100 a	100 a	100 a	100 a
Weedy-Check	No	0 d	0 d	0 e	0 e
Weed-Free	Yes	100 a	100 a	100 a	100 a

*Racer applied using a broadcast over-the-top application.

**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Crop Injury

No significant differences were observed between onion cultivars for crop injury; crop injury is presented averaged across cultivars. Onion injury increased as Racer® application rates, peaking at 3 DAT and decreasing to 33 DAT where there was not a significantly difference among the treated and untreated controls (Table 2).

[9] SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513.

Table 2. Crop injury averaged across onion varieties at 3, 10, 18, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer® 7.5%*	No	10 c**	6 c**	4 c**	2 a**
Racer® 7.5%	Yes	10 c	6 c	4 c	2 a
Racer® 10%	No	25 b	20 b	11 b	2 a
Racer® 10%	Yes	25 b	20 b	11 b	2 a
Racer® 15%	No	50 a	44 a	23 a	2 a
Racer® 15%	Yes	50 a	44 a	23 a	2 a
Weedy-Check	No	2 d	2 d	2 d	2 a
Weed-Free	Yes	2 d	2 d	2 d	2 a

*Racer applied using a broadcast over-the-top application.
**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Onion Yields
Data are for the total marketable yield combined across the 4 onion grades. There were significant yield differences between cultivars and among weed control treatments (Table 3). Onion yields decreased as Racer rates increased, with the greatest yields at the 7.5% rate. Yield differences between the non hand-weeded and hand-weeded treatments within Racer application rates indicate that the lack of weed control reduced crop yields. Cimarron yields were greater than Candy yields when comparing application rates and control treatments (weedy-check and weed-free).

Table 3. Total onion yields for Cimarron and Candy for Lane, OK as a result of weed control treatments.

Weed Control Treatment	Hand-Weeded	Cimarron	Candy
		lb/a	lb/a
Racer® 7.5%*	No	419 e**	82 e**
Racer® 7.5%	Yes	1209 b	825 a
Racer® 10%	No	320 f	24 f
Racer® 10%	Yes	945 d	750 b
Racer® 15%	No	307 f	42 ef
Racer® 15%	Yes	1017 c	683 c
Weedy-Check	No	261 g	44 ef
Weed-Free	Yes	1524 a	628 d

*Racer applied using a broadcast over-the-top application.
**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Conclusions: Broadcast applications of Racer® at 7.5 produced poor (70% or less) broadleaf weed control, while Racer® at 10 and 15% provided excellent (≥90%) total broadleaf weed control. Onion injury increased as Racer® application rate increased with no significant difference among treatments at 18 DAT. Crop injury and lack of weed control from Racer® did reduced crop yields compared to the untreated weedy-check. If the Racer's® application method can be modified to reduce crop injury, the higher application rate has potential to make significant impact on broadleaf weed control in spring-transplanted onions.

Acknowledgements: The authors would like to thank Sam McClure, Spring Creek Ranch, Calvin, OK for supplying the onion transplants and Falcon Lab LLC, Wilmington, Delaware for providing the Racer®. We appreciate Buddy Faulkenberry, USDA, ARS, Research Technician, for his field work, data processing, and leadership of the field crews. We would also like to thank Tony Goodson, Ron Marble, Tim Abney and John Johnson for helping to transplant the onions and Buddy Faulkenberry and Will Baze for plot maintenance and harvesting.

References: Webber, C.L. III and J.W. Shrefler. 2006. Corn gluten meal and spring-transplanted onions (*Allium cepa* L.): Crop safety, weed control, and yields. 2006 National Allium Research Conference. Dec. 6-9, 2006. College Station, TX. p. 87-97.

Efficacy and Crop Safety of Spartan Charge on Cowpea

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New formulations of existing herbicides need to be examined to determine if the new material will provide similar effects for weed control and crop safety. In 2009 a new formulation of Spartan (sulfentrazone), "Spartan Charge" (sulfentrazone + carfentrazone) was released by its parent company for use in leguminous crops. The objective of this study was to provide a field trial for Spartan Charge to determine both crop safety and efficacy for use in cowpea production alone and in combination with glyphosate.

