2008 Vegetable Trial Report

January 2009

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

The Department of Horticulture and Landscape Architecture, cooperating departments and experimental farms conducted a series of experiments on field vegetable production. Data were recorded on a majority of aspects of each study, and can include crop culture, crop responses and yield data. This report presents those data, thus providing up-to-date information on field research completed in Oklahoma during 2008.

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.seminis.com

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www.willhiteseed.com

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Crop Culture

Brassica Greens Variety Trial

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

Brassica greens are an important commercial vegetable crop for producers within Oklahoma. These crops are grown for both processing and for fresh market. During the past few years as consumers have begun to give more consideration to the nutritional content of their diets, crops such as brassica greens have become more popular because of their high levels of vitamins and minerals. Cultivar trials are an important tool for increasing production efficiency. The objective of this trial was to observe improved cultivars of brassica greens for yield and quality.

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 435,600 seeds per acre. Plots were direct seeded on 3/28/08 using a research cone planter. Weed control included 0.5 lb ai/acre of Treflan (trifluralin) applied pre-plant incorporated on 3/18/08/ and one hand weeding on 5/12/08. No other pest control efforts were necessary. The study received 60 lbs N/acre (50 lbs from 46-0-0 and 10 lbs from 21-0-0-24) on 4/25/08 and 60 lbs N/acre (50 lbs from 46-0-0 and 10 lbs from 21-0-0-24) on 5/12/08. Eleven cultivars were included in the study (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 all plants having flower stalks present. Data recorded at harvest included overall plot yields and bolting. Plots were also rated for percent re-growth and bolting on 6/6/08.

Kale yields were significantly higher for Darkibor which yielded 12.9 tons/acre compared to Dwarf Siberian, Red Russian, and Winterbor which had 8.1, 5.6, and 3.9 tons/acre, respectively (Table 1). Mustard yields were significantly higher for Miike Giant compared to Indian Red Giant with yields of 12.1 and 4.5 tons/acre, respectively. Mustard spinach yields were highest for Savannah, Summer Fest, and Misome which recorded yields of 9.8, 8.1, and 6.8 tons/acre. Bolting ratings on 6/4/08 had the highest percentage differences. Misome, Choho, Indian Red Giant, Green Boy, and Miike Giant had the highest amount of bolting of all cultivars in the trial with percent bolting of 91, 30, 26, 24, and 19%, respectively.

In general, the authors felt that the most important aspect of the trial was the opportunity to observe these cultivars for bolting resistance. There were significant differences observed between different cultivars with the Kales as a group being the most bolt-resistant. Highest yielding cultivars in the trial included Darkibor kale, Miike Giant Mustard, and Savannah mustard spinach.

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

Table 1. Spring 2008 Greens cultivar trial, Bixby, OK

Cultivar	Type	Days to Harvest	% Emergence	% Bolting 5/21/08	% Bolting 6/4/08	% Regrowth 6/4/08	Yield tons/acre [z]
Red Russian	Kale	58	84 a-b [y]	0 d	0 d	83 a-b	5.6 d-e
Darkibor	Kale	65	65 c-d	0 d	0 d	6 e	12.9 a
Winterbor	Kale	58	69 b-d	0 d	0 d	65 c	3.9 e
Dwarf Siberian	Kale	58	76 a-d	0 d	0 d	89 a	8.1 c-d
Indian Red Giant	Mustard	58	61 d-e	0 d	26 b-c	84 a	4.5 e
Miike Giant	Mustard	65	50 e	0 d	19 c	18 d	12.1 a-b
Choho	Mustard spinach	58	78 a-c	2 c	30 b	88 a	5.4 d-e
Green Boy	Mustard spinach	58	79 a-c	5 b	24 b-c	83 a-b	5.9 d-e
Misome	Mustard spinach	58	83 a-b	10 a	91 a	74 b	6.8 c-e
Summer Fest	Mustard spinach	57	88 a	0 d	1 d	86 a	8.1 c-d
Savannah	Mustard spinach	57	86 a	0 d	0 d	90 a	9.8 b-c

[z] Yield data on 5/21, 5/22, and 5/29.
[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 2008, 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 8 to 10 seed per foot and were planted on 6/3/08. A preemergence application of Dual Magnum at 1.0 lb ai/acre on 6/4/08 followed by an overhead irrigation of 0.5 inches of water. Supplemental water was supplied through overhead irrigation. Plots were fertilized on 6/19/08 with 25lbs N/acre. The trial included 4 replications for the 14 replicated lines and 2 replications for the 20 observational lines (Tables 1, 2). The trial was machine harvested on 9/19/08 and dry and imbibed yields were recorded subsequently. Data was analyzed using Duncan's multiple range test with comparisons made between varieties within a pea type (blackeye, cream, pinkeye types were compared only to other peas within that given type).

Results and Discussion: Percent moisture of the harvested peas is also an indicator of maturity. The blackeyes range from 13.4% being TX2042-6-1-0-0 and the lowest being AR01-1764 at 11.0%. Pinkeye's moisture ranges from 12.5% with AR00-178 and the lowest being 10.9% for AR01-821 (Table 1.). Percent moisture ranged between 10.3 to 11.2% for blackeyes in the observational trial 10.1 and 11.2% for the creams, and 10.0 to 12.1% for the pinkeyes. There were two red peas with moisture reading of 9.7 for AR07-727 and 9.9 for AR07-303 (Table 2).

Imbibed yields in the blackeye type ARK Blackeye #1 had 2791 lbs/acre, which was significantly higher than the other blackeyes. Coronet was the highest yielding pinkeye with a yield of 1158 lbs/acre and an imbibed yield of 2276 lbs/acre. AR 07-216 had an imbibed yield of 3660 lbs/acre in the observational trial. Early Acre was the highest yielding cream. AR07-303 was the highest yielding red with 1278 lbs/acre dry and 1951 lbs/acre imbibed yield.

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 and Allen Canning for financial support.

Table 1. Spring 2008 Southern Pea Trial, Bixby, OK. Replicated Trial.

Variety	Source	% Moisture[y]		Shelled yield lbs./acre Dry[x]		Imbibed[x]	
Blackeye types							
AR01-1764	U of Arkansas	11.0	b	477	c	1027	c
TX2028-1-3-1-0BEgc	Texas A & M	11.7	b	884	b	1753	b
TX2028-2-2-0-0BEgc	Texas A & M	12.3	a-b	820	b	1611	b-c
TX2042-6-1-0-0BEgc	Texas A & M	13.4	a	595	b-c	1187	b-c
ARK Blackeye #1	Industry Standard	12.3	a-b	1404	a	2791	a
Pinkeye types							
AR00-178	U of Arkansas	12.5	a	855	b-c	1786	a-b
AR01-821	U of Arkansas	10.9	c	1078	a-b	2226	a
AR01-1237	U of Arkansas	11.4	b-c	847	b-c	1746	a-b
AR01-1293	U of Arkansas	12.0	a-b	919	a-b	1881	a
TX2044-5-1-0PEgc	Texas A & M	12.0	a-b	602	c-d	1246	b-c
TX2044-5-2-0PEgc	Texas A & M	11.4	b-c	516	d	1077	c
TX2044-6-5-1-0PEgc	Texas A & M	11.1	b-c	436	d	919	c
Charleston GreenPak	Industry Standard	12.1	a-b	625	c-d	1267	b-c
Coronet	Industry Standard	11.9	a-c	1158	a	2276	a

[z] Moisture=percent moisture on 9/22/08.
[y]Dry shelled wt.=mechanically harvested on 9/19/08 yield in lbs./acre.
[x]Imbibed wt.=Imbibed weight in lbs./acre.
[w]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 2008 Southern Pea Trial, Bixby, OK. Observational Trial.

			Shelled yield lbs./acre	
Variety	**Source**	**% Moisture[y]**	**Dry[x]**	**Imbibed[x]**
		Blackeye types		
AR01-1704	U of Arkansas	10.8 a	1098 a-c	2228 a-b
TX2012-5-1-2-0BE	Texas A & M	10.3 a	502 d	1037 c
TX2015-2-1-1-0BEgc	Texas A & M	10.9 a	1346 a	2734 a
TX2028-1-5-1-0BEgc/gt	Texas A & M	10.9 a	1093 a-c	2173 a-b
TX2028-2-2-1-0BEgc	Texas A & M	11.2 a	837 b-d	1661 b-c
TX2032-4-1-2-0BEgc	Texas A & M	10.7 a	753 c-d	1514 b-c
ARK Blackeye #1	Industry Standard	11.2 a	1267 a-b	2528 a
		Cream types		
AR01-1781	U of Arkansas	10.1 b	907 a	1951 a
Early Acre	Industry Standard	11.2 a	1175 a	2367 a
		Red types		
AR07-303	U of Arkansas	9.9 a	1278 a	2615 a
AR07-727	U of Arkansas	9.7 a	418 b	873 b
		Pinkeye types		
AR07-216	U of Arkansas	11.6 a	1801 a	3660 a
AR07-786	U of Arkansas	10.3 a	773 b-c	1566 c-d
AR07-1223	U of Arkansas	11.5 a	1138 a-c	2301 b-d
AR07-1279	U of Arkansas	12.1 a	1747 a	3524 a-b
TX2044-4-6-4-0PEgc	Texas A & M	10.0 a	661 c	1366 c-d
TX2044-6-2-1-0PEgc	Texas A & M	10.6 a	454 c	935 d
TX2044-6-5-0-0PEgc	Texas A & M	10.8 a	513 c	1072 d
Charleston GreenPak	Industry Standard	11.3 a	693 c	1400 c-d
Coronet	Industry Standard	10.9 a	1397 a-b	2720 a-c

[z] Moisture=percent moisture on 9/22/08.
[y]Dry shelled wt.=mechanically harvested on 9/19/08 yield in lbs./acre.
[x]Imbibed wt.=Imbibed weight in lbs./acre.
[w]Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Food Safety on Leafy Greens

Spring 2008
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Introduction and objective: Studies completed in the spring of 2007 indicated that soil-borne bacteria could be transferred to the leaves of fresh greens. These studies were developed to determine if different inoculation media could be used to further refine and separate treated and untreated plots within an inoculation study. This study was meant to verify results from a fall 2007 study that used livestock bedding as an inoculation media.

Methods: The study was conducted at the Oklahoma State University Vegetable Research station in Bixby, Oklahoma. Plots were arranged in a randomized block design with four replications, each plot consisting of 4 rows of spinach on 12 inch row centers, rows being 20 feet long. The study included one treatment inoculated with generic E. coli and a non-inoculated control. Prior to planting, non-treatment plots received a total of 50 lbs of clean wood shavings (livestock bedding "LB") having an equivalent application rate of 13.6 tons/acre. Treatment plots inoculated with E. coli received LB as a split application with 37.5 lbs/plot of non-inoculated LB followed by 12.5 lbs/plot of inoculated LB with CFU (colony forming units) per gram ranging from about 500 to 1,500 CFU. All LB applications were made uniformly to the surface of each plot then incorporated to a depth of 1.5 inches with one pass of a tractor mounted rototiller (non-inoculated plots first, then followed by inoculated plots). On 4/28/08 after application and incorporation of the livestock bedding, plots were direct seeded to the spinach variety Padre using a seeding rate of approximately 1.1 million seeds/acre (non-inoculated plots first followed by inoculated plots). Following planting and inoculation with E. coli the entire test area received 0.65 lb ai/acre of Dual Magnum (S-metolachlor) followed by approximately 0.5 inch of irrigation from overhead irrigation. Due to heavy rain and resulting poor plant stands, the test site was tilled up and the entire process repeated in respective plots on 5/09/08. Each plot had soil samples taken on 5/09/08, 5/14/08, 5/22/08, 5/29/08, 6/5/08, and 6/12/08, leaf samples were not collected due to poor crop stands. Field samples were collected then transferred to the laboratory in an ice-chest with ice. Samples were processed the following day with E. coli counts recorded on each of the six sample dates.

Results and discussion: Numbers of coliforms detected in the non-inoculated bedding at study initiation on 5/9/08 were zero (Table 1), while those from samples of the inoculated bedding were 6,794 CFU/gram (colony forming units per gram). Soil samples collected from inoculated plots on 5/9/08, 5/14/08, 5/22/08, and 5/29/08 had Coliform counts of 2007, 4, 295, and 7 CFU/gram, respectively, compared to zero for the non-inoculated control for each date. Soil samples collected on 6/5/08 and 6/12/08 from both the inoculated and non-inoculated plots had no detectible levels of coliforms.

Results from this study indicate that livestock bedding can be used as a means of inoculating plots with E. coli. While livestock bedding was effective as an inoculation media, the authors deduce that serious crop stand reductions took place as a result of using it. Future studies will need to focus on exploring different means of inoculating plots with E. coli to simplify inoculation procedures and to increase the potential for successfully growing crops in the inoculated plots. Furthermore, as the season progressed and temperatures increased, the number of detectible coliforms decreased significantly providing some evidence that coliform populations in the top soil will not survive well at summer temperatures.

Table 1. 2008 Food safety study, Number of Coliform Bacteria Detected in livestock bedding and soil samples. Bixby, Oklahoma.

	Wood	Soil CFU/gram soil					
Treatment	shavings	5/9/08	5/14/08	5/22/08	5/29/08	6/5/08	6/12/08
Control	0	0 b[z]	0 a	0 b	0 a	0	0
Inoculated	6794	2007 a	4 a	295 a	7 a	0	0

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

Food Safety on Spinach

Fall 2008
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Introduction and objective: Studies completed in fall 2007 and spring 2008 indicated that different methods of inoculation were needed to provide a more efficient means for studying soil-borne bacteria under field conditions. The current studies were developed to determine if different inoculation methods could be used to simplify research methods and improve conditions for the growth of crops under investigation.

Methods: The study was conducted at the Oklahoma State University Vegetable Research station in Bixby, Oklahoma. Plots were arranged in a randomized block design with four replications, each plot consisting of 8 rows of spinach on 6 inch row centers, rows being 20 feet long. The study included three treatments inoculated with generic E. coli and a non-inoculated control. Treatments are described in Table 1 and consisted of plots treated with inoculated livestock bedding-tilled-planted, plots sprayed with inoculum-tilled-planted, and plots tilled-planted-sprayed with inoculum. The study was initialized on 10/02/08 with treatment applications and seeding of spinach. Plots were direct seeded to the spinach variety Padre at a seeding rate of approximately 1.1 million seeds/acre (non-inoculated plots first followed by inoculated plots). Following planting and inoculation with E. coli the entire test area received 0.65 lb ai/acre of Dual Magnum (S-metolachlor) followed by approximately 0.5 inch of irrigation from overhead irrigation. Soil samples were collected and tested for levels of E. coli on 10/02/08, 10/07/08, 10/13/08. Field samples were collected then transferred to the laboratory in an ice-chest with ice. Samples were processed the following day with coliform counts recorded on each of the four sample dates.

Results and discussion: Coliform counts from soil samples on the first sampling date were negligible for the non-inoculated control and 18,836, 86,099, and 2,455, respectively, for the livestock bedding-tilled-plant, spray-tilled-plant, and the tilled-plant-spray treatments (Table 2). The non-inoculated control and the tilled-plant-spray treatment had negligible soil coliforms on 10/7/08 and 10/13/08. Counts of soil samples for the livestock bedding-tilled-plant and spray-tilled-plant treatments, respectively, were 91,201 and 45,446 on 10/7/08 and 17,783 and 218,776 CFU/gram on 10/14/08. Although the study is still ongoing, there are two outcomes that are becoming evident. First, inoculating plots by spraying inoculum on the soil surface after planting (tilled-plant-spray treatment) is not an effective inoculation procedure. Second, inoculating plots by spraying inoculum on the soil surface and immediately tilling appears to be as effective as using livestock bedding as an inoculation media. The ability to directly apply inoculum as a spray to study plots will provide a more efficient means of initializing studies and will simplify the inoculation procedures. These studies will continue on into the fall-early winter with soil sampling and additional sampling of spinach leaf tissue as the crop becomes established.

Table 1. Food safety study on spinach, Treatment descriptions, fall 2008.