Materials and Methods: The study included both preplant and preemergence treatments and a weeded check. Herbicides included in the study were Spartan, Spartan Charge, Dual Magnum (S-metolachlor), and glyphosate alone and in combination for a total of 11 treatments plus a weeded check (Table 1). All plots were arranged in a randomized block design with four replications. Plots included two rows of the Early Scarlet variety of cowpea planted on three foot row centers with a 20 foot plot length. Plots were planted on 6/24/09 at a seeding rate of approximately 87,000 seeds per acre. Preplant treatments were applied on 6/18/09 with preemergence treatments being applied on 6/24/09 following planting. All treatments were applied with a CO_2 sprayer using a hand-boom with a six foot wide spray pattern. The overall spray rate was 25 gallons of spray material per acre for both preplant and preemergence treatments. Plots received a total of 25 lbs of nitrogen per acre on 7/09/09. Weeded check plots were hand hoed on 7/24/09. Crop injury and efficacy ratings were recorded on 7/24/09 and 8/04/09 for all treatments. The rating scale that was used was a 0 to 100 scale where 0 represents no visible weed control or crop injury and 100 represents 100% control of the weed species or death of the crop. Yields were recorded on 10/07/09 when the plots were machine harvested.

Results and Discussion: Crop injury ranged from 0-8% for both dates that data was recorded (Table 1). No differences between the weeded check and any of the herbicide treatments were observed. Both Palmer amaranth and goosegrass control was excellent in the study for all of the herbicide treatments, but there was a difference between the weeded check and the herbicide treatments on 7/24/09 because the weeded check plots had not been hand weeded prior to ratings being recorded. Yields did not vary between treatments or the weeded check at harvest.

Conclusions: Based on the results of this study, the authors conclude that Spartan Charge is a viable replacement for the previous formulation of Spartan in cowpea production. Furthermore, when Spartan Charge is tank-mixed with glyphosate it appears that there is no change in effective weed control or crop safety for Spartan Charge.

Acknowledgements: The authors wish to acknowledge the partial financial support of the study by FMC and want to thank Chad Godsey, Jeff Edwards, and Bob Heister for assistance in machine harvesting the study.

Table 1. 2009 Spartan Charge herbicide study, Bixby, OK.

Treatment lbs ai/acre	% Injury		% Palmer amaranth control		% Goosegrass control		Yield (lbs./ac)
	7/24/09	8/4/09	7/24/09	8/4/09	7/24/09	8/4/09	10/7/09
Weeded check	0 b	0 a	20 b	94 a	20 b	85 a	2572 a
Dual Magnum 0.75 pre	0 b	0 a	100 a	100 a	100 a	96 a	2155 a
Spartan Charge 0.14 + Glyphos 0.7 pre-plant	0 b	0 a	100 a	100 a	93 a	86 a	2369 a
Spartan Charge 0.21 + Glyphos 0.7 pre-plant	3 b	5 a	96 a	98 a	94 a	88 a	2596 a
Spartan Charge 0.14 + Glyphos 0.7 pre	0 b	0 a	100 a	100 a	98 a	96 a	2452 a
Spartan Charge 0.21 + Glyphos 0.7 pre	0 b	5 a	100 a	100 a	99 a	97 a	2608 a
Spartan Charge 0.14 pre-plant	0 b	0 a	99 a	99 a	94 a	90 a	2214 a
Spartan Charge 0.21 pre-plant	4 b	5 a	99 a	99 a	95 a	89 a	1844 a
Spartan Charge 0.14 pre	0 b	0 a	100 a	98 a	98 a	89 a	2659 a
Spartan Charge 0.21 pre	3 b	6 a	100 a	100 a	98 a	95 a	1914 a
Spartan 4 F 0.125 pre	0 b	3 a	99 a	98 a	76 a	60 b	2279 a
Spartan 4 F 0.19 pre	8 a	3 a	100 a	100 a	98 a	96 a	2212 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.

Spartan Charge Efficacy Trial

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When new formulations of herbicides are released by the manufacturer it is important that field trials be completed to determine if the new material will provide similar effects for weed control and crop safety. In 2008 a tank combination of Spartan and glyphosate was applied to a no-till crop and it appeared that Spartan reduced the effectiveness of glyphosate for the control of existing Palmer amaranth. The objective of this study was to provide a field trial for Spartan Charge (sulfentrazone + carfentrazone) a reformulation of Spartan to determine its effectiveness for control of weed species in combination with glyphosate compared to glyphosate alone.

Materials and Methods: Plots were arranged in a randomized block design with three replications, each plot consisted of a weedy crop free area 6'x20' in size. Treatments included two herbicides Spartan Charge and glyphosate (Table 1). Glyphosate was applied alone (glyphosate + surfactant at 0.25%) and in combination with Spartan Charge for a total of 2 treatments (Table 1). Treatments were applied to each 6'x20' plot area with a hand-boom CO_2 research sprayer at an overall application rate of 25 gallons per acre. Plots were rated for % control of six different weed species: Palmer amaranth (*Amaranthus palmeri*), johnsongrass (*Sorghum halepense*), bermudagrass (*Cynodon dactylon*), dock (*Rumex crispus*), cocklebur (*Xanthium strumarium*), and eclipta (*Eclipta* sp.) on 7/22/09 and 8/12/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible weed control and 100 represents 100% of the weed species being dead or non-existent.

Results and Discussion: On 7/22/09 there was a significant reduction in Palmer amaranth control for Spartan Charge + glyphosate compared to glyphosate alone (Table 1). Spartan Charge + glyphosate had 47% control compared to glyphosate alone at 78%. Other weed species in the study responded differently to the treatments, both Johnsongrass and Bermudagrass control appeared unaffected by treatments, dock and eclipta control appeared to be improved by Spartan charge + to glyphosate. Dock control was 52 and 13% and eclipta control was 85 and 10%, respectively, for Spartan Charge + glyphosate and glyphosate alone on 7/22/09. On 8/12/09 no differences were observed between treatments regarding control of weed species.

In conclusion, it does appear that tank mixing Spartan Charge with glyphosate decreases the effectiveness of glyphosate for the postemergence control of Palmer amaranth. The authors are not certain, but there are reports of this herbicide combination having reduced effectiveness particularly when the pH of the water used in the spray is alkaline. Further testing of the spray water source should help answer this question. No detrimental effects were observed for control of other weed species.

Acknowledgements: The authors wish to thank Merlin and Lillian Schantz for their support and cooperation in this field demonstration.

Table 1. Efficacy of Spartan Charge and glyphosate alone and in combination, Hydro, OK.

Treatment lbs ai/acre	Palmer amaranth	Johnson grass	Bermuda grass	Dock	Cocklebur	Eclipta
Percent control on 7/22/09						
Untreated check	0 c[z]	0 b	0 b	0 b	0 b	0 c
Spartan Charge 0.21 + Glyphos 0.7	47 b	48 a	42 a	52 a	58 ab	85 a
Glyphos 0.7	78 a	60 a	43 a	13 b	95 a	10 b
Percent control on 8/12/09						
Untreated check	0 b	0 b	0 b	0 a	0 b	n/a
Spartan Charge 0.21 + Glyphos 0.7	77 a	78 a	25 a	48 a	100 a	50 a
Glyphos 0.7	92 a	67 a	37 a	50 a	100 a	45 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.

Spinach Herbicide Study

Bixby, Oklahoma
Lynn Brandenberger and Lynda Carrier
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Introduction: Screening new compounds for weed control is important for all crops, but with spinach it is particularly urgent because of the limited number of herbicides that are available for the crop and the sensitivity of spinach to many compounds. The objectives of this study were to compare Laudis (tembotrione) to both pre and post herbicides that are labeled for use in spinach in replicated trials to determine if it has potential for weed control in commercial spinach production.

Methods and Materials: Plots were arranged in a randomized block design with four replications. Treatments included three herbicides Dual Magnum (S-metolachlor), Laudis, and Spin-Aid (phenmedipham) alone and in combination, some pre and some post for a total of seven treatments (Table 1). Treatments were applied with a hand-boom CO_2 research sprayer at an overall application rate of 25 gallons per acre. Preemergence treatments were applied immediately after direct seeding of spinach (Padre cultivar) on 9/28/09 and postemergence treatments were applied on 11/10/09. Each plot consisted of four rows of spinach with rows 12 inches apart and approximately 10 seeds per row foot. All plots received a total of 100 lbs of nitrogen per acre applied as a split application of 50 lbs per acre on two different dates (11/04/09 and 11/17/09). Plots were rated for emergence on 10/19/09, crop injury on 10/19/09, 11/17/09, and 12/01/09, control of henbit (*Lamium amplexicaule* L.) on 12/01/09 and yields were recorded on 12/01/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop emergence, weed control or crop injury and 100 represents 100% emergence of the crop, control and or death of the weed species or the crop.