Application method for field plots	Inoculum media	Original inoculum^z diluted in
Non-inoculated	NA	NA
Livestock bedding-tilled^x-plant	Wood shavings sprayed^y with inoculum & mixed in cement mixer	1 gal H_2O
Sprayed- tilled-plant	Water	1 gal H_2O
Tilled-plant-sprayed	Water	1 gal H_2O

^{z}Original inoculum consisted of 250 ml of liquid culture at ~ 10^9 cfu/ml of generic E. coli
^{y}Spray method included use of 2 gal. hand-pump sprayer with one flat-fan spray nozzle
^{x}Soil was tilled with 4.5 ft. wide tractor mounted rototiller at a depth of 3-4 inches

Table 2. Food safety study on spinach, Number of Coliform Bacteria Detected on soil, Bixby, Ok, fall 2008

	Treatment Soil CFU/gram soil			
Date	Non inoculated Control	Livestock bedding-tilled-plant	Spray-tilled-plant	Tilled-plant-spray
10/2/08	10 c[z]	18,836 ab	86,099 a	2,455 b
10/7/08	10 b	91,201 a	45,446 a	10 b
10/14/08	10 c	17,783 b	218,776 a	10 c
10/21/08	10 b	19,953 a	19,953 a	10 b
10/28/08	10 b	14,125 a	5,309 a	10 b
11/4/08	10 c	14,962 a	5,012 b	10 c
11/11/08	10 c	8,414 a	1,122 b	10 c
11/24/08	10 c	4,467 a	266 b	10 c

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

Onion Cultivar Evaluation - Lane

Jim Shrefler, Tony Goodson, Charles Webber and Buddy Faulkenberry

Introduction: Onions are an important crop for various vegetable growers such as farmer's market growers. Growers currently use a combination of short day and intermediate day cultivars. This practice extends the time period over which transplanting and harvesting can be accomplished. The intermediate cultivars available to growers have been limited in number. Newly available intermediate cultivars may offer additional features compared to those currently used. Desirable characteristics that would be beneficial include delayed maturity, greater size uniformity, and improved handling characteristics. The objective of this study was to evaluate and compare onion cultivars for yield, bulb size distribution, and bolting potential using onion transplants locally produced in a hoop house production system.

Materials and Methods: Onions were seeded Nov. 4, 2007 on 4 inch high beds on the floor of hoop houses located at Lane, Oklahoma. The houses measure approximately 20 feet wide and 40 feet long. On each bed, rows were spaced 5 inches apart and seeds were sown at a density that resulted in plant stands of 20 to 40 plants per foot of row. Soil was irrigated as needed to obtain seedling establishment. No subsequent water was applied after November. Weeds were removed by hoeing and hand weeding. Twelve cultivars were used in the trial as shown in Table 1. Each cultivar was planted in a sub-plot in each of four beds. On March 25 plants were dug and replanted outdoors. These plants were used to establish 4 replications of field plantings. The field planting used raised beds that were 4 feet wide and on 6 foot centers. Plots consisted of 2 rows of onions of the same cultivar with 30 plants per row. Within a bed, rows were spaced 24 inches apart and plants were spaced 6 inches apart within the row. Following transplanting, Prowl 3.3EC and Goal 2XL herbicides were applied at 1 pint each per acre as a tank mix. During field preparation fertilizer was applied and incorporated based on Oklahoma State University soil testing results and recommendations. Nitrogen was applied using 46-0-0 as a side-dress on April 21 and May 9 at 46 lbs. of N per acre at each application. Rainfall provided adequate soil moisture during the period from transplanting until late May. Drip irrigation was used during June.

Data collection included enumeration of seed-stalk formation, bulb diameter and bulb weight. Plant bolting percentage was determined on May 30. Onion cultivars were harvested in early July once appreciable top break over of the tops was observed. Following harvest, onion bulbs were sorted by diameter. Onions of size categories <2 inches, 2-3 inches, 3-4 inches and >4 inches were counted and weighed. Total and marketable onion bulb yields were calculated and bulb size distribution was assessed.

Results and Discussion: Total and marketable onion yields are shown in Table 1. Total yields ranged from 78 to 180 hundredweight units per acre. Five cultivars within the top yielding group did not differ statistically from Sequoia, which had the largest mean. Marketable yield excludes onions having bulb diameters below 2 inches. For marketable yield there was a larger group that did not differ from the top yielding cultivar. A total of 8 cultivars were in this group. All cultivars produced some marketable yield.

Onion bulb size distribution is shown in Table 2. Onion bulbs larger than 4 inches in diameter were found only for the cultivar Chief, with 2% of bulbs being 4 inches or greater. In the bulb diameter categories <2 inches and 2-3 inches, there were no statistical differences among cultivars. In the 3-4 inch category, all cultivars except Red Bull had at least some bulbs in the category. Sequoia had 50% of bulbs in the 3-4 inch category. Five additional cultivars fell within a group that did not differ from Sequoia in percentage of 3-4 inch bulbs. Outside of this group, no cultivar had more than an average of 16% of bulbs within the 3-4 inch bulb category.

Seed-stalk formation became evident on May 2 and was quantified on May 30. The percentage of bolted plants ranged from 0 to 18%. Cultivars with bolting over 5% included Cimarron, Rumba, Renegade and Sequoia. Bolting was also influenced by position in the field as one replication had no bolting. This suggests that variation in management practices, such as side-dress fertilizer application, may have had an influence on bolting. This was the greatest incidence of bolting observed for onions produced from hoop house grown transplants over 5 years of trials in Oklahoma with this plant production technique.

This study shows that several of these cultivars may be useful for producers interested in using the hoop house transplant production system for onion production in Oklahoma. The group of cultivars that includes

Sequoia, Renegade, Denali, Cimarron, Chief and White Wing each produced at least 25% of bulbs with a 3 inch diameter or greater. Of this group, all cultivars are yellow with the exception of White Wing which is white. Three of these were also in the group producing greater than 5% seed-stalk formation. However, because this was the greatest incidence of seed-stalk formation observed over 5 years of trials, it does not appear that greater levels of seed-stalk formation are to be expected.

Acknowledgements: The authors thank Tanner Jones and Taylor Runyan for assistance with field work. We thank Nunhems USA, Inc. and Bejo Seeds Inc. for providing cultivars used in these trials.

Table 1. Onion yields in the onion cultivar trial.

Cultivar	Yield			
	Total		Marketable[a]	
	- - - - - - *100 lbs. units acre^{-1}* - - - - - -			
Sequoia	182	a[b]	166	a
Renegade	165	ab	157	a
Denali	165	ab	160	a
Cimarron	174	a	159	a
Chief	152	abc	147	ab
White Wing	128	bcd	115	abc
Desperado	118	cde	114	abc
1015Y	128	bcd	106	abc
Virgin	118	cde	93	b
Cowboy	111	bcd	95	b
Rumba	94	de	69	c
Red Bull	78	e	60	c

[a] Marketable yield includes onions having a bulb diameter of 3 inches or greater.
[b] Means within a column followed by a common letter are not different based on Duncan's multiple range test with alpha=0.05.

Table 2. Size distribution of onion bulbs.

	Bulb size category (inches)				
Cultivar	<2	2-3	3-4		>4
	- - - - - - ***percent of bulbs*** - - - - - -				
Sequoia	12	37	50	a[a]	0
Renegade	15	41	44	ab	0
Denali	9	49	42	ab	0
Cimarron	12	47	41	abc	0
Chief	9	52	36	abcd	2
White Wing	24	51	25	abcde	0
Desperado	10	74	16	bcde	0
1015Y	26	57	16	bcde	0
Virgin	34	55	11	cde	0
Cowboy	19	71	10	de	0
Rumba	35	61	4	e	0
Red Bull	39	61	0	e	0
	ns[b]	ns			ns

[a] Means within a column followed by a common letter are not different based on Duncan's multiple range test with alpha=0.05.
[b] An "ns" indicates no statistical differences among the cultivars at the 0.05 alpha level.

Sweet Corn Variety Trial

Spring 2008, 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 24 varieties (yellow or bicolor) for yield, earliness, and overall quality. Varieties were grouped as se or sh_2 for isolation purposes.

Materials and Methods: Plots were direct seeded on April 28. 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. Types were separated into two groups, with sh_2 types in one area of the field and se and mixed hybrids in the other area. Plots were sprayed with S-metolachlor herbicide on April 28, at the rate of ¾ pint/acre. Plots were thinned to 20 plants per row on May 30. Overall early vigor was very good. Fertilizer was applied two times, April 28 at 50 lbs. N/acre and June 11 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. Standards of comparison were 'Incredible' in the se group and 'GSS 0966' in the sh_2 group. Marketable yields did not differ among the 8 entries in the se group. 'Montauk' had relatively attractive ears. In the sh_2 group, 'Ranger', 'Obsession', and 'Overland' matched 'GSS 0966' for tonnage of marketable ears, but only 'Ranger' also matched it for marketable sacks/A. ''Overland' had tip-cover problems that contributed to high corn earworm damage; however, apart from damaged tips, the shucked ears were very attractive. 'Fantastic' stood out among the relatively early corns in this group, as it did in 2007, despite above-average cull ear production.

One objective of this trial was to compare several Mirai™ cultivars with other sweet corns. Mirai™ cultivars are marketed as having particularly good eating quality. Taste is very subjective; however, several people in our research group tested Mirai™ cultivars against others harvested on the same days, and most felt that the eating quality was very good. After four years of testing, it appears that the claim of superior flavor in the Mirai™ cultivars has merit. Yield and vigor are improving in the newer Mirai™ cultivars, but they still cannot match later-maturing, more vigorous types like 'GSS 0966' for sheer tonnage. However, for Oklahoma markets where volume of production is less important and a premium can be earned for outstanding flavor, the newer Mirai™ cultivars like '350BC' are definitely worth considering. Those growing Mirai™ cultivars should follow a good corn earworm management program and carefully follow guidelines provided by Centest, including attention to stand establishment.

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 2008 Sweet Corn Variety Trial, Bixby[z] .

Variety[y]	Company/ Source	Genetics	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											
Incredible	Crookham	Homozygousyellow	221	4.7	1.2	79	3.8	3.2	2.0	7.6	3.5
Sumptuous	Mesa Maize	Homozygous yellow	215	4.5	0.7	77	2.7	2.8	1.8	7.8	3.0
Brocade	Mesa Maize	Homozygous bicolor	213	3.9	0.4	73	2.2	2.5	1.9	7.7	2.5
Cameo	Crookham	Synergistic bicolor	203	4.7	0.7	81	3.5	2.5	2.1	7.8	3.0
Montauk	Mesa Maize	Synergistic bicolor	197	4.4	0.5	77	2.0	2.3	2.0	7.7	2.8
Manitou	Mesa Maize	Synergistic bicolor	185	4.0	0.6	79	3.0	3.2	2.0	7.3	3.2
Saugatuck	Mesa Maize	Synergistic bicolor	180	3.5	0.3	73	2.0	3.3	1.9	7.2	2.3
Breeders Choice	Mesa Maize	Homozygous yellow	176	2.9	0.7	73	3.5	2.5	1.7	7.1	2.8
		Mean	199	4.1	0.6	77	2.8	2.8	1.9	7.5	2.9
		$LSD_{0.05}$	NS	NS	0.4	--	0.6	0.5	0.1	0.4	0.7
Group: sh2											
GSS 0966	Syngenta	Attribute® yellow	424	7.0	0.1	79	2.2	2.7	1.8	7.3	2.0
Ranger	Seedway	yellow	361	6.9	0.2	81	2.8	2.5	1.9	7.2	3.2
Obsession	Seedway	bicolor	318	6.1	0.4	77	2.5	2.5	1.9	7.8	3.5
BSS 0977	Syngenta	Attribute® bicolor	285	4.6	0.1	79	2.7	3.0	1.7	6.9	2.0
Overland	Syngenta	yellow	285	6.4	0.0	81	2.8	1.5	2.0	8.3	4.5
Xtra Tender 282A	Harris	bicolor	271	5.6	0.1	81	2.2	3.0	2.0	7.1	3.5
Fantastic	Seedway	bicolor	267	4.5	0.9	70	2.3	2.5	1.8	7.5	2.5
Xtra Tender 281A	Seedway	bicolor	254	5.0	0.5	79	2.0	2.3	1.9	7.6	3.3
Passion	Seedway	yellow	248	5.3	0.5	79	2.7	2.5	2.0	7.8	3.3
Mirai 350BC	Centest	bicolor	223	4.3	0.6	77	3.0	2.8	1.9	7.5	3.0
BSS 0982	Syngenta	Attribute® bicolor	215	4.7	0.0	81	2.3	2.3	2.0	7.4	2.0
77747B	Centest	bicolor	199	3.8	0.8	73	3.2	2.8	1.9	7.7	2.8
Mirai 130Y	Centest	yellow	191	2.8	0.8	70	3.3	2.8	1.7	7.8	3.0
Surpass	Crookham	bicolor	178	3.2	0.4	77	3.8	2.8	1.9	7.4	3.2
Mirai 336BC	Centest	bicolor	176	3.3	0.8	73	3.2	2.3	1.8	8.0	2.5
Optimum	Crookham	bicolor	172	2.9	0.8	77	3.3	3.3	2.0	7.2	3.7
		Mean	254	4.8	0.4	77	2.8	2.6	1.9	7.5	3.0
		$LSD_{0.05}$	67	1.3	0.6	--	0.5	0.7	0.1	0.2	0.6

[z]Seeded April 28, 2008; Plot size: 1.8m x 6.0m (2 rows/plot, 3 plots each variety, plots thinned to 20 plants/row.) Harvested 7/7/08 to 7/18/08
[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 were alternated and applied a total of 7 times between silking & harvest to entire planting.

Summer Squash Variety Trial, Bixby, OK

Brian Kahn, Lynda Carrier, Robert Havener, Robert Adams

Introduction and Objectives: Summer squashes are picked while still small and immature, and have thin edible skins. The three main kinds of summer squash grown in Oklahoma are green zucchini, yellow straightneck, and yellow crookneck. This year's trial was conducted at the Bixby Vegetable Research Station and featured 11 varieties of green zucchini summer squash.

Materials and Methods: Urea was broadcast and incorporated to provide 50 lbs/acre of N on May 5, 2008. Next, raised beds were created on 5' centers, with trickle irrigation tubing on the surface down the center of each bed but without plastic mulch. Varieties were direct seeded on May 5. Six seeds were sown per "hill" with 3 hills per plot and hills 2' apart within rows. Plots were 6' long and were arranged in a randomized block design with 3 replications. After planting, plots were sprayed with ethalfluralin 1¼ pts/acre. A preliminary thinning was done on May 30, and final thinning to 2 plants per hill occurred on June 11. Plants were topdressed with 60 lbs/acre of N from urea on June 11 and again on June 30. Insecticides were applied twice prior to harvesting. Plants were harvested 3 times a week starting on June 13 and final harvest on July 28 with 18 picks total.

Results and Discussion: All entries performed satisfactorily. Most were typical speckled, medium green zucchinis. 'Independence II' and 'Judgement III' had the most pronounced speckles. 'Envy' and 'Magnum' had shiny, dark green skins that sometimes had distinct ridge lines, and both tended to become more bulbous towards the end of the season. At first glance, some fruits of 'Envy' and "Magnum' could have been mistaken for cucumbers due to the color and shine. One farmers' market grower indicated the darker green zucchini types were in demand. Virus pressure was minimal this season. Heavy rains interfered with pollination early in the trial.

Table 1. Summer Squash Variety Trial, Bixby, 2008 (Green Zucchini type)

		Yield (ctns/A)^z				Avg.
Variety^y	**Company/ Source**	**Market**	**Early mkt.^{y}**	**Culls^x**	**Total^w**	**mkt. fruit wt. (lbs.)**
Justice III	Seminis	858	135	842	1700	0.48
Payroll	Syngenta	802	118	759	1561	0.51
Judgement III	Seedway	800	159	1036	1836	0.47
Leopard	Seedway	789	181	774	1563	0.53
Dividend	Syngenta	771	103	423	1194	0.41
Reward	Seedway	754	193	473	1227	0.40
CashFlow	Syngenta	741	148	405	1146	0.45
Independence II	Seminis	730	151	719	1449	0.51
Wildcat	Seedway	705	136	606	1311	0.48
Envy	Syngenta	699	166	767	1466	0.43
Magnum	Seedway	653	98	907	1560	0.42
	Mean	752	145	697	1448	0.46
	LSD $_{0.05}$	NS	NS	NS	NS	NS

^{z}One carton=42 pounds
^{y}Early market = harvest dates 6/13/08 to 6/27/08 (6 picks)
^{x}Predominant reasons for culls were overmature fruit and poor pollination.
^{w}Total yield=market + culls

Tomato Variety Trial

Spring 2008, Bixby, Oklahoma
Brian Kahn, Lynda Carrier, Robert Havener, and Robert Adams

Introduction and Objectives: Commercial tomato production in Oklahoma is almost exclusively for fresh market. Oklahoma tomato crops usually are established with transplants in the spring for summer production. This trial was designed to evaluate yield and fruit quality of 16 determinate tomato cultivars. Plants were grown using surface drip irrigation and the stake-and-weave cultural system.