Results: In general emergence was poor due to high levels of rainfall that fell after the study was planted. There were no differences observed between treatments for emergence ratings, although ratings ranged from 13 and 15% for the two Laudis pre treatments up to 46% for Dual Magnum alone that was used as an industry standard (Table 1). Crop injury was observed as crop desiccation and death of the crop. Crop injury ratings were highest for Laudis for any days following application of the herbicide. Applications of Laudis pre in combination with Dual Magnum resulted in significantly higher crop injury for each of the three dates shown. In addition, all treatments that included post applications of Laudis had significantly higher levels of injury than other treatments on dates following their application. Injury ratings on 12/01/09 were 100,100, 89, and 90%, respectively, for Laudis pre, Dual Magnum + Laudis pre, Dual Magnum pre + Laudis post at 0.08 lbs ai/acre, and Dual Magnum pre + Laudis post at 0.16 lbs ai/acre. Control of henbit was at a high level for all treatments and ranged from 91 to 100%. In general yields were low due to high rainfall during the period of time that the study was completed. Yields varied significantly ranging from 0 for all Laudis treatments to 4,108 lbs per acre for Dual Magnum pre.

Conclusions: Based on the results, the authors would conclude that Laudis does not have any potential for weed control in spinach. Treatments that received Laudis experienced high levels of crop injury and death which resulted in no marketable yields for any treatments utilizing this herbicide.

Acknowledgements: The authors would like to thank Bayer Crop Science and Syngenta Crop Protection Inc. for supplying herbicides for this study.

Table 1. 2009 Spinach Pre and Post herbicide study, Bixby, OK[z].

	% Emergence	% Injury			% control Henbit	Yield (lbs./ac)
Treatment lbs ai/acre	**10/19/09**	**10/19/09**	**11/17/09**	**12/01/09**	**12/1/09**	**12/1/09**
Dual Magnum 0.65 pre	46 a[y]	3 b	0 d	0 c	91 a	4108 a
Laudis 0.08 pre	13 a	79 a	100 a	100 a	95 a	0 c
Dual Magnum 0.65 pre + Laudis 0.08 pre	15 a	68 a	100 a	100 a	100 a	0 c
Dual Magnum 0.65 pre + Laudis 0.08 post	38 a	10 b	11 b-d	89 a	100 a	0 c
Dual Magnum 0.65 pre + Laudis 0.16 post	38 a	9 b	5 c-d	90 a	100 a	0 c
Dual Magnum 0.65 pre + Spin-Aid 0.4875 post	40 a	8 b	16 b-c	41 b	100 a	913 b-c
Dual Magnum 0.65 pre + Spin-Aid 0.975 post	43 a	13 b	23 b	50 b	100 a	3065 a-b

[z] Preemergence herbicides applied 8/28/09, Postemergence treatments applied 11/10/09.
[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.

Valor Efficacy Observational Trial on Pepper

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In Cooperation with Schantz Farms

Introduction: Commercial peppers have few herbicides available for either pre or postemergence weed control. Postemergence broadleaf weed control is normally handled by hand hoeing. Hoeing is an expensive method to use, often costing several hundred dollars per acre if the producer is able to find labor to do it. Therefore there is a real need to identify potential postemergence herbicides that can be utilized for controlling broadleaf weeds in pepper fields. The objective of this trial was to determine if Valor (flumioxazine) has potential as a postemergence herbicide for use in commercial pepper production when applied postemergence with a hooded sprayer.