Materials and Methods: Plants were started in the greenhouse on March 21, 2008. Peat pots 2¼ inches in diameter were used with a peat-based plug and seedling mix. Plants were removed from the greenhouse to be "hardened off" on April 21. A preplant application of urea to supply 50 lbs/A of N was made at Bixby on April 21, followed by an application of trifluralin at 0.5 lbs/A (a.i.) and incorporation. Plants were transplanted to the field on April 22. There were 6 plants per plot arranged in a randomized block design with 3 replications. Plots were 5.9 ft x 11.8 ft. with plants spaced at 24 in. within rows. Each plant received one cup of a starter solution made from 6 lbs. 20-20-20 fertilizer plus 1/2 pint diazinon per 100 gallons of water. Metal posts for the stake-and-weave system were installed beginning on May 12. Plants subsequently were pruned by removing all suckers up to the one immediately below the first flower cluster, after which the first string was installed. Additional strings were installed as needed during the season. Plants were sidedressed with 50 lbs/A of N from urea on May 30 and again on June 23. Insecticide applications began on May 14 and continued through July 21, with a total of 5 applications. Fungicide applications began on May 14 and continued through July 21, with a total of 3 applications. Harvest began on June 19 and continued 2 times weekly until July 28, with a total of 12 harvests.

Results and Discussion: Results are shown on the following pages. Persistent rains early in the season slowed growth and limited spraying, leading to fruitworm injury on the earliest fruits. Radial fruit cracking was common. Plants subsequently grew out, but total yields were relatively low. 'Florida 7514' and 'Florida 7964' showed good heat-set ability, but were not superior in this trial to 'Florida 91'. 'Solar Fire' and 'Top Gun' should be considered for trial by Oklahoma producers. Tomato spotted wilt virus was not a factor in this trial.

Spring Tomato Replicated Variety Trial – Bixby, 2008

Summary of notes recorded by B.A. Kahn throughout the trial. Specific observations of vines were performed on 26 June. All notes based on three plots per variety. An asterisk (*) indicates a variety claimed to have resistance to tomato spotted wilt virus (TSWV).

Variety	Notes
Amelia *	Relatively sparse plants. Performed well in 2006 but not in 2008; needs further trials.
Bella Rosa*	No comments; needs further trials.
BHN 602*	Some fruits were pointed and some developed side cracks.
Crista*	Some nice fruits despite above-average radial cracking. Good vines.
Florida 7514	Good yield and relatively early.
Florida 7964*	Fruits tended to be pointed and to have radial cracking, and some were relatively small. Despite this, had very good marketable and total yield.
Florida 91	Among the best for fruit size and appearance. Continues to be a standard of comparison for adaptation to Oklahoma.
Mountain Glory*	Smaller plants than some. Some fruits were pointed, but many were nice.
Nico*	Good production, but second worst in the trial for radial cracking.
QualiT 23	Should be trialed again; performed well in 2006. Had some radial cracking and blossom-end rot.
Redline*	Some big individual fruits, and intermediate in radial cracking.
Scarlet Red	Much like 'Redline', but may have a few more culls due to misshapen fruit and side cracks.
Solar Fire	Relatively small fruits and some were pointed, but good overall. Also performed well in 2006, and should be considered for trial in Oklahoma.
Soraya	Among the best for fruit appearance; occasional side cracks. Also had low cull production in 2006, but has been consistently low in total yield.
Talladega*	The worst in the trial for radial cracking, and vines varied in vigor. Also had a lot of cracking in 2006, and does not appear to be adapted to Oklahoma.
Top Gun*	Among the best for fruit appearance. This variety also was relatively crack-resistant in 2006, and is recommended for trial in Oklahoma.

Tomato Variety Trial – Bixby, 2008[z]

Variety/line	Seed source	Yield (ctns/A)[y] Marketable	Early mkt[x]	Culled[w]	Total[v]	Resistance to radial cracking[u]	Average mkt. fruit wt. (lbs)
Florida 91	Seedway	454	133	160	615	1	0.55
Florida 7964	Univ. of Florida	426	174	281	707	5	0.44
Florida 7514	Rupp	424	198	221	646	4	0.52
Solar Fire	Seedway	420	105	196	616	2	0.49
Scarlet Red	Seedway	404	179	274	678	3	0.57
Nico	Seedway	402	131	281	683	5	0.49
Mountain Glory	Syngenta	394	191	206	600	2	0.52
Top Gun	Twilley	374	125	174	549	1	0.52
QualiT 23	Syngenta	349	167	276	625	5	0.53
BHN 602	Seedway	336	81	282	617	3	0.56
Redline	Syngenta	315	155	225	541	3	0.53
Bella Rosa	Seedway	269	120	205	474	2	0.52
Crista	Seedway	225	107	298	523	4	0.55
Talladega	Syngenta	192	96	395	587	5	0.47
Amelia	Twilley	192	105	250	442	4	0.55
Soraya	Seedway	192	23	184	376	1	0.55
	Mean	336	131	244	580	--	0.52
	$LSD_{0.05}$	122	71	NS	NS	--	NS

[z]Transplanted: April 22, 2008
Plot size: 5.9' x 11.8'; 6 plants per plot.
Harvested: 6/19/08 to 7/28/08 (12 picks).
[y]One ctn (carton) = 25 lbs.
[x]Early harvest: 6/19/08 to 6/30/08 (4 picks).
[w]Predominant reasons for culls were cracking and insect damage.
[v]Total = marketable + culls.
[u]Scale of 1=excellent to 5=poor, with 3=average.

Disease Management

Control of Bacterial Leaf Spot on Mustard Greens - Spring Trial

Stillwater, 2008
John Damicone, 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. Because they are caused by bacteria, 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, Basicop) 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 (26-70-70 lb/A N-P-K) and the herbicide Trifluralin 4E at 1.0 pt/A were incorporated into the soil prior to planting the cultivar 'Savannah' on 15 Apr. 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 5 May. 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 applied 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* (10^7 cells/ml) on 12 May, 7 days after the first treatment application. Plots were inoculated again on 19 May. Plots were mowed and top dressed with additional granular fertilizer (50-0-0 lb/A N-P-K) on 19 May. Plots were inoculated with *Psm* for a third time on 25 May. Plots were sprayed with the insecticides Ambush 2E at 6.4 fl oz on 1 June and with Baythroid 1E at 3.2 fl oz on 6 June to control false chinch bugs. Rainfall during the cropping period (15 Apr to 12 June) totaled 0.21 inches in April, 6.37 inches in May, and 2.57 inches for June. Plots received 22 applications of sprinkler irrigation at 0.16 to 0.36 inches of water that totaled 5.9 inches to promote stand establishment, plant growth, and disease development. Plots were visually assessed for disease incidence (percentage of leaves with symptoms) in three areas per plot on 5 June and 12 June.

Results: Rainfall was above normal and monthly average temperature was near normal (30-year average) during May and June. However, bacterial leaf spot did not develop in this trial to the severe levels observed in previous trials with this disease. Symptoms appeared only in the second cutting after the third inoculation and did not spread past the inoculated areas of the plots. Plots receiving Kocide, Actigard, and Kocide + Actigard had reduced disease incidence compared to the untreated control (Table 1). Other treatments had levels of disease similar to or greater that the untreated control. Damage from false chinch bug became severe in this trial and the insecticide applications made were not effective. High winds during many days in May and June may have limited leaf wetness periods and resulting disease development.

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 Brian Heid at the Entomology/Plant Pathology Research Farm in the establishment and maintenance of the trial are greatly appreciated.

Table 1. Control of bacterial leaf spot with bactericides and other products on "Savannah" spinach-mustard greens, Stillwater, OK, Spring 2008.

Treatment and rate/A	Bacterial leaf spot (%)[1]
1. Kocide 3000 0.75 lb	0.8 cd[2]
2. Kasumin 2F 16 fl oz	2.1 bcd
3. GWN-9350 3.5 lb + GWN-6500 0.125%	13.3 a
4. Agrimycin 17W 0.25 lb	2.5 bcd
5. Actigard 50WG 1.0 oz	0.8 cd
6. Actigard 50WG 1.0 oz + Kocide 3000 0.75 lb	0.0 d
7. Oxidate 1 gal	3.3 bcd
8. Keyplex 350 1.5 qt	3.3 bcd
9. Taegro 24W 3.5 oz	3.3 bcd
10. Citrex 3.84 fl oz	4.7 b
11. MOI 106 1 qt	4.2 bcd
12. Serenade 0.5 to 1.0 lb	2.1 bcd
13. Omega Grow 2 qt	3.3 bcd
14. SE57 1 pt	3.5 bcd
15. check	5.8 b
LSD (P=0.05)[3]	4.2

[1] Percentage of leaves with symptoms on 5 June.
[2] Means followed by the same letter are not statistically different at P=0.05 according to Fisher's Least Significant Difference test.
[3] Least significant difference.

Control of Bacterial Leaf Spot on Mustard Greens - Fall Trial

Stillwater, 2008
John Damicone, 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. Because they are caused by bacteria, 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, Basicop) 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. This trial was done in the spring, but is being repeated because the disease pressure was low and the previous trial was not definitive.

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 Brassica greens. Residual nitrogen from the previous precluded the need for pre-plant fertilizer. The herbicide Trifluralin 4E at 1.0 pt/A was incorporated into the soil prior to planting the cultivar 'Savannah' on 19 Sep. Savannah is a spinach-mustard cultivar used by the processing industry as mustard greens. Plots were top dressed with granular fertilizer (46-0-0 lb/A N-P-K) on 9 Oct. 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 three times on 7-day intervals beginning when plants had 5 to 6 true leaves. Plots were inoculated by spraying an entire outer row of each plot with a suspension of *Psm* (10^7 cells/ml) on 8 Oct and 13 Oct. Rainfall during the cropping period (19 Sep to 5 Nov) totaled 0.0 inches in Sep, 2.07 inches in Oct, and 0.0 inches in Nov. Plots received 13 applications of sprinkler irrigation at 0.16 to 0.48 inches of water that totaled 3.2 inches to promote stand establishment and plant growth. Plots were visually assessed for disease incidence (percentage of leaves with symptoms) in three areas per plot on 5 Nov. Disease incidence and severity were also assessed on harvested leaves. 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 50% below normal and monthly average temperature was 3^{o}F below normal (30-year average) during October. Bacterial leaf spot did not develop in this trial to the severe levels observed in previous years. Symptoms appeared mostly in the inoculated row and did not spread extensively into the middle two rows where the ratings were taken. Leaf injury was present across the trial from a hard freeze on 28 Oct which made rating the disease difficult. Disease ratings were variable and did not statistically differ among treatments (Table 1). Actigard and Actigard+Kocide treatments numerically had the lowest disease incidence.

Conclusions: Treatments with Actigard and Actigard+Kocide had the lowest levels of bacterial leaf spot, but disease pressure was not sufficient to definitively assess the treatments. These treatments also had the lowest levels of disease in the spring trial.

Acknowledgements: Financial support from the IR4 Project and Allen Canning Co. is greatly appreciated.

Table 1. Control of bacterial leaf spot with bactericides and other products on "Savannah" spinach-mustard greens, Stillwater, OK, Fall 2008.

Treatment and rate/A[1]	Bacterial leaf spot (%)		
	plot[2]	leaves[3]	leaf area[4]
1. Kocide 3000 0.75 lb	17.5	15.0	2.5
2. Kasumin 2F 16 fl oz	11.7	14.2	6.5
3. GWN-9350 3.5 lb + GWN-6500 0.125%	13.7	15.7	4.7
4. Agrimycin 17W 0.25 lb	13.3	30.0	6.6
5. Actigard 50WG 1.0 oz	5.0	9.0	2.9
6. Actigard 50WG 1.0 oz + Kocide 3000 0.75 lb	3.7	5.0	1.5
7. Oxidate 1 gal	12.1	19.0	4.7
8. Keyplex 350 2 qt	10.4	19.2	6.3
9. Keyplex 1000DP 1.5 qt	7.5	12.7	3.7
10. Taegro 24W 3.5 oz	11.6	18.5	6.9
11. Citrex 3.84 fl oz	16.2	20.7	10.2
12. MOI 106 1 qt	10.0	23.5	9.6
13. Serenade 1.0 lb	17.1	20.0	5.6
14. Omega Grow 2 qt	14.6	19.2	5.2
15. check	12.9	31.0	11.4
LSD (P=0.05)[3]	NS	NS	NS

[1] Treatments were applied on 8 Oct, 13 Oct, and 21 Oct.
[2] Percentage of plot foliage with symptoms on 5 Nov.
[3] Percentage of leaves with symptoms from 30 harvested leaves on 5 Nov.
[4] Percentage of leaf area with symptoms from 30 harvested leaves on 5 Nov.
[5] Least significant difference; NS=treatment effect not significant at P=0.05.

Reaction of Leafy Brassica Cultivars to Bacterial Leaf Spot

Stillwater, 2008
John Damicone, 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 greens (turnip, mustard, collards, kale, etc) in Oklahoma. Because they are caused by bacteria, 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 bactericides and various plant defence activators such as 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 selected leafy Brassica cultivars for their reaction to bacterial leaf spot in hopes of identifying resistant types.

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 wheat. 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 on 15 Apr. Plots were top dressed with additional granular fertilizer (50-0-0 lb/A N-P-K) on 5 May. 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. Plots were inoculated by spraying a 3-ft section of the center two rows of each plot with a suspension of *Psm* (10^7 cells/ml) on 12 May, 19 May, and again on 25 May. Plots were sprayed with the insecticides Ambush 2E at 6.4 fl oz on 1 June and with Baythroid 1E at 3.2 fl oz on 6 June to control false chinch bugs. Rainfall during the cropping period (15 Apr to 12 June) totaled 0.21 inches in April, 6.37 inches in May, and 2.57 inches for June. Plots received sprinkler irrigation as needed to promote stand establishment and plant growth. Plots were visually assessed for disease incidence (percentage of leaves with symptoms) in three areas per plot on 5 June and 12 June.

Results: Rainfall was above normal and monthly average temperature was near normal (30-year average) during May and June. However, bacterial leaf spot did not develop in this trial to the severe levels observed in previous trials with this disease. Symptoms of bacterial leaf spot appeared only after the third inoculation and did not spread extensively beyond the inoculated areas of the plots. The cultivars Darkibor, Winterbor, and Mustard Miike Giant were the most resistant (Table 1). The cultivars Red Russian and Indian Mustard Red Giant were the most susceptible. Black rot appeared in the cultivar Dwarf Siberian on 12 June which contributed to the higher disease ratings on that date. Fall chinch bugs were severe in the trial and were not effectively controlled by the insecticides applied. The cultivar Mustard Miike Giant was particularly attractive to false chinch bugs. High winds during many days in May and June may have limited leaf wetness periods and resulting disease development.

Conclusions: Differences in reaction to bacterial leaf spot were detected among the cultivars, however, disease pressure was not sufficient to definitively assess the cultivars.

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

Table 1. Cultivar reactions of leafy Brassica greens to bacterial leaf spot, Stillwater, OK, 2008.

Cultivar	Type	Bacterial leaf spot (%)[1]	
		5 June	12 June
Red Russian	kale	17.1 b	18.7 bc[2]
Darkibor	kale	0.0 d	0.0 e
Winterbor	kale	0.0 d	0.0 e
Dwarf Siberian	kale	7.1 b	27.5 a
Indian Mustard Red Giant	mustard	26.2 a	17.5 c
Mustard Miike Giant	mustard	1.2 d	3.1 e
Coho	mustard spinach	5.0 cd	4.9 de
Green Boy	mustard spinach	4.3 cd	26.7 ab
Misome	mustard spinach	0.8 d	19.2 abc
Summer Fest	mustard spinach	1.2 d	12.4 cd
Savannah	mustard spinach	9.2 c	15.0 c
Alamo	turnip	4.7 cd	6.2 de
LSD (P=0.05)[3]		5.1	4.2

[1] Percentage of leaves with symptoms.
[2] Means followed by the same letter are not statistically different at P=0.05 according to Fisher's Least Significant Difference test.
[3] Least significant difference.

Control of Bacterial Spot on Bell Pepper Cultivars

Stillwater, 2008
John Damicone and Matt Elliot, 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 antibiotics (Kasumin, Agrimycin, and GWN-9350), applied in alternation with copper (Kocide), with recommended copper based spray programs. The fungicide Tanos was included because it is reported to have bactericidal activity.

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 wheat. Granular fertilizer (57-57-57 lb/A N-P-K) and the herbicide Trifluralin 4E at 1.25 pt were incorporated prior to transplanting pepper seedlings on 5 June. The experimental design was a split plot with spray program as the whole plot treatment and pepper cultivar as the split-plot treatment. The cultivars were Aristotle (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 43 gal/A at 40 psi. Bactericides were applied on 7-day intervals from 27 June to 5 Sep. Split plots were inoculated immediately following the first application on 27 June by spraying one plant per split plot to runoff with a bacterial suspension (10^7cells per ml) of a strain of the bacterial spot pathogen isolated from a vegetable farm in Payne Co. in 2007. Tomato hornworms were controlled with Ambush 2E at 6.4 fl oz/A on 2 Aug. Rainfall during the cropping period (5 June to 15 Sep) totaled 4.8 inches in June, 5.0 inches in July, 41.32 inches in Aug, and 1.64 inches in Sep. The trial received 14 applications of sprinkler irrigation that totaled 3.75 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 of marketable peppers was determined from five harvests from 1 Aug to 15 Sep.

Results: Rainfall was near normal (30-yr avg.) in June, twice normal in July, and below normal in Aug. and Sept. Average daily temperature was near normal in June and July, but below normal during Aug and Sept. Conditions generally favored disease development, and bacterial spot increased during the trial to reach moderate levels (80% incidence and 37% defoliation) in the susceptible cultivar Jupiter by the end of the trial (Table 1). However, the trial was situated on sloped site and the 4.4 inches of rain that within a week after transplanting resulted in soil washing and apparent plant stunting from herbicide damage over plots on the low end of the site. The stunted plots never produced a full canopy and had low disease pressure and yield. Overall, the resistant cultivar Aristotle had lower levels of bacterial spot and higher yields than the susceptible cultivar Jupiter. On the cultivar Aristotle, all of the bactericide programs provided a high level of disease control compared to the untreated check. On the cultivar Jupiter, all of the bactericide programs except Kocide/GWN-9350 and Kocide/Tanos reduced bacterial spot compared to the untreated check. Kocide/Maneb and Kocide/Agrimycin provided the best disease control. Yields were highly variable and did not differ among treatments (Table 1) for either cultivar. Overall yield was higher for the resistant cultivar Aristotle X3R compared to Jupiter. However, the yield response could not be attributed to bacterial spot because there was no statistical yield effect for bactericide programs for the susceptible cultivar.

Conclusions: The X3R type of resistance from the *bs2* gene was effective against a local strain of bacterial spot. The resistance was as effective as bactericide spray programs. Of the antibiotics, Agrimycin (streptomycin sulfate) was most effective, but was not better than a recommended treatment of Kocide+Maneb. Streptomycin is currently only registered for use on peppers and tomatoes in the greenhouse transplant production.

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

Table 1. Response of resistant (Aristotle 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]		Yield (cwt/A)[4]	
	AX3R[5]	JUP[6]	AX3R	JUP	AX3R	JUP
Check…………………………….	24 a[7]	79 a	8 a	37 a	183.9	130.0
Kocide 3000 1.25 lb (1-10)…….	2 b	47 bc	0 b	16 bc	171.1	171.2
Kocide 3000 1.25 lb + Maneb 75DF 2 lb (1-10)……….	3 b	21 c	1 b	6 c	134.5	65.9
Kocide 3000 1.25 lb (<alt>) Kasumin 2L 16 fl oz ……………	0 b	44 bc	0 b	13 bc	249.1	108.0
Kocide 3000 1.25 lb (<alt>) Agrimycin 17W 0.5 lb …………	0 b	19 c	0 b	4 c	183.9	121.1
Kocide 3000 1.25 lb (<alt>) GWN-9350 3.5 lb……………….	1 b	52 ab	0 b	21 b	166.1	95.5
Kocide 3000 1.25 lb (<alt>) Tanos 50DF 8 oz………………..	1 b	63 ab	0 b	23 b	206.9	96.0
mean	4	47	1	17	185.1	111.7
$LSD_{0.05}$[7]	13	28	5	12	NS	NS

1 Sprays 1 to 10 were made on 7-day intervals beginning on from 27 June to 5 Sep; <alt> indicates alternating sprays of the two products beginning with Kocide on 27 June from sprays 1 to 10.
2 Percentage of leaves with bacterial spot including defoliation on 12 Sep.
3 Percentage of leaves with bacterial spot including defoliation on 12 Sep.
4 Marketable fruit from 5 harvests from 1 Aug to 15 Sep.
5 Cultivar Aristotle X3R.
6 Cultivar Jupiter.
7 Least significant difference; NS = treatment effect not significant at P=0.05.

Fungicide Effects on Control of Pod Decay of Snap Bean

Bixby – 2008
John Damicone and Matt Elliot, OSU Entomology and Plant Pathology

Introduction and Objective: Pod decay is a problem in the production for snap beans grown 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,* the cause of "cottony leak" on numerous vegetable crops, has been a primary cause of pod decay in previous field trials. Fungicides have not provided a high level of disease control, but Ridomil/Copper, Ranman, and Reason have performed the best in previous trials. The objective of this study was to evaluate application timings of these fungicides for control of pod decay on snap bean.

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 the cultivar Roma II on 28 Apr. Plots were top-dressed with additional granular fertilizer at 46-0-0 lb/A N-P-K as urea on 20 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 20 May. The experimental design was a randomized complete blocks with four replications. Plots consisted of two, 20-ft-long rows spaced 3 ft apart. 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. The full application program consisted of three applications (1 to 3) on 7-day intervals beginning when pin-sized pods first appeared on 4 June. Early and late reduced programs consisted of applications made on spray dates 1 and 2, and 2 and 3, respectively. Rainfall during the cropping period (28 Apr to 7 July) totaled 9.57 inches in May, 8.06 inches in June, and 0.65 inches in July. The trial was sprinkler irrigated 4 times at 0.75 to 1 inch per application. Disease incidence was assessed by counting the number of 6-inch row segments with cottony leak on 30 June. The counts were converted to the percentage of row length affected. Yield was taken on 7 July when the beans graded 125 mm (combined length of the largest seed from 10 large pods). Pods were stripped from 1 m of row and classified as either disease or healthy. A 2-lb sample of pods from each plot was enclosed in a plastic bag and incubated for 4 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: Rain was over twice normal levels in both May and June which caused prolonged periods of saturated soil which contributed to reduced plant growth and canopy development. A low level of decayed pods with white moldy growth that resembled cottony leak was present on 30 June a week prior to harvest maturity. Disease incidence as measured by the percentage of row length with symptomatic pods ranged from 4 to 9% and did not differ among treatments (Table 1). By harvest, moldy pods had dried and shriveled and the only disease apparent in the harvested pods was a dry, red-colored decay of pod tips. Isolations revealed the cause of this decay to be *Rhizoctonia solani*. Disease incidence by weight of harvested beans ranged from 4 to 12% and did not differ among treatments (Table 1). Following incubation in plastic bags, the incidence of moldy pods ranged from 6 to 18% and did not differ among treatments. Isolations from diseased pods yielded mostly *Rhizoctonia solani. Pythium* and *Phytophthora* species that cause cottony leak were not recovered from the diseased pods.

Conclusions: The fungicides tested in this trial were selected for their activity on the water-mold fungi *Pythium* and *Phytophthora* that cause cottony leak. However, cottony leak was not present at harvest or in pod samples incubated in plasic bags to simulate post-harvest disease development. Instead *Rhizoctonia solani*, the cause of web and pod tip blights of beans was the primary disease in this trial. Abound has a high level of activity on Rhizoctonia and may have been more effective than the fungicides tested. However, results are similar to those from previous trials where fungicides have not been very effective in reducing pod decay diseases in snap beans. Methods for producing greater and more uniform levels of disease are needed.

Acknowledgements: Financial support from Allen Canning Co. and ISK Biosciences is greatly appreciated.

Table 1. Effect of fungicides and application timing on control of pod decay on 'Roma II' snap beans at Bixby, OK - 2008.

Treatment and rate/A (timing[1])	Pod decay (% row)[2]	Yield (cwt/A)[3]		Nested pods (%)[4]
		healthy	diseased	
Ridomil Gold/Copper 65W 2.5 lb (1,2,3)	3.7	89.6	6.0	12.7
Ridomil Gold/Copper 65W 2.5 lb (1,2)	5.6	72.4	7.7	9.7
Ridomil Gold/Copper 65W 2.5 lb (2,3)	8.7	83.2	6.0	11.8
Ranman 3.3F 2.75 fl oz (1,2,3)	4.4	88.3	12.2	6.2
Ranman 3.3F 2.75 fl oz (1,2)	8.1	82.1	8.5	9.6
Ranman 3.3F 2.75 fl oz (2,3)	9.4	92.5	6.6	13.1
Reason 4.13F 8.2 fl oz (1,2,3)	5.0	101.6	4.2	12.1
Reason 4.13F 8.2 fl oz (1,2)	5.6	83.7	11.5	14.6
Reason 4.13F 8.2 fl oz (2,3)	5.6	91.9	6.0	12.9
Check	3.7	97.4	8.0	18.5
LSD (P=0.05)[5]	NS	NS	NS	NS

[1] Timing numbers (1 to 3) correspond to the spray dates of 1=4 June, 2=11 June, and 3=19 June.
[2] Number of 6-inch row segments with pod decay symptoms on 30 June. Counts were converted to the percentage of row length affected.
[3] From hand harvesting 1 m of row in each sub plot on 7 July. Pods were classified as healthy or disease. Diseased pods had mostly a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*. Pod grade at harvest was 125 mm (total length of the largest seed in each of 10 large pods).
[4] Percentage of pods with moldy decay from a 2-lb sample incubated in a plastic bag at room temperature for 4 days. Isolations from diseased pods yielded mostly *Rhizoctonia solani*.
[5] Fisher's Least Significant Difference. NS=treatment effect not significant at P=0.05.

Cultivar and Fungicide Effects on Snap Bean Pod Decay

Bixby – 2008
John Damicone and Matt Elliot, 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. In general, fungicides have not provided good control of pod decay. The objective of this study was to screen various snap bean cultivars for their reaction to pod decay in a field with a history of the disease. While true resistance to a general pathogen like *Pythium* may not be available, cultivars with an upright growth habit may permit plants to escape the disease. Fungicide deposition to the lower pods may also be improved with such cultivars. Therefore, cultivars were evaluated both with and without a fungicide program for pod decay. All cultivars were flat-podded romano types and included the local standard cultivar Roma II.

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 28 Apr. Plots were top-dressed with additional granular fertilizer at 46-0-0 lb/A N-P-K as urea on 20 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 20 May. The experimental design was a split plot with four replications. The whole plot treatment was cultivar while the subplot treatment was fungicide program. Whole plots consisted of four 20-ft-long rows spaced 3 ft apart. Sub-plots consisted of two rows either treated with fungicide or not. The fungicide Ranman was applied three times on 7-day intervals beginning when pin-sized pods first appeared on 4 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 (28 Apr to 7 July) totaled 9.57 inches in May, 8.06 inches in June, and 0.65 inches in July. The trial was sprinkler irrigated 4 times at 0.75 to 1 inch per application. Plant characteristics possibly related to pod decay (lodging, canopy density, and pod set height) were rated on 30 June. Disease incidence was assessed by counting the number of 6-inch row segments with cottony leak on 30 June. The counts were converted to the percentage of row length affected. Yield was taken on 7 July when pods were stripped from 1 m of row from each split plot and classified as either disease or healthy. A 2-lb sample of pods from each split plot was enclosed in a plastic bag and incubated for 4 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 was 4 inches above inches above normal (30-year average) for May and 3 inches above normal for June. Average monthly temperature was 1 to 2^{o}F below normal for May and June. The excessive rain during May and June caused prolonged periods of saturated soil which reduced plant growth and canopy development and differences in plant growth characteristics among cultivars were not great (Table 1). The cultivars with a small plant canopy (Roma II, Herrera, and Primo) tended also to have the lowest levels of lodging. Romano 942 set pods higher on the plant than the other cultivars.

Table 1. Plant characteristics and yield of snap bean cultivars evaluated for reaction to pod decay, Bixby - 2008.

Cultivar	Lodging (1-10)[1]	Canopy (1-10)[2]	Pod height (1-5)[3]	Yield (cwt/A)[4]		Grade (mm)[5]
				healthy	diseased	
Roma II	17 c[6]	2.2 c	1.2 c	67.6 c	7.3 bc	130
Tapia	36 ab	4.9 b	1.7 b	91.9 abc	10.8 b	140
Cerler	25 bc	5.1 ab	2.0 b	94.8 ab	5.4 c	132
Hererra	25 bc	2.7 c	1.7 b	72.4 bc	4.6 c	152
Primo	19 c	3.2 c	1.1 c	98.3 a	6.5 bc	127
Romano 942	39 a	6.5 a	2.7 a	104.8 a	4.4 c	145
Navarro	24 c	5.6 ab	1.9 b	94.7 ab	16.8 a	137
LSD (P=0.05)[7]	11	1.4	0.4	24.7	5.3	-

[1] Lodging score where 1 = 0% lodged, 10 = 100% lodged on 30 June.
[2] Canopy density rating where 1 = least dense, 10 = most dense on 30 June.
[3] Rating of height of lowest pods where 1 = low, 5 = high on 30 June.
[4] From hand harvesting 1 m of row in each sub plot on 7 July. Pods were classified as healthy or diseased. Diseased pods had mostly a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*.
[5] Total length of the largest seed from 10 large pods averaged over two samples per cultivar.
[6] Means in a column followed by the same letter are not statistically different.
[7] Least significant difference.

A low level of decayed pods with white moldy growth that resembled cottony leak was present on 30 June a week prior to harvest. Disease incidence as measured by the percentage of row length with symptomatic pods was less than 1% and did not differ among cultivars (Table 2). By harvest, moldy pods had dried and shriveled and the only disease apparent in the harvested pods was a dry, red-colored decay of pod tips. Isolations revealed the cause of this decay to be *Rhizoctonia solani*. Disease incidence by number of disease pods (Table 2) weight of diseased pods (Table 1) differed among cultivars. The percentage of total yield with pod decay ranged from 4% for Romano 942 to 15% for Navarro. The cultivar Navarro had higher levels of disease at harvest compared to the other cultivars. Following incubation in plastic bags, the incidence of moldy (nested) pods ranged from 2 to 15%, but did not did not differ among cultivars. Isolations from diseased pods yielded mostly *Rhizoctonia solani. Pythium* and *Phytophthora* species that cause cottony leak were not recovered from the diseased pods. Yields of healthy pods were highest for Romano 942 and lowest for Roma II (Table 1). Overall, yields were low compared to previous trials at this site.

Levels of disease measured before or at harvest were not correlated with lodging, canopy, and pod height ratings. Lodging score was weakly correlated with post-harvest disease development measured as nested pods (r=0.31, P=0.01). Levels of disease and yield did not differ between untreated sub-plots and those treated with Ranman (Table 3).

Table 2. Main effects of cultivar on pod decay of snap bean, Bixby - 2008.

Cultivar	Pod decay (% row)[1]	Diseased pods[2]	Nested pods[3]
Roma II	0.3 a[4]	9.9 b	10.4 a
Tapia	0.4 a	12.9 b	14.4 a
Cerler	0.0 a	8.0 b	5.9 a
Hererra	0.3 a	6.1 b	14.9 a
Primo	0.7 a	7.9 b	2.3 a
Romano 942	0.0 a	7.0 b	10.8 a
Navarro	0.3 a	21.2 a	5.1 a
LSD (P=0.05)[4]	NS	7.4	NS

[1] Number of 6-inch row segments with 'cottony leak' symptoms on 30 June. Counts were converted to the percentage of row length affected.
[2] Number of pods with decay at harvest on 7 July. 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 2-lb sample incubated in a plastic bag at room temperature for 4 days. Isolations from diseased pods yielded mostly *Rhizoctonia solani*.
[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.

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 plasic bags to simulate post-harvest disease development. Instead *Rhizoctonia solani*, the cause of web and pod tip blights of beans was the primary disease in this trial. Factors other than just high soil moisture must affect cottony leak development because the high levels of rainfall experienced in this trial produced prolonged periods of saturated soil that should have been favorable for spread and development of water molds such as *Pythium*. There were cultivar differences in pod decay levels among cultivars, and Romano 942, which has previously had lower levels of cottony leak, also had low levels of pod decay caused by *Rhizoctonia* in this trial. The lack of any fungicide effect in this trial was likely due in part to the known lack of activity of Ranman against *Rhizoctonia*. The fungicide Quadris has a high level of activity on *Rhizoctonia* and may have been more effective than Ranman. However, results are similar to those from previous trials where fungicides have not been very effective in reducing pod decay diseases in snap beans. Methods for producing greater and more uniform levels of cottony leak are needed.

Acknowledgements: Financial support from Allen Canning Co. and ISK Biosciences is greatly appreciated.

Table 3. Main effects of fungicide on pod decay and yield of snap bean cultivars, Bixby - 2008.

Treatment and rate/A (timing)[1]	Pod decay (% row)[2]	Diseased pods (no.)[3]	Yield (cwt/A)[4]		Nested pods (%)[5]
			healthy	diseased	
Check	0.3 a[6]	11.2 a	88.3 a	8.5 a	8.8 a
Ranman 3.3F 2.75 fl oz (1-3)	0.3 a	9.6 a	90.1 a	7.4 a	9.4 a
LSD (P=0.05)[7]	NS	NS	NS	NS	NS

[1] Application numbers (1 to 3) correspond to the spray dates of 4 June, 11 June, and 19 June.
[2] Number of 6-inch row segments with 'cottony leak' symptoms on 30 June. Counts were converted to the percentage of row length affected.
[3] Number of pods with decay at harvest on 7 July. Most diseased pods had a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*.
[4] From hand harvesting 1 m of row in each sub plot on 7 July. Pods were classified as healthy or diseased. Diseased pods had mostly a dry, reddish brown decay of the pod tips typically caused by *Rhizoctonia solani*.
[5] Percentage of pods with moldy decay from a 2-lb sample incubated in a plastic bag at room temperature for 4 days. Isolations from diseased pods yielded mostly *Rhizoctonia solani*.
[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 Watermelon Foliar Diseases

Stillwater, 2008
John Damicone and Matt Elliot, 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. Where the disease develops and fields are not protected with fungicide, the disease can cause rapid defoliation. In 2007, downy mildew became a problem in the watermelon fungicide trial that compared fungicide treatments for another disease, gummy stem blight. 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, Previcur Flex, 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. Downy mildew became severe in 2008 during September in western Oklahoma, and was present in an adjacent trial. However, powdery mildew but not downy mildew developed in this trial.