Methods and Materials: A large field plot consisting of eight rows 200 feet long was sprayed for each treatment in the trial. Treatments included two herbicides Valor and glyphosate (Table 1). Valor was applied alone at two rates i.e. one and two ounces/acre (0.025 and 0.050 lbs ai/acre) and in combination with glyphosate at 0.050 lbs ai/acre of Valor plus 1.0 lbs ai/acre of glyphosate for a total of three treatments. All treatments also included 'Softcede' water conditioner and 'Spredde' surfactant, both at a rate of 0.25% v/v of water. Treatments were applied to each plot area with a tractor drawn hooded sprayer at an overall application rate of 10 gallons per acre. Treatments were rated for % control of two different weed species: Palmer amaranth (*Amaranthus palmeri*) and puncturevine (*Tribulus terrestris* L.) and for crop injury on 7/22/09 and 8/12/09. The rating scale that was used was a 0 to 100 scale where 0 represents no visible weed control or crop injury and 100 represents 100% of the weed species or crop being dead or non-existent.

Results and Discussion: No crop injury was observed on either of the two dates that plot ratings were recorded (Table 1). Palmer amaranth control ranged from 0% for the one ounce rate of valor to 85% control for the Valor + glyphosate treatment on 7/22/09 and was 15, 75, and 80%, respectively, for Valor at the one and two ounce rates alone and for the Valor + glyphosate combination on 8/12/09. Puncturevine control observed was considerably less than for Palmer amaranth. Puncturevine control on 7/22/09 ranged from 0% for the one ounce rate of Valor to 30% for the two ounce rate of Valor alone and the combination of Valor + glyphosate. Control of this weed species decreased to 15% on 8/12/09 for Valor alone and the combination of Valor + glyphosate.

Conclusions: In conclusion, it does appear that tank mixing Valor with glyphosate increases the effectiveness of Valor for the postemergence control of Palmer amaranth. Furthermore, Valor alone and Valor + glyphosate appear to have no detrimental effects on pepper when applied as a hooded sprayer application.

Acknowledgements: The authors wish to thank Merlin and Lillian Schantz for their support and cooperation in this field demonstration.

Table 1. 2009 Valor SX herbicide study on Peppers, Hydro, OK.

	% Injury		**% Control**			
	Pepper		**Palmer amaranth**		**Puncturevine**	
Treatment/ acre[z]	**7/22/09**	**8/12/09**	**7/22/09**	**8/12/09**	**7/22/09**	**8/12/09**
1 oz Valor SX	0	0	0	15	0	
2 oz Valor SX	0	0	60	75	30	15
2oz Valor SX + Glyphos at 1 qt	0	0	85	80	30	15

[z] all treatments include Softsede water conditioner and Spredde surfactant at 0.25% V/V with spray tank water.

Watermelon Herbicide Demonstration

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In Cooperation with Bill Shelby

Watermelon is a major vegetable crop grown in the state of Oklahoma. Weed control on this crop is crucial for commercial growers particularly as labor costs increase and availability of hoeing crews becomes less. Weed infested fields can be a source of insect and disease pests along with the obvious loss of yield and additional harvest cost. The objective of this study was to provide a practical field demonstration of several labeled herbicides for use in commercial watermelon production in Oklahoma.

Methods and Materials: Plots were arranged in a randomized block design with three replications, each plot consisted of 1 row on 12 foot row centers 20 feet long. Watermelon was direct seeded during the week of May 11 to the cultivar Starbright with 10 feet between rows and in-row spacing of 3 feet. Treatments were applied on 5/18/09 and included four herbicides Command 3ME (clomazone), Curbit (ethalfluralin), Sandea (halosulfuron), and Strategy (ethalfluralin+clomazone) alone and in combination for a total of 5 different pre treatments (Table 1). Treatments were applied to each 12'x20' plot area with a hand-boom CO_2 research sprayer at an overall application rate of 25 gallons per acre. Plots were rated for % injury, % stunting, and plant counts on 6/02/09. Weed counts of different species were recorded on 6/17/09 along with % stunting ratings. The rating scale that was used was a 0 to 100 scale where 0 represents no visible crop damage or weed control and 100 represents 100% of the crop or weed species being dead or non-existent, stand counts were actual plants per plot being converted to number of crop plants/acre. The producer recorded weed control ratings and fruit counts during the week of 8/24/09.

Results and Discussion: Plant counts taken on 6/02/09 did not vary between treatments in the study (Table 1). Crop injury both as % stunting did not vary for treatments on either of the days that ratings were recorded. Weed counts did not vary significantly for either purslane or barnyardgrass on 6/17/09. Although there was a wide range of weed numbers between treatments variability between plots for these naturally occurring populations is why no differences were recorded. Producer weed control ratings ranged from 6.7 to 8.7 indicating moderate levels of weed control for all treatments. Yields ranged from 2,360 to 2,965 watermelons per acre with no significant differences observed in the study.