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. Granular fertilizer (50-0-0 lb/A N-P-K) was incorporated prior to direct seeding the variety 'Royal Sweet' on 3 July at a rate of 3 seeds per ft. 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 additional granular fertilizer (23-0-0 lb/A N-P-K) on 31 July. Plots were single, 20-ft-long rows spaced 15 ft apart. Plots were then thinned to a 2-ft within row spacing. Aphids were controlled with Capture 2E at 6.4 fl oz/A on 26 Aug and with Provado 1.6F at 3.8 fl oz/A on 29 Aug. 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 seven times on 7-day intervals beginning at flowering on 26 Aug. Rainfall during the cropping period (4 July to 17 Oct) totaled 5.0 inches for July, 1.32 inches for Aug, and 1.65 inches for Sep, and 1.27 inches for Oct. Plots received 17 applications of sprinkler irrigation at 0.25 to 2.0 inches per application that totaled 9.6 inches of water. Disease was assessed by visually estimating the percentage of leaves with symptoms and defoliated in three areas of each plot. Yield of marketable melons weighing 14 or more lb was taken on 17 Oct.

Results: Rainfall was above normal and average daily temperature was near normal (30-year avg.) for July. Thereafter, rainfall and temperature were below normal. Heavy rainfall (4.44 inches) fell within 10 days of planting which apparently caused herbicide damage that reduced stand establishment and reduced early-season vine growth. A severe aphid in late August further delayed the crop. Downy mildew did not develop in the trial despite its appearance on 24 Sep in an adjacent cucurbit plot on the farm designed to monitor downy mildew. Powdery mildew appeared in August and reached a moderate level by harvest (Table 1). All of the treatments reduced powdery mildew and defoliation compared to the untreated check. The full-season programs with Bravo (chlorothalonil) and LBG-31FCL (chlorothalonil + phosphorous acid) had the lowest numerical levels of disease, but disease control did not statistically differ from the other fungicide programs that used Bravo in alternation with a downy mildew fungicide. The low yields were attributed to the adverse growing conditions described above and were highly variable (c.v. = 34.4%). There was a numeric trend for reduced yield in the untreated check; however, the effect of treatment on yield was not statistically significant.

Conclusions: Preventive spray programs using broad-spectrum fungicides such as Bravo are recommended for foliar disease control in Oklahoma, but may not provide adequate disease control under heavy downy mildew pressure. The alternation of downy-mildew specific fungicides with Bravo was not beneficial in this trial because downy mildew did not develop and these fungicides have no or little activity on other disease such as powdery mildew. Disease control in this trial would have been approved by alternating Bravo, which has contact activity on powdery mildew, with a systemic fungicide such as Folicur or Nova, or Quintec which have the best powdery mildew activity.

Acknowledgements: Financial support from Syngenta Crop Protection and ISK Biosciences, and the assistance of Rocky Walker and Brian Heid 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 powdery mildew on watermelon (‘Royal Sweet’), Stillwater - 2008.

Treatment and rate/A (timing)[1]	Powdery Mildew (%) [2] 16 Oct	Defoliation (%)[3] 16 Oct	Yield (cwt/A)[4]
Check	72.5 a	50.8 a	14.7 a
Bravo 6F 2 pt (1-7)	20.8 b	7.1 b	18.3 a
Bravo 6F 2 pt (1,3,5,7) Ranman 3.3F 2.75 fl oz + Silwet L-77 2 fl oz (2,4,6)	35.0 b	16.2 b	20.5 a
Bravo 6F 2 pt (1,3,5,7) Presidio 4F 3 fl oz (2,4,6)	28.7 b	13.3 b	20.9 a
Bravo 6F 2 pt (1,3,5,7) Revus 2.08F 8 fl oz (2,4,6)	29.2 b	9.6 b	19.2 a
Bravo 6F 2 pt (1,3,5,7) Previcur Flex 6L 1.2 pt (2,4,6)	20.4 b	9.2 b	19.0 a
LBG-31FCL 4 pt (1-7)	17.9 b	10.4 b	23.3 a
Bravo 6F 2 pt (1,3,5,7) Tanos 50DF 8 fl oz (2,4,6)	27.5 b	15.0 b	23.7 a
LSD (P=0.05)[5]	20.1	19.0	NS

[1] Timing numbers 1 to 7 correspond to the spray dates of 1=26 Aug, 2=1 Sep, 3=9 Sep, 4=16 Sep, 5=23 Sep, 6=30 Sep, and 7=8 Oct.
[2] Leaves with symptoms of powdery mildew (including defoliation).
[3] Leaves defoliated from powdery mildew.
[4] Marketable melons weighing 14 lb or more taken on 17 Oct.
[5] Least significant difference. NS=treatment effect not significant.

Watermelon Foliar Fungicide Timing Trial - Lane

Jim Shrefler, Tony Goodson, Benny Bruton, and John Damicone

Introduction: Foliar diseases are a recurring 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. Effective fungicides are available for the control of these diseases. However, 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), applications based on general weather forecasts, or applying 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 applied as a preventive practice rather than as a "cure". An additional means of determining when to apply fungicides is an Anthracnose Forecaster that was developed for Anthracnose prevention in Oklahoma watermelon production. The forecaster is available on the Oklahoma Mesonet system at http://agweather.mesonet.org/horticulture/default.html. It is recommended that the forecaster be used on a trial basis until its dependability can be verified. One concern is that the forecaster is specific for anthracnose. Consequently, forecasts obtained with the forecaster do not consider the infection of watermelon 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 June 23, 2008 at the center of beds and thinned on July 17 to 1 plant per 3 feet of row. Preemergence herbicides 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 75DF 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, Dithane was used at 2 lbs. product per treated acre, Topsin at ½ lb. and Bravo Weatherstick at 1 pint. 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 later than intended and was made once fruit set became evident on July 31. Subsequent applications were made to the calendar treatments on 8-21, 9-8 and 9-26 and 10-1 and to the forecaster treatments on 8-22, 8-28, 9-8 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 on 9-9, 9-26 and 10-10. Marketable size fruits were harvested and weighed on Sept. 8 and 10-7.

Results and Discussion: Field conditions were excellent for crop establishment and early growth. However, in mid August, a prolonged period of rainfall resulted in saturated soil conditions that lasted for several days. Watermelon vines survived these saturated soil conditions but older foliage took on a wilted appearance and some of this older foliage died early. Following the wet period vines showed fairly good recovery and resumption of growth. Obvious effects of saturated soil were primarily seen on crown foliage. Because of this, disease evaluations were conducted on foliage outside of the row area.

Visible symptoms of foliar disease became evident in early September and disease was evaluated on Sept. 9, 26 and Oct. 10 (Table 1). Soon after initial observation of disease symptoms substantial defoliation was evident in the untreated check plots. These symptoms were found to be primarily anthracnose. On Sept. 9 no differences were detected for leaf spotting or defoliation among the treatments receiving fungicide. Leaf spotting was greater for the untreated plots than treated plots. Defoliation was less for the Dithane+Topsin Forecaster treatment than for the untreated plots. At Sept. 26 defoliation was very severe in untreated plots and significantly less in treated plots. Treated plots differed in defoliation with Dithane + Topsin Forecaster having less defoliation than the others. On Sept. 26 leaf spotting was greatest in the Bravo Calendar treatment. The low value in the untreated plot at this evaluation is due to the fact that evaluations were made on new leaf growth since most of the older foliage was dead. The Dithane and Topsin treatments provided better protection of foliage from disease than the Bravo treatment applied every two weeks.

At the Oct. 10 evaluation there was a major change in the disease symptoms and Downy Mildew was found to be the major source of disease. This was evidenced by infestations on younger watermelon foliage. Downy mildew on untreated watermelon is again misleading in that the only remaining foliage is new growth. Both of the forecaster treatments were provided better control of Downy Mildew than did the calendar treatments.

Watermelon yields were measured on Sept. 8 and Oct. 7 and total yields and yields for individual harvest dates are presented in Table 2. Significant differences were found among treatments for the second harvest date but not for the first or the total harvest.

Foliage loss in untreated plots of this trial was rapid with anthracnose being the major disease that was identified. The foliage that survived the anthracnose infestation was later attacked by downy mildew. All fungicide treatments provided similar control of the anthracnose infestation. While both of the forecaster treatments seemed to provide comparable control of downy mildew, the Dithane + Topsin treatment resulted in the least defoliation at the Oct. 10 evaluation. This was reflected in the greater yields found in the Oct. 7 harvest.

Table 1. Evaluation of foliar diseases in watermelon at Lane in 2008.

		Visual Disease Evaluation[1]					
		Percent defoliation[2]			**Percent leaf spot[3]**		**Downy mildew[4]**
Fungicide Treatment	**Application timing**	**9-9**	**9-26**	**10-10**	**9-9**	**9-26**	**10-10**
Untreated	-	25 a[5]	88 a	86 a	73 a	24 b	19 b
Dithane + Topsin	Calendar	17 ab	38 b	46 cd	17 b	30 b	62 a
Dithane + Topsin	Forecaster	10 b	24 c	30 d	15 b	24 b	33 b
Bravo	Calendar	18 ab	43 b	66 b	20 b	42 a	74 a
Bravo	Forecaster	19 ab	39 b	47 c	16 b	33 ab	38 b

[1] Visual evaluations where 0 = no disease or defoliation and 100 = all leaves affected.
[2] Percent defoliation refers to the portion of foliage lost from a complete canopy.
[3] Percent leaf spot is the portion of leaves with disease symptoms.
[4] Severity of downy mildew where 0=none and 100=all leaves all dead.
[5] Values in a column followed by the same letter are not significantly different ($LSD_{0.05}$).

Table 2. Fruit yield in the 2008 watermelon foliar fungicide timing trial at Lane.

		Yield (lbs. per acre)[1]		
Fungicide Treatment	**Application Timing**	**Sept. 8**	**Oct. 7**	**Total**
Untreated	---	28,516	642 b[2]	29,158
Dithane + Topsin	Calendar	31,352	1252 b	32,603
Dithane + Topsin	Forecaster	28,740	3491 a	32,230
Bravo	Calendar	32,701	1797 b	34,479
Bravo	Forecaster	33,323	654 b	33,977
		NS[3]		NS

[1] Fruits of marketable size at Sept. 8 and Oct. 7. Lowest fruit weight included is 9 lbs.
[2] Values in a column followed by the same letter are not significantly different ($LSD_{0.05}$).
[3] NS indicates no statistical differences among means within a column.

Weed Management

Cilantro Herbicide Study
Spring 2008

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Introduction and objective: Cilantro has the potential to become a new processing crop for Oklahoma producers. One of the biggest issues for new crops is the control of weeds. Growing a crop without adequate weed control will reduce crop yields because of weed competition and can render the crop unmarketable due to contamination of crop from weed debris. Studies were begun in 2006 to screen for herbicides that are effective for weed control and are safe to use on cilantro. This spring (2008) a study was completed to further refine herbicide rates and to provide additional performance data for compounds that have potential for labeling for use in cilantro production.

Methods: The study was completed at the Vegetable research station at Bixby during the spring season. Six different compounds were included in the study (Barricade, Dual Magnum, Define, Prowl H_2O, Spartan, and Lorox) at different rates for a total of 12 treatments plus weeded and un-weeded checks (Table 1). The study was initiated on 4/7/08 by planting the experimental area to the Santo variety of cilantro at an overall plant population of 25 seeds per row foot. Plots consisted of 4 rows of cilantro on 12 inch row centers and were 20 feet long. Treatments were replicated 4 times in a randomized block design. All herbicide treatments except for Lorox were applied after planting on 4/7/08 as preemergence treatments, with Lorox being applied after crop establishment as a postemergence treatment on 5/19/08. Applications were made using a hand-held spray boom with 4 nozzles and a spray width of 6 feet. Preemergence treatments were applied at an overall spray rate of 25 gallons per acre and postemergence treatments were applied at an overall rate of 30 gallons per acre. Plots were rated for crop emergence and control of Palmer amaranth on 5/19/08 and for crop damage, Palmer amaranth, and primrose control on 5/29/08. Ratings were completed as a percentage where 0 = 0% control, damage, or emergence and 100% = complete death or absence of cilantro or a given weed species or no loss of emergence.

Results and discussion: Emergence was poor for the entire study including the weeded and un-weeded checks, probably due to heavy rainfall during the establishment period i.e. several 3 to 5 inch rainfalls occurred during this time. The weeded check had the highest level of emergence at 50% while Dual Magnum at 0.975, Define at 0.6 and 0.9, Prowl H_2O at 0.75, and Spartan at 0.05 lbs. ai/acre had significantly lower emergence than the weeded check (Table 1). These treatments ranged in emergence from 8 to 22%. Control of Palmer amaranth ranged from 0 to 98% on 5/19/08. Treatments with significantly higher levels of Palmer amaranth control on 5/19/08 included all rates of Dual Magnum, Define, and Spartan, which ranged from 88 to 98% control on that date. On 5/29/08, all rates of Dual Magnum, Define, Spartan, and Lorox provided significantly higher levels of control for Palmer amaranth than the un-weeded check. These treatments had Palmer amaranth control ratings from 76 to 94% on 5/29/08. Only treatments that included Lorox were rated for primrose control due to sparse populations of this species in the other treatment's plots. Control of primrose was 48, 60, and 97% for the 0.1, 0.2, and 0.3 lb ai/acre rates of Lorox. Crop damage ratings on 5/29/08 were highest for Define at 0.9 and Spartan at 0.075 lbs. ai/acre rates, damage was 28 and 46%, respectively for these treatments.

Conclusions: The authors would conclude that based upon the results of this study, Dual Magnum, Spartan and Lorox have potential for use in cilantro. Further work is warranted for these materials utilizing higher rates and different application times to test for crop safety and weed control.

Table 1. 2008 Cilantro preemergence and postemergence herbicide study, Bixby, OK.

	% emergence		% weed control[z]						% damage[y]	
	5/19/08		5/19/08		5/29/08				5/29/08	
Treatment lbs ai/acre			**Palmer**		**Palmer**		**Primrose**			
Untreated check	30	a-b [x]	0	d	0	e	n/a		0	c
Weeded check	50	a	0	d	70	b-c	n/a		0	c
Barricade 4FL 0.66	24	a-c	71	b	53	c-d	n/a		18	b-c
Dual Magnum 0.65	26	a-c	89	a	81	a-b	n/a		11	b-c
Dual Magnum 0.975	9	b-c	95	a	91	a-b	n/a		25	a-c
Define DF 0.6	8	b-c	98	a	90	a-b	n/a		19	b-c
Define DF 0.9	9	b-c	96	a	94	a	n/a		28	a-b
Prowl H_2O 0.5	34	a-b	51	c	44	d	n/a		15	b-c
Prowl H_2O 0.75	22	b-c	60	b-c	53	c-d	n/a		20	b-c
Spartan 0.05	11	b-c	88	a	76	a-b	n/a		19	b-c
Spartan 0.075	24	a-c	93	a	89	a-b	n/a		46	a
Lorox 0.1/Post	24	a-c	n/a		79	a-b	48	a	24	a-c
Lorox 0.2/Post	32	a-b	n/a		85	a-b	60	a	23	a-c
Lorox 0.3/Post	20	b-c	n/a		86	a-b	97	a	21	b-c

[z] Weed control=percent control of Palmer (Palmer amaranth) in pre & post treatments and primrose in Lorox post treatments.
[y] % Damage to crop
[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.

Cilantro Herbicide Study
Fall 2008

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Introduction and objective: There are two herbicides that are currently labeled for use on cilantro. One is a broad spectrum preemergence herbicide and the other is a postemergence herbicide with activity on grassy weed species. Unfortunately broadleaf weed control with these materials is less than desirable and efforts are needed to find both pre and postemergence herbicides that will provide adequate control of broadleaf weeds for this crop in commercial fields. A study was completed this spring (2008) to further refine herbicide rates and to provide additional performance data for compounds that have potential for labeling for use in cilantro production. The objective of this study was to continue these efforts to provide performance data for the fall cilantro production cycle.