In conclusion, although no differences were observed in this demonstration for injury, weed control, or yield the authors would conclude that it is not surprising that the four labeled herbicides in the demonstration all performed well and resulted in similar results. Furthermore, based upon the performance of these herbicides, producers should consider herbicide selection for weed control in watermelon based upon the cost of the treatments that are being considered, rather than being overly concerned with performance.

Acknowledgements: The authors wish to thank Bill Shelby for his support and cooperation in this field demonstration.

Table 1. 2009 Watermelon herbicide study, Webbers Falls, OK.

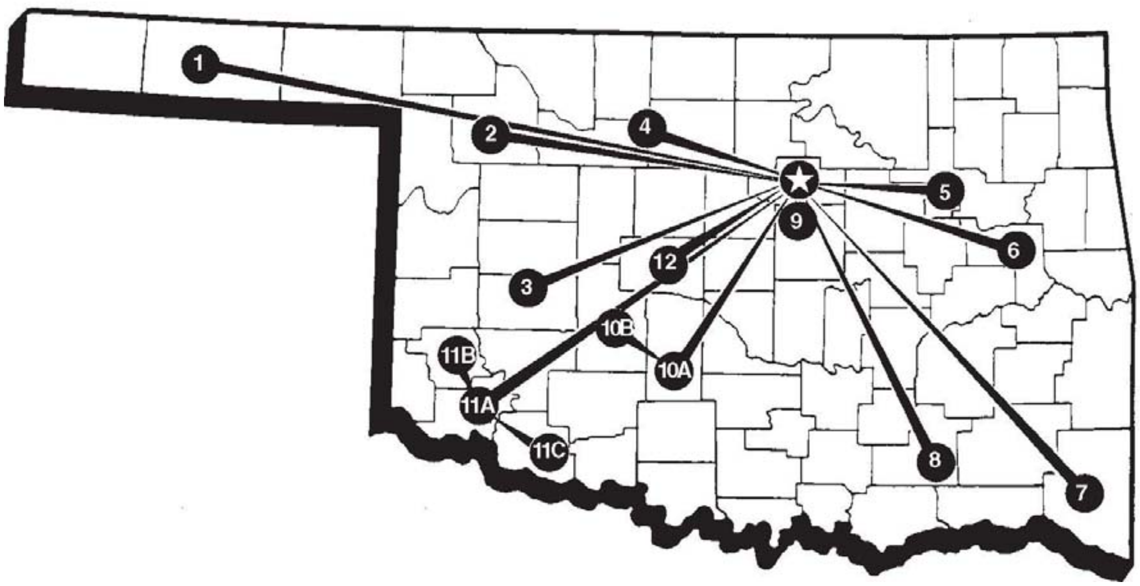
Treatment lbs ai/acre	Plant counts[w] 6/2/09	% Stunting 6/2/09	% Stunting 6/17/09	# Weeds/acre Purslane	# Weeds/acre Barnyard Grass	Weed Control[z]	Yield Number melons /acre[y]
Sandea 0.032	787 a[x]	10 a	20 a	545 a	182 a	7.7 a	2723 a
Curbit 1.1	908 a	7 a	13 a	484 a	1936 a	8.3 a	2360 a
Command 0.15 + Curbit 0.56 + Sandea 0.024	968 a	3 a	10 a	60 a	121 a	8.7 a	2965 a
Command 0.15 + Curbit 0.56 + Sandea 0.032	968 a	8 a	18 a	242 a	484 a	7.0 a	2844 a
Strategy 0.65	1089 a	3 a	10 a	363 a	726 a	6.7 a	2904 a

[z] Weed control ratings taken by producer during the week of 8/24/09 using a scale of 1-10, 10=no weeds, 1=weedy
[y] Harvest yield data from week of 8/24/09
[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.
[w] Plant counts were the number of watermelon plants per plot converted to number of plants per acre for the table.

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. **A. Agronomy Research Station—*Perkins***
   B. Oklahoma Fruit and Pecan 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***