Methods: The study was completed at the Vegetable research station at Bixby during the fall 2008 season. Seven different compounds were included in the study (Dual Magnum, Define, Prowl H_2O, Spartan, Lorox, Prefar, and Poast) at different rates for a total of 15 treatments plus a weeded check (weeded on 9/25/08) (Table 1). The study was initiated on 8/21/08 by planting the experimental area to the Santo cilantro variety at an overall planting rate of 25 seeds per row foot. Plots included 4 rows of cilantro on 12 inch row centers 20 feet long. Treatments were replicated 4 times in a randomized block design. All treatments except for Poast and Lorox postemergence were applied after planting on 8/21/08 as preemergence treatments with the exception of Prefar which was pre-plant incorporated (PPI). Postemergence treatments were applied on 9/25/08. Both pre and post applications were made using a hand-held spray boom with 4 nozzles and a spray width of 6 feet at an overall rate of 25 gallons per acre. Plots were rated for crop emergence, injury, and control of Palmer amaranth on 9/25/08 and for crop injury and Palmer amaranth control on 10/02/08. Ratings were completed as a percentage where 0 = 0% control, damage, or emergence and 100% = complete death or absence of cilantro or a given weed species or no loss of emergence. Plots were harvested with a mechanical plot harvester on 10/20/08.

Results and discussion: No differences were observed for crop emergence on 9/25/08 (Table 1). Emergence ranged from a low of 59 to a high of 91% with a high level of variability between plots. This was more than likely due to soil temperature which was still relatively high (low to high 80's^{o}F). Crop injury was observed as reduced growth (stunting) in some treatment plots. Injury was highest on 9/25/08 for Define, Spartan, Dual Magnum at 0.975 lbs ai/acre, and Prefar at 6 lbs ai/acre pre treatments that had 21, 20, 16, and 14% injury, respectively. Highest crop injury on 10/02/08 was recorded for Spartan, Lorox 0.2 lbs ai/acre pre, and Prefar at 12 lbs ai/acre. Post treatments of Lorox for all rates had injury ratings in the single digits. Palmer amaranth (*Amaranthus palmeri) control was 90% or higher on 9/25/08 for* pre treatments including Dual Magnum, Define, Prowl H_2O 0.75 lbs ai/acre, Spartan, and Lorox 0.3 lbs ai/acre pre. On 10/02/08 Palmer amaranth control was highest for Dual Magnum, Define, Prowl H_2O, Spartan, Lorox 0.3 lbs ai/acre pre, and Lorox 0.3 lbs ai/acre post, these treatments recorded 76 to 96% control. A majority of treatments did not vary significantly in yield, more than likely due to variability in stands. Both Prowl H_2O treatments had the highest yields recorded in the study followed by Lorox 0.3 lbs ai/acre pre.

Conclusions: There are several things that the authors would conclude from these studies. First, Lorox at the rates tested appears to be very safe postemergence and possibly even preemergence. Additionally, based on other studies by the authors, Lorox postemergence rates could very likely be increased substantially from those utilized in these studies. Prefar the only labeled preemergence herbicide that was included in this work did not provide long term control of Palmer amaranth. The initial control ratings on 9/25/08 were lower for Prefar than a majority of the other pre treatments. On 10/02/08 amaranth control was lowest for Prefar at the 6.0 and 12.0 lbs ai/acre rates except for Lorox 0.1 lbs ai/acre pre. The authors would conclude that there is a need for a more effective preemergence herbicide for cilantro and would recommend future studies target both Prowl H_2O and Lorox alone and Lorox combined in tank-mixes with Prowl H_2O, Dual Magnum, and Prefar for increased preemergence control of grassy weeds.

Table 2. Fall 2008 Cilantro pre and post emergence herbicide study, Bixby, OK.

Treatment lbs ai/acre	% Emergence 9/25/08	% injury 9/25/08	% injury 10/02/08	% Palmer amaranth control[z] 9/25/08	% Palmer amaranth control[z] 10/02/08	Yield (lbs/acre) 10/20/08
Weeded check	83 a[y]	0 e	0 c	0 g	95 a	361 b
Dual Magnum 0.65 Pre	74 a	10 b-e	5 b-c	96 a-b	93 a	535 b
Dual Magnum 0.975 Pre	83 a	16 a-c	10 a-c	99 a	95 a	521 b
Define DF 0.6 Pre	61 a	21 a	10 a-c	95 a-b	96 a	441 b
Prowl H_2O 0.5 Pre	85 a	4 d-e	3 b-c	84 b-c	88 a	646 b
Prowl H_2O 0.75 Pre	90 a	3 e	1 b-c	91 a-c	76 a	1207 a
Spartan 0.05 Pre	59 a	20 a-b	20 a	90 a-c	89 a	236 b
Lorox 0.1/Pre	80 a	8 c-e	4 b-c	34 f	9 e-f	419 b
Lorox 0.2/Pre	70 a	10 b-e	19 a	70 d-e	65 a-c	241 b
Lorox 0.3/Pre	86 a	8 c-e	9 a-c	91 a-c	89 a	554 b
Prefar 6.0 PPI	69 a	14 a-d	10 a-c	66 e	38 c-e	374 b
Prefar 12.0 PPI	71 a	9 c-e	13 a-b	80 c-d	29 d-f	359 b
Poast 0.28/Post	88 a	0 e	3 b-c	0 g	3 f	466 b
Lorox 0.1/Post	90 a	0 e	6 b-c	0 g	19 d-f	354 b
Lorox 0.2/Post	91 a	0 e	6 b-c	0 g	45 c-d	376 b
Lorox 0.3/Post	74 a	0 e	7 b-c	0 g	83 a	191 b

[z] Percent control of Palmer amaranth
[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.

Safety and Effectiveness of Lorox in Cilantro

Fall 2008
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Cooperating with Schantz Farms, Custer County, Oklahoma

Introduction and objective: Cilantro has the potential to become a viable commercial crop in Oklahoma, but weed control options for this crop are limited to only one broad spectrum preemergence herbicide and one postemergence herbicide for grass control. Unfortunately neither herbicide is adequate for controlling warm or cool season broadleaf weeds which are the primary weeds that producers have to contend with. Lorox (linuron) is labeled for use in several crops related to cilantro (parsley, carrot) and has been effective in trials and commercial carrot fields in Oklahoma. The objective of this trial was to determine the crop safety aspects of Lorox when used in cilantro.

Methods: The study was conducted at Schantz Farms in SE Custer County, Oklahoma. Plots were arranged in a randomized block design with three replications, each plot consisting of 12 rows of cilantro on 6 inch row centers, rows being 20 feet long. The study included four rates (0.5, 1.0, 1.5, 2.0 lbs ai/acre) of Lorox and an untreated check (Table 1). The study was initialized on 10/03/08 with treatment postemergence applications to plots of cilantro that had been direct seeded to the cultivar Santos on 9/05/08 at a rate of 2.8 million seeds/acre. Cilantro was approximately 3 to 5 inches in height at the time of application. Applications were made using a CO_2 plot-sprayer with a hand-held boom using four flat-fan nozzles with a six feet wide spray pattern. The overall application rate for all plots was 25 gpa (gallons per acre). Plots were rated on 10/10/08 for crop injury and control of Palmer amaranth (*Amaranthus palmeri*), carpetweed (*Mollugo verticillata*), and field pennycress (*Thlaspi arvense*) and machine harvest occurred on 11/4/08 with treatment plot yields being recorded.

Results and discussion: Ratings taken on 10/10/08 exhibited no differences between treatments for crop injury or control of Palmer amaranth, carpetweed, or field pennycress (Table 1). Zero damage was recorded for all treatments when compared to the untreated check. Weed control ranged from 55 to 73% for control of Palmer amaranth, 78 to 92% for control of carpetweed, and 45 to 75% for field pennycress for the Lorox treatments. Yields ranged from 10,116 to 12,027 lbs/acre for different rates of Lorox. No yield data was collected from the untreated check due to variability in check plots, but visual observations of these plots indicated much lower potential yields than the treatment plots.
In conclusion, the authors observed no crop injury from Lorox at any of the rates used in these studies and yields of the different treatments bore this out. Our recommendation based upon these and other studies would be that Lorox has potential to be a good tool for postemergence control of broadleaf weeds in this leafy vegetable crop.

Table 1. Fall 2008 Cilantro post emergence herbicide study (Lorox), Hydro, OK.

		% Weed Control ^{z}			
Treatment lbs ai/acre	**% Damage^y**	**Palmer amaranth**	**Carpet Weed**	**Field Pennycress**	**Yield (lbs/acre)**
Untreated check	0	0 b	0 b	0 b	n/a
Lorox 0.5	0	60 a	78 a	45 a	10,680 a
Lorox 1.0	0	55 a	85 a	75 a	10,116 a
Lorox 1.5	0	63 a	88 a	62 a	12,027 a
Lorox 2.0	0	73 a	92 a	72 a	10,358 a

^{z} Weed control=percent control of pigweed (Palmer amaranth), carpet weed, and field pennycress.
^{y} % Damage to crop
^{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.

Corn Gluten Meal for Weed Control in Cowpea

Spring 2008
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Introduction and objective: Cowpea is grown primarily in Oklahoma as a processing crop for canning with some acreage utilized for fresh market peas for farmer's markets and other fresh produce outlets. In the past, weed control for this crop has been handled primarily with preemergence herbicides. Recently fresh market growers have shown interest in examining organic means of weed control including corn gluten meal as a preemergence material. The objective of this study was to further validate results from a 2006 study that utilized corn gluten meal for controlling weeds in cowpea.

Methods: The study was direct seeded to cowpea (Early Scarlet cultivar) on 7/17/08, each plot consisted of four rows on 36 inch row centers 20 feet in length. Herbicide and corn gluten meal (CGM) treatments were applied on 7/17/08. CGM treatments were applied to the two middle rows of the four row plots. Plots were arranged in a randomized complete block design utilizing four replications. Hand weeding times were recorded for the two middle rows of each plot for each weeding throughout the study. Weeded checks were hand weeded on 7/31/08. All CGM treatments, weeded checks and unweeded checks were cultivated on 8/07/08. All treatments including the one herbicide treatment were hand weeded on 8/07/08, 8/27/08, 9/28/08. The two middle rows of each of the plots were machine harvested on 10/27/08.

Results and discussion: The Dual Magnum-Pursuit herbicide treatment used significantly less time and money to provide for weed control compared to all other treatments in the study (Table 1). Hand weeding time ranged from 8 hours/acre for Dual Magnum-Pursuit to 33 hours/acre for the weeded check. CGM at 2178 lbs/acre-solid, CGM at 6534 lbs/acre-banded, and CGM at 6534 lbs/acre-solid recorded 22, 18, and 19 hours/acre of hand weeding, respectively, compared to 33 hours for the weeded check. Hand weeding costs/acre ranged from 80 to 330 dollars/acre for the herbicide treatment and the weeded check, respectively. All costs were in direct proportion to the time required for hand weeding using a cost of $10/hour for labor.

Conclusions: Based on the results, it appears that a majority of the corn gluten meal treatments had a positive effect on controlling weeds when hand weeding costs were compared. That said, there is still a wide gap between all of the CGM treatments and the preemergence herbicide treatment in the study when comparing hours and costs for hand weeding. The authors would suggest that other forms of corn gluten meal or other application means be explored to increase the effectiveness of this material for weed control and that an economic analysis be completed to review the overall costs involved in all treatments included in the study.

Table 1. Cowpea Corn gluten meal study, Bixby, OK.

Material	Rate (lbs/acre)	Application	Hand weeding[z] hours/acre	Hand weeding[z] cost/acre	Yield (lbs/ac)
Corn gluten meal	2178	Banded	26 a-b	$260 a-b	1258 a
Corn gluten meal	2178	Solid	22 b-c	$220 b-c	1760 a
Corn gluten meal	6534	Banded	18 c	$180 c	1350 a
Corn gluten meal	6534	Solid	19 c	$190 c	1124 a
Weeded Check	NA	NA	33 a	$330 a	1302 a
Weedy check	NA	NA	27 a-b	$270 a-b	1254 a
Dual Magnum + Pursuit	0.75 + 0.063	Solid	8 d	$80 d	1356 a

[z] Hand weeding costs were estimated using a cost of $10.00/hour.
[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.

Preemergence Herbicide Efficacy on Cowpea

Spring 2008
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Robert Havener, Robert Adams
Oklahoma State University

Introduction and objective: Cowpea is a major vegetable crop within Oklahoma. Weed control for cowpea is challenging because of the limited number of herbicides and because of the development of herbicide resistant weed species. Herbicide resistant populations of Palmer amaranth currently exist in the state. Because of this, it is important that efforts be initiated toward finding new weed control chemistries for this crop. The objective of this study was to determine the effectiveness of several herbicides applied preplant and preemergence at different rates on cowpea compared to a standard weed control program.

Methods: The study was completed at the Vegetable research station in Bixby during summer 2008. Four compounds at two rates alone and one rate of each tank-mixed with Dual Magnum were compared to a Dual Magnum-Pursuit tank-mix. All treatments had two different application times (Preplant and Pre following planting) providing 26 separate treatments (Table 1). The study was initiated on 7/03/08 by overseeding all plots with four different weed species including: Large crabgrass (*Digitaria sanguinalis*) (1.4 million seed/acre); Barnyardgrass (*Echinochloa crusgalli*) (600,000 seed/acre); Velvetleaf (*Abutilon theophrasti Medic*.) (280,000 seed/acre); morningglory species (*Ipomoea species*) (72,600 seed/acre). Although Palmer amaranth (*Amaranthus palmeri*) was not seeded into the study plots, an ample population for study purposes exists on the research station. Following overseeding, a drag harrow was utilized to cover weed seeds prior to applying preplant treatments. Thirteen preplant treatments were applied on 7/03/08. All plots were direct seeded on 7/16/08 to four rows of Early Scarlet cowpea on 36" row centers at an overall planting rate of 6 seeds/row foot. Following planting, preemergence treatments were applied on 7/16/08 using the same sprayer and application rates used for preplant applications. The entire study area received an additional application on 7/16/08 of glyphosate at 0.75 lbs ai/acre to control existing weeds that had germinated prior to planting and the application of preemergence treatments. All applications were made using a tractor mounted research sprayer with a 12' wide spray boom and an overall spray rate of 27 gallons per acre. Treatments were replicated 4 times in a randomized block design. Plots were rated for crop injury on 7/31/08, 8/21/08, and 9/02/08, counts of crop plants in the two middle rows/plot and percentage of flowering ratings were recorded on 9/02/08, and yields were recorded on 10/27/08. Ratings for control of the four planted weed species and Palmer amaranth were recorded on 7/15/08, 8/21/08, and 9/02/08, counts of each weed species were recorded on 9/02/08. Weed control and crop injury ratings were completed as a percentage where 0 = 0% control or damage, or emergence and 100% = complete crop or weed death or absence of a given weed species.

Results and discussion: Crop injury ratings on 8/21/08 and 9/02/08 were higher for Valor at 0.375 lbs ai/acre preemergence compared to all other treatments (Table 1). Although no differences in plant numbers, percent flowering or yield were recorded, Valor at 0.375 lbs ai/acre preemergence had the lowest percent flowering and yield of all treatments.

Palmer amaranth control varied only at the first rating on 7/15/08 (Table 2). On that date, all preemergence treatments had significantly less control for Palmer amaranth than the majority of preplant treatments. Number of Palmer amaranth was only higher for Sandea at 0.048 lbs ai/acre preplant on 9/02/08.

Morningglory control varied on each of the three rating dates (Table 3). On 7/15/08, preplant treatments of Valor at 0.375 lbs ai/acre, Spartan at 0.188 and 0.375, Valor + Dual Magnum, and Spartan + Dual Magnum had 89-98% control of morningglory. Morningglory control on 8/21/08 was highest for preplant applications of Valor at 0.375 lbs ai/acre, Spartan at 0.188 and 0.375, Sandea at 0.048, Valor + Dual Magnum, Spartan + Dual Magnum, and preemergence applications of Valor at 0.375 lbs ai/acre and Reflex at 0.375. These treatments had morningglory control ratings from 96 to 100% control. On 9/02/08 control of morningglory was highest for preplant applications of Valor at 0.375 lbs ai/acre, Spartan at 0.375, Sandea at 0.048, Valor + Dual Magnum, Spartan + Dual Magnum, and preemergence applications of Valor at 0.375 lbs ai/acre, Reflex at 0.375, Spartan at 0.188, Reflex + Dual Magnum, Valor + Dual Magnum, and Spartan + Dual Magnum which ranged between 96 to 100% control. The number of morningglory was higher only for Sandea at 0.024 lbs ai/acre pre on 9/02/08.

All treatments performed well in controlling crabgrass, only on 8/21/08 were there any differences between treatments for control (Table 4). On 8/21/08, Reflex at 0.375 lbs ai/acre preplant and Sandea 0.048 preplant had ratings that were lower than some of the other treatments. Crabgrass control for these two treatments on

8/21/08 was 85 and 86%, respectively. No differences were recorded between treatments regarding the number of crabgrass plants counted on 9/02/08.
Barnyardgrass control varied for treatments on 8/21/08 and 9/02/08 (Table 5). On 8/21/08 Pursuit + Dual Magnum preplant and Reflex + Dual Magnum, and Valor + Dual Magnum preemergence had the highest control ratings for Barnyardgrass with ratings of 95, 94, and 98%, respectively. Control ratings on 9/02/08 were highest for Pursuit + Dual Magnum preplant that recorded 93% control of Barnyardgrass. The highest counts for Barnyardgrass on 9/02/08 were for preplant treatments of Sandea. The 0.024 and 0.048 lbs ai/acre preplant treatments of Sandea had 11.3 and 9.5 Barnyardgrass plants, respectively.
Velvetleaf control varied between treatments on 7/15/08 only (Table 6). Preplant treatments that included Valor at 0.188 and 0.375 lbs ai/acre, Spartan at 0.188 and 0.375, Valor + Dual Magnum, and Spartan + Dual magnum had control ratings that were 100, 100, 96, 96, 100, and 100%, respectively on 7/15/08.

Conclusions: Overall it appears that all treatments were safe for use in cowpea except for preemergence applications of Valor at the 0.375 lbs ai/acre rate which had higher levels of crop damage and a tendency for yield reduction. The first weed control rating for all broadleaf weed species showed a marked difference between the preplant and preemergence treatment groups. By the second rating fewer differences were seen between the preplant and preemergence treatments due to the effect of the post-plant glyphosate application. This should provide some evidence that these materials lack postemergence activity. Barnyardgrass control was highest for the Pursuit + Dual Magnum preplant treatment, but also was good for the Pursuit + Dual Magnum preemergence treatment which recorded no Barnyardgrass in the 9/02/08 plant counts. As a result of what was observed through the study, the authors would conclude that Reflex, Spartan, and Sandea show promise as preplant and preemergence treatments for cowpea crops and that when combined with Dual Magnum they are safe for use on this crop. Further, we would recommend that several of the more promising treatments be demonstrated on commercial production sites.

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Table 1. Crop injury, plant numbers, flowering, and yield of preplant and preemergence herbicide applications on cowpea, Bixby, OK, 2008.

Treatment		% Injury[y]			Number	%	Yield
lbs. ai/acre	Timing[z]	7/31/08	8/21/08	9/2/08	Plants[x]	Flowers[y]	(lbs/ac)
Valor 0.188	Preplant	10 a[w]	3 a	0 a	120 a	80 a	1066 a
Valor 0.375	Preplant	10 a	6 a	8 a	131 a	79 a	956 a
Reflex 0.188	Preplant	5 a	0 a	4 a	136 a	83 a	984 a
Reflex 0.375	Preplant	8 a	6 a	5 a	134 a	81 a	1015 a
Spartan 0.188	Preplant	9 a	6 a	3 a	148 a	83 a	1100 a
Spartan 0.375	Preplant	13 a	4 a	0 a	132 a	83 a	977 a
Sandea 0.024	Preplant	6 a	5 a	3 a	146 a	80 a	984 a
Sandea 0.048	Preplant	13 a	3 a	1 a	129 a	83 a	1296 a
Pursuit 0.063 + Dual Magnum 0.75	Preplant	6 a	1 a	0 a	147 a	81 a	951 a
Reflex 0.188 + Dual Magnum 0.75	Preplant	5 a	4 a	3 a	118 a	81 a	1065 a
Valor 0.188 + Dual Magnum 0.75	Preplant	11 a	3 a	1 a	135 a	81 a	899 a
Spartan 0.188 + Dual Magnum 0.75	Preplant	13 a	4 a	0 a	121 a	83 a	830 a
Sandea 0.048 + Dual Magnum 0.75	Preplant	9 a	3 a	0 a	141 a	83 a	1153 a
Valor 0.188	Preemergence	6 a	6 a	3 a	142 a	78 a	982 a
Valor 0.375	Preemergence	9 a	23 b	18 b	132 a	73 a	719 a
Reflex 0.188	Preemergence	14 a	8 a	6 a	130 a	80 a	997 a
Reflex 0.375	Preemergence	6 a	3 a	3 a	123 a	80 a	918 a
Spartan 0.188	Preemergence	6 a	0 a	0 a	156 a	80 a	976 a
Spartan 0.375	Preemergence	8 a	1 a	0 a	131 a	79 a	870 a
Sandea 0.024	Preemergence	11 a	3 a	0 a	142 a	81 a	1001 a
Sandea 0.048	Preemergence	4 a	1 a	0 a	147 a	83 a	990 a
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	5 a	0 a	0 a	153 a	85 a	806 a
Reflex 0.188 + Dual Magnum 0.75	Preemergence	5 a	5 a	4 a	137 a	80 a	970 a
Valor 0.188 + Dual Magnum 0.75	Preemergence	9 a	8 a	3 a	146 a	80 a	936 a
Spartan 0.188 + Dual Magnum 0.75	Preemergence	10 a	1 a	0 a	129 a	83 a	1098 a
Sandea 0.048 + Dual Magnum 0.75	Preemergence	4 a	6 a	0 a	127 a	84 a	986 a

[z] Timing=13 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] % injury to cowpeas, % flowering of cowpeas.
[x] Number of plants in 2 – 20' rows
[w] 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. Efficacy of preplant and preemergence herbicide applications on Palmer amaranth, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	% Palmer amaranth control 7/15/08	8/21/08	9/2/08	Number Palmer amaranth[y]
Valor 0.188	Preplant	100 a[x]	100 a	100 a	0.0 b
Valor 0.375	Preplant	100 a	100 a	100 a	0.0 b
Reflex 0.188	Preplant	100 a	98 a	96 a	0.0 b
Reflex 0.375	Preplant	75 a-b	83 a	80 a	0.0 b
Spartan 0.188	Preplant	100 a	100 a	100 a	0.0 b
Spartan 0.375	Preplant	98 a	100 a	100 a	0.0 b
Sandea 0.024	Preplant	98 a	90 a	85 a	0.3 b
Sandea 0.048	Preplant	95 a	95 a	83 a	1.0 a
Pursuit 0.063 + Dual Magnum 0.75	Preplant	100 a	100 a	98 a	0.0 b
Reflex 0.188 + Dual Magnum 0.75	Preplant	100 a	90 a	79 a	0.5 b
Valor 0.188 + Dual Magnum 0.75	Preplant	100 a	95 a	94 a	0.0 b
Spartan 0.188 + Dual Magnum 0.75	Preplant	100 a	100 a	100 a	0.0 b
Sandea 0.048 + Dual Magnum 0.75	Preplant	100 a	99 a	99 a	0.0 b
Valor 0.188	Preemergence	28 b-c	95 a	93 a	0.0 b
Valor 0.375	Preemergence	45 a-c	100 a	100 a	0.0 b
Reflex 0.188	Preemergence	50 a-c	94 a	93 a	0.0 b
Reflex 0.375	Preemergence	50 a-c	96 a	95 a	0.0 b
Spartan 0.188	Preemergence	45 a-c	98 a	94 a	0.0 b
Spartan 0.375	Preemergence	33 b-c	100 a	100 a	0.0 b
Sandea 0.024	Preemergence	8 c	94 a	91 a	0.0 b
Sandea 0.048	Preemergence	28 b-c	98 a	94 a	0.0 b
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	31 b-c	100 a	100 a	0.0 b
Reflex 0.188 + Dual Magnum 0.75	Preemergence	8 c	100 a	100 a	0.0 b
Valor 0.188 + Dual Magnum 0.75	Preemergence	3 c	100 a	100 a	0.0 b
Spartan 0.188 + Dual Magnum 0.75	Preemergence	26 b-c	98 a	98 a	0.0 b
Sandea 0.048 + Dual Magnum 0.75	Preemergence	38 b-c	91 a	81 a	0.0 b

[z] Timing=12 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] Number of live palmer amaranth in 1.1 feet ^{2} on 9/02/08.
[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.

Table 3. Efficacy of preplant and preemergence herbicide applications on morningglory, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	% Morningglory control 7/15/08	8/21/08	9/2/08	Number Morningglory[y]
Valor 0.188	Preplant	58 b[x]	95 a-c	89 a-c	0.3 c
Valor 0.375	Preplant	95 a	100 a	100 a	0.0 c
Reflex 0.188	Preplant	30 c	83 a-d	81 a-c	0.5 b-c
Reflex 0.375	Preplant	35 b-c	61 d	65 c	0.3 c
Spartan 0.188	Preplant	94 a	100 a	95 a-b	0.0 c
Spartan 0.375	Preplant	98 a	100 a	100 a	0.0 c
Sandea 0.024	Preplant	49 b-c	88 a-c	80 a-c	0.8 a-c
Sandea 0.048	Preplant	43 b-c	96 a	96 a	0.0 c
Pursuit 0.063 + Dual Magnum 0.75	Preplant	48 b-c	91 a-c	91 a-c	0.8 a-c
Reflex 0.188 + Dual Magnum 0.75	Preplant	44 b-c	80 a-d	74 a-c	0.5 b-c
Valor 0.188 + Dual Magnum 0.75	Preplant	91 a	100 a	96 a	0.3 c
Spartan 0.188 + Dual Magnum 0.75	Preplant	89 a	100 a	100 a	0.0 c
Sandea 0.048 + Dual Magnum 0.75	Preplant	54 b-c	99 a	95 a-b	0.3 c
Valor 0.188	Preemergence	0 d	94 a-c	95 a-b	0.0 c
Valor 0.375	Preemergence	0 d	100 a	98 a	0.0 c
Reflex 0.188	Preemergence	0 d	74 b-d	76 a-c	0.8 a-c
Reflex 0.375	Preemergence	0 d	99 a	98 a	0.0 c
Spartan 0.188	Preemergence	0 d	98 a	96 a	0.0 c
Spartan 0.375	Preemergence	0 d	95 a-c	93 a-c	0.0 c
Sandea 0.024	Preemergence	0 d	81 a-d	75 a-c	1.5 a
Sandea 0.048	Preemergence	0 d	73 c-d	66 b-c	1.0 a-c
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	0 d	79 a-d	75 a-c	1.3 a-b
Reflex 0.188 + Dual Magnum 0.75	Preemergence	0 d	80 a-d	100 a	0.8 a-c
Valor 0.188 + Dual Magnum 0.75	Preemergence	0 d	99 a	98 a	0.0 c
Spartan 0.188 + Dual Magnum 0.75	Preemergence	0 d	99 a	98 a	0.0 c
Sandea 0.048 + Dual Magnum 0.75	Preemergence	0 d	85 a-c	73 a-c	0.5 b-c

[z] Timing=13 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] Number of live morningglory in 1.1 feet ^{2} on 9/02/08.
[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.

Table 4. Efficacy of preplant and preemergence herbicide applications on crabgrass, Bixby, OK, 2008.

Treatment		% Crabgrass control			Number
lbs. ai/acre	Timing[z]	7/15/08	8/21/08	9/2/08	Crabgrass[y]
Valor 0.188	Preplant	100 a[x]	93 a-d	94 a	0.3 a
Valor 0.375	Preplant	100 a	96 a-b	94 a	1.0 a
Reflex 0.188	Preplant	100 a	96 a-b	80 a	0.0 a
Reflex 0.375	Preplant	100 a	85 d	75 a	0.3 a
Spartan 0.188	Preplant	100 a	93 a-d	94 a	0.0 a
Spartan 0.375	Preplant	100 a	96 a-b	95 a	0.3 a
Sandea 0.024	Preplant	100 a	93 a-d	90 a	1.0 a
Sandea 0.048	Preplant	100 a	86 c-d	89 a	0.0 a
Pursuit 0.063 + Dual Magnum 0.75	Preplant	100 a	99 a-b	98 a	0.5 a
Reflex 0.188 + Dual Magnum 0.75	Preplant	100 a	91 a-d	89 a	1.3 a
Valor 0.188 + Dual Magnum 0.75	Preplant	100 a	96 a-b	85 a	0.0 a
Spartan 0.188 + Dual Magnum 0.75	Preplant	100 a	91 a-d	91 a	0.5 a
Sandea 0.048 + Dual Magnum 0.75	Preplant	100 a	90 b-d	89 a	0.5 a
Valor 0.188	Preemergence	100 a	98 a-b	95 a	0.0 a
Valor 0.375	Preemergence	100 a	95 a-c	98 a	0.0 a
Reflex 0.188	Preemergence	100 a	99 a-b	98 a	0.0 a
Reflex 0.375	Preemergence	100 a	99 a-b	99 a	0.0 a
Spartan 0.188	Preemergence	100 a	95 a-c	94 a	0.5 a
Spartan 0.375	Preemergence	100 a	98 a-b	96 a	0.0 a
Sandea 0.024	Preemergence	100 a	95 a-c	91 a	1.8 a
Sandea 0.048	Preemergence	100 a	96 a-b	90 a	1.0 a
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	100 a	100 a	93 a	0.3 a
Reflex 0.188 + Dual Magnum 0.75	Preemergence	100 a	98 a-b	99 a	0.3 a
Valor 0.188 + Dual Magnum 0.75	Preemergence	100 a	98 a-b	100 a	0.0 a
Spartan 0.188 + Dual Magnum 0.75	Preemergence	100 a	98 a-b	99 a	0.0 a
Sandea 0.048 + Dual Magnum 0.75	Preemergence	100 a	96 a-b	99 a	0.0 a

[z] Timing=13 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] Number of live crabgrass in 1.1 $feet^2$ on 9/02/08.
[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.

Table 5. Efficacy of preplant and preemergence herbicide applications on barnyardgrass, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	% Barnyardgrass control 7/15/08	% Barnyardgrass control 8/21/08	% Barnyardgrass control 9/2/08	Number Barnyardgrass[y]
Valor 0.188	Preplant	100 a[x]	80 d-f	71 b-g	2.3 d-g
Valor 0.375	Preplant	100 a	89 a-d	89 a-b	1.0 f-g
Reflex 0.188	Preplant	100 a	69 g	55 g-j	6.3 b-d
Reflex 0.375	Preplant	78 a	73 f-g	56 g-j	7.5 a-c
Spartan 0.188	Preplant	100 a	81 c-f	49 i-j	4.3 c-g
Spartan 0.375	Preplant	100 a	90 a-d	79 a-e	4.5 c-g
Sandea 0.024	Preplant	100 a	69 g	39 j	11.3 a
Sandea 0.048	Preplant	100 a	81 c-f	53 h-j	9.5 a-b
Pursuit 0.063 + Dual Magnum 0.75	Preplant	100 a	95 a	93 a	2.0 d-g
Reflex 0.188 + Dual Magnum 0.75	Preplant	100 a	73 f-g	59 f-i	3.8 c-g
Valor 0.188 + Dual Magnum 0.75	Preplant	100 a	91 a-c	78 a-e	2.0 d-g
Spartan 0.188 + Dual Magnum 0.75	Preplant	100 a	83 b-f	70 c-h	5.5 b-f
Sandea 0.048 + Dual Magnum 0.75	Preplant	100 a	90 a-d	80 a-d	5.0 b-f
Valor 0.188	Preemergence	100 a	78 e-g	70 c-h	1.3 e-g
Valor 0.375	Preemergence	100 a	88 a-e	79 a-e	2.0 d-g
Reflex 0.188	Preemergence	100 a	68 g	49 i-j	4.8 b-g
Reflex 0.375	Preemergence	100 a	73 f-g	66 d-i	3.3 c-g
Spartan 0.188	Preemergence	100 a	73 f-g	55 g-j	3.3 c-g
Spartan 0.375	Preemergence	100 a	80 d-f	75 a-f	2.0 d-g
Sandea 0.024	Preemergence	100 a	76 f-g	61 e-i	6.5 b-d
Sandea 0.048	Preemergence	100 a	76 f-g	61 e-i	4.8 b-g
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	100 a	93 a-b	89 a-b	0.0 g
Reflex 0.188 + Dual Magnum 0.75	Preemergence	100 a	94 a	88 a-c	2.3 d-g
Valor 0.188 + Dual Magnum 0.75	Preemergence	100 a	98 a	88 a-c	1.8 d-g
Spartan 0.188 + Dual Magnum 0.75	Preemergence	100 a	91 a-c	88 a-c	2.3 d-g
Sandea 0.048 + Dual Magnum 0.75	Preemergence	100 a	88 a-e	83 a-d	1.3 e-g

[z] Timing=12 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] Number of live barnyardgrass in 1.1 feet ^{2} on 9/02/08.
[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.

Table 6. Efficacy of preplant and preemergence herbicide applications on velvetleaf, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	% Velvetleaf control 7/15/08	8/21/08	9/2/08	Number Velvetleaf[y]
Valor 0.188	Preplant	100 a[x]	100 a	98 a	0.0 b
Valor 0.375	Preplant	100 a	100 a	100 a	0.0 b
Reflex 0.188	Preplant	89 a-b	98 a	88 a	0.5 a-b
Reflex 0.375	Preplant	66 b-d	96 a	66 b	1.0 a
Spartan 0.188	Preplant	96 a	99 a	95 a	0.3 b
Spartan 0.375	Preplant	96 a	100 a	100 a	0.0 b
Sandea 0.024	Preplant	45 d-e	96 a	91 a	0.5 a-b
Sandea 0.048	Preplant	63 c-d	95 a	94 a	0.0 b
Pursuit 0.063 + Dual Magnum 0.75	Preplant	83 a-c	100 a	100 a	0.0 b
Reflex 0.188 + Dual Magnum 0.75	Preplant	91 a-b	93 a	93 a	0.0 b
Valor 0.188 + Dual Magnum 0.75	Preplant	100 a	100 a	100 a	0.0 b
Spartan 0.188 + Dual Magnum 0.75	Preplant	100 a	99 a	100 a	0.0 b
Sandea 0.048 + Dual Magnum 0.75	Preplant	85 a-c	98 a	96 a	0.0 b
Valor 0.188	Preemergence	0 f	99 a	100 a	0.0 b
Valor 0.375	Preemergence	0 f	100 a	96 a	0.0 b
Reflex 0.188	Preemergence	0 f	93 a	89 a	0.0 b
Reflex 0.375	Preemergence	0 f	94 a	88 a	0.5 a-b
Spartan 0.188	Preemergence	0 f	96 a	95 a	0.0 b
Spartan 0.375	Preemergence	25 e-f	98 a	98 a	0.0 b
Sandea 0.024	Preemergence	0 f	88 a	89 a	0.0 b
Sandea 0.048	Preemergence	0 f	99 a	96 a	0.5 a-b
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	0 f	96 a	100 a	0.0 b
Reflex 0.188 + Dual Magnum 0.75	Preemergence	0 f	96 a	96 a	0.0 b
Valor 0.188 + Dual Magnum 0.75	Preemergence	0 f	100 a	99 a	0.0 b
Spartan 0.188 + Dual Magnum 0.75	Preemergence	0 f	100 a	95 a	0.0 b
Sandea 0.048 + Dual Magnum 0.75	Preemergence	0 f	94 a	93 a	0.0 b

[z] Timing=13 days preplant = 7/3/08, Preemergence=7/16/08 following seeding
[y] Number of live velvetleaf in 1.1 $feet^2$ on 9/02/08.
[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.

Preemergence Herbicide Crop Safety on Cowpea

Spring 2008
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Robert Havener, Robert Adams
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Introduction and objective: Cowpea is a major vegetable crop within Oklahoma. Weed control for cowpea is challenging because of the limited number of herbicides. An integral part of discovering new herbicides for crop use is determining if they are safe for use on a particular crop. The objective of this study was to determine the safety of several herbicides applied preplant and preemergence at different rates on cowpea compared to a standard weed control program.

Methods: The study was completed at the Vegetable research station in Bixby during summer 2008. Four compounds at two rates alone were compared to a Dual Magnum-Pursuit tank-mix. All treatments had two different application times (Preplant and Pre following planting) providing 18 separate treatments (Table 1). The study was initiated on 7/03/08 Nine preplant treatments were applied on 7/03/08. All plots were direct seeded on 7/17/08 to four rows of Early Scarlet cowpea on 36" row centers at an overall planting rate of 6 seeds/row foot. Following planting, nine preemergence treatments were applied on 7/17/08 using the same sprayer and application rates used for preplant applications. The entire study area received two additional applications on 7/17/08. The first one utilized glyphosate at 0.75 lbs ai/acre to control existing weeds that had germinated prior to planting. The second application consisted of a tank-mix of Dual Magnum at 0.75 lbs ai/acre and Pursuit at 0.063 lbs ai/acre over the top of preplant and preemergence treatments except for the Dual Magnum + Pursuit treatment plots for overall weed control in the study. All applications were made using a tractor mounted research sprayer with a 12' wide spray boom and an overall spray rate of 25 gallons per acre. Treatments were replicated 4 times in a randomized block design. Plots were rated for crop injury on 7/31/08, 8/21/08, and 9/02/08 and counts of crop plants in the two middle rows/plot on 7/31/08. The percentage of flowering ratings were recorded on 9/02/08 and yields were recorded on 10/27/08. Crop injury ratings were completed as a percentage where 0 = 0% damage, or emergence and 100% = complete crop death. Weed counts were made on 7/15/08 and were the number of weeds counted in a 1.1 ft^2 area within a given plot, they were made on naturally occurring weed populations.

Results and discussion: On the three different dates that crop injury ratings were taken there was only one treatment that had higher levels of injury compared to the Dual Magnum + Pursuit tank-mixes and other single herbicide treatments (Table 1). Valor at 0.375 lbs ai/acre preemergence had injury ratings of 28 and 20%, respectively on 8/21/08 and 9/02/08. This compares to all other treatments that had injury ratings of less than 10% for those days. There were no differences observed for the number of plants, percent flowering, or yield for treatments in the study.

Weed control was not a planned aspect of this study, but counts of Palmer amaranth and morningglory species were made on 9/02/08. Differences were observed for numbers of Palmer amaranth, but not for morningglory (Table 2). Several of the preemergence treatments had higher numbers of amaranth than the preplant treatments. Spartan at 0.188 and 0.375 lbs ai/acre preemergence had 41 and 33 Palmer amaranth, respectively, compared to zero for all preplant treatments. Several other preemergence treatments had counts in the double digits although not all varied significantly from the preplant treatments.

Conclusions: Based upon the results of this study, the authors would recommend that commercial field trials be utilized to further determine the crop safety of the herbicides included in this year's study. Furthermore it appears that preplant application provided for higher levels of crop safety particularly for Valor and that control of Palmer amaranth was also improved by preplant application.

Acknowledgements: The authors would like to thank Bob Heister for combining the peas and Allen Canning for financial support.

Table 1. Crop safety of preplant and preemergence herbicide applications on cowpea, weed, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	% Injury[y] 7/31/08	8/21/08	9/2/08	Number Plants[x]	% Flowers[y]	Yield (lbs/ac)
Valor 0.188	Preplant	8 a[w]	4 b-c	1 b	119 a	83 a	864 a
Valor 0.375	Preplant	3 a	3 b-c	3 b	120 a	81 a	1144 a
Reflex 0.188	Preplant	5 a	1 b-c	0 b	116 a	81 a	1169 a
Reflex 0.375	Preplant	5 a	3 b-c	5 b	123 a	80 a	982 a
Spartan 0.188	Preplant	4 a	4 b-c	0 b	129 a	79 a	1057 a
Spartan 0.375	Preplant	10 a	3 b-c	0 b	127 a	79 a	1379 a
Sandea 0.024	Preplant	5 a	3 b-c	0 b	127 a	86 a	1091 a
Sandea 0.048	Preplant	6 a	1 b-c	3 b	110 a	81 a	1084 a
Pursuit 0.063 + Dual Magnum 0.75	Preplant	3 a	4 b-c	4 b	101 a	84 a	596 a
Valor 0.188	Preemergence	3 a	11 b	0 b	140 a	81 a	1306 a
Valor 0.375	Preemergence	3 a	28 a	20 a	129 a	60 b	1112 a
Reflex 0.188	Preemergence	5 a	3 b-c	1 b	114 a	85 a	1122 a
Reflex 0.375	Preemergence	0 a	3 b-c	3 b	144 a	84 a	1018 a
Spartan 0.188	Preemergence	3 a	4 b-c	1 b	130 a	83 a	1180 a
Spartan 0.375	Preemergence	0 a	0 c	0 b	136 a	83 a	1213 a
Sandea 0.024	Preemergence	0 a	1 b-c	0 b	116 a	83 a	1121 a
Sandea 0.048	Preemergence	0 a	3 b-c	1 b	124 a	83 a	809 a
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	3 a	5 b-c	3 b	131 a	79 a	1255 a

[z] Timing: preplant = 7/9/08, preemergence following planting = 7/16/08
[y] % injury to cowpeas, % flowering of cowpeas on 9/2/08.
[x] Number of plants in 2 – 20' rows counts on 7/31/08
[w] 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. Efficacy of preplant and preemergence herbicide applications to cowpea, Bixby, OK, 2008.

Treatment lbs. ai/acre	Timing[z]	Number Palmer amaranth[y]	Number Morningglory[y]
Valor 0.188	Preplant	0 c[x]	0.0 a
Valor 0.375	Preplant	0 c	0.0 a
Reflex 0.188	Preplant	0 c	0.0 a
Reflex 0.375	Preplant	0 c	0.0 a
Spartan 0.188	Preplant	0 c	0.0 a
Spartan 0.375	Preplant	0 c	0.0 a
Sandea 0.024	Preplant	0 c	0.0 a
Sandea 0.048	Preplant	0 c	0.0 a
Pursuit 0.063 + Dual Magnum 0.75	Preplant	0 c	0.0 a
Valor 0.188	Preemergence	16 b-c	0.0 a
Valor 0.375	Preemergence	9 c	0.5 a
Reflex 0.188	Preemergence	13 b-c	0.3 a
Reflex 0.375	Preemergence	9 c	0.0 a
Spartan 0.188	Preemergence	41 a	0.8 a
Spartan 0.375	Preemergence	33 a-b	0.3 a
Sandea 0.024	Preemergence	22 a-c	1.0 a
Sandea 0.048	Preemergence	12 b-c	1.3 a
Pursuit 0.063 + Dual Magnum 0.75	Preemergence	3 c	0.5 a

[z] Timing: preplant = 7/9/08, preemergence following planting=7/16/08
[y] Number of Palmer amaranth and morningglory in a 1.1ft^2 area
[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.

Matran (50% Clove Oil) Broadcast Application for Broadleaf Weed Control in Spring-Transplanted Onions

Charles L. Webber III[a] and James W. Shrefler[b]
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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.

Although previous studies yielded important information concerning use of clove oil 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 clove oil on weed control efficacy, crop injury, and yields.

Materials and Methods: The field experiment was conducted Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2008 into 2 rows per 6 ft-wide raised beds. Each research plot consisted of two onion rows per 10 ft length of bed. The experiment included 6 weed control treatments (2 application rates, 2 hand-weeding levels, 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 clove oil on the broadleaf weeds. Matran EC [1, 2] (50% clove oil) was applied at two rates, 5 and 7% v/v with Biolink[3] (0.25% v/v) as an adjuvant, over-the-top broadcast application on May 3, 2008, 44 days after transplanting (DATr) using a tractor mounted CO2 sprayer equipped with four extended range, stainless steel, 0.20 gallons/min nozzles[4] on 20-inch spacings at a spraying height of 19 inches at 50 gpa. The two weed control treatments within each application rate (5 and 7% 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 2, 10, 18, 26, 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

[1] Matran EC, 50% Clove Oil, EcoSMART Technologies, Inc., 3600 Mansell Road, Suite 150, Alpharetta, GA 30022.

[2] 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.

[3] Organic BioLink Surfactant and Penetrant, 30% Yucca extract and 10% Garlic extract, Westbridge Agricultural Products, 1150 Joshua Way, Vista, CA 92081.

[4] XR TeeJet, XR8002VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

Onions were harvested on June 09, 2008, 81 days after transplanting (37 DAT), 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[5] and mean separation using LSD with P=0.05.

Results and Discussions:

Rainfall
Rainfall during the 2008 growing season, from transplanting to harvest (81 days), was 13.87 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 9) is 13.77 inches.

Weed Control
The experiment had very high weed densities with multiple broadleaf species. The 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 vinegar 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 here.

Weed control from Matran treatments peaked at 2 DAT, averaging 53 and 60% total broadleaf weed control for the 5 and 7% application rates without hand-weeding (Table 1). Weed control for the 5 and 7% treatments without hand-weeding decreased from the peak at 2 DAT until harvest (33 DAT) to 0 and 2%, respectively.

Table 1. Total broadleaf weed control percentage at 2, 10, 18, 26, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT	26 DAT	33 DAT
		%	%	%	%	%
Matran EC 5%	No	53 b**	44 b	6 c	6 c	0 b
Matran EC 5%	Yes	100 a	100 a	100 a	100 a	100 a
Matran EC 7%	No	60 b	46 b	19 b	19 b	2 b
Matran EC 7%	Yes	100 a	100 a	100 a	100 a	100 a
Weedy-Check	No	0 c	0 c	0 d	0 d	0 b
Weed-Free	Yes	100 a	100 a	100 a	100 a	100 a

*Matran EC 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. The greatest onion injury was recorded 10 DAT, averaging 3.5 and 7.5% for the 5 and 7% application rates, respectively (Table 2). Visual crop injury due to Matran decreased to 1.6 (5% Matran) and 3.9% (7% Matran) by 26 DAT. Crop injury decreased to 0% injury for both application rates for the remainder of the growing season.

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

Table 2. Crop injury averaged across onion varieties at 2, 10, 18, 26, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT	26 DAT	33 DAT
		%	%	%	%	%
Matran EC 5%	No	2 a**	3.5 a	2 a	1.6 a	0 a
Matran EC 5%	Yes	2 a	4 a	2 a	2 a	0 a
Matran EC 7%	No	5 a	7.5 a	5 a	3.9 a	0 a
Matran EC 7%	Yes	5 a	6.5 a	5 a	3.9 a	0 a
Weedy-Check	No	0 a	0 a	0 a	0 a	0 a
Weed-Free	Yes	0 a	0 a	0 a	0 a	0 a

*Matran 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
Yield data in this presentation will include only the total marketable yield combined across the 4 onion grades. There were significant yield differences between cultivars and among weed control treatments (Table 3). The application of Matran decreased onion yields compared to the untreated weed-free control. 'Cimarron' and 'Candy' yields were significantly better when applying Matran than the weedy-check (2218 and 3328 lb/a, respectively).

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
Matran EC 5%	No	2423 d**	3086 e
Matran EC 5%	Yes	3832 b	5033 b
Matran EC 7%	No	2494 d	4580 d
Matran EC 7%	Yes	3222 c	4738 c
Weedy-Check	No	2218 e	3328 f
Weed-Free	Yes	4445 a	6797 a

*Matran 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: This research indicates that broadcast applications of 5 and 7% rates of Matran EC provided poor (60% or less) broadleaf weed control at 2 DAT and less than 20% at 18 DAT until the end of the season. The visual injury ratings for the two varieties were not significantly different, but the yield response for the onion cultivars varied depending on weed control treatment. Although Matran did not cause severe visual crop injury or reduce onion plant populations, onion yields were reduced, indicating that it should be applied as broadcast herbicide with caution.

Acknowledgements: The authors would like to thank Sam McClure, Spring Creek Ranch, Calvin, OK for supplying the onion transplants and 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 Tony Goodson, Zach Berry, Tanner Jones, Brooke Jones, and Taylor Runyan 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. 2006.

Racer (40% Ammonium Nonanoate) Broadcast Application for Broadleaf Weed Control in Spring-Transplanted Onions

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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] was just recently 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 field experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2008 into 2 rows per 6 ft-wide raised beds. Each research 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) was applied at three rates, 7.5, 10, and 15% v/v, over-the-top broadcast application on May 3, 2008, 44 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 2, 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

[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 09, 2008, 81 days after transplanting (37 DAT), 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 2008 growing season, from transplanting to harvest (81 days), was 13.87 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 9) is 13.77 inches.

Weed Control
The experiment had very high weed densities with multiple broadleaf species. The 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 vinegar 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 here.

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 and until 18 DAT for Racer at 15%. Only Racer at 15% provided good (≥80%) weed control. while Racer at 15% 7.5% peaked at 10 DAT, Racer 10% held constant across 2 and 10 DAT,

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

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer* 7.5%	No	23 d**	20 c	6 c	0 b
Racer 7.5%	Yes	100 a	100 a	100 a	100 a
Racer 10%	No	43 c	45 c	13 c	0 b
Racer 10%	Yes	100 a	100 a	100 a	100 a
Racer 15%	No	83 b	80 b	79 b	5 b
Racer 15%	Yes	100 a	100 a	100 a	100 a
Weedy-Check	No	0 e	0 d	0 d	0 b
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 increased with no visual injury by 18 DAT (Table 2).

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

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

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer* 7.5%	No	5 c**	11 d	0 a	0 a
Racer 7.5%	Yes	5 c	13 d	0 a	0 a
Racer 10%	No	19 b	20 c	0 a	0 a
Racer 10%	Yes	19 b	21 c	0 a	0 a
Racer 15%	No	35 a	25 bc	0 a	0 a
Racer 15%	Yes	35 a	33 a	0 a	0 a
Weedy-Check	No	0 c	0 e	0 a	0 a
Weed-Free	Yes	0 c	0 e	0 a	0 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
Yield data in this presentation will include only 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. 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. Yields for “Cimarron” at the 7.5% Racer rate were greater than the untreated weedy-check, while “Candy” yields were greater at the 7.5 and 10% Racer rates compared to the untreated weedy-check.

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	2435 e**	3026 c
Racer 7.5%	Yes	3368 b	4900 a
Racer 10%	No	2140 g	2902 d
Racer 10%	Yes	2837 c	4883 a
Racer 15%	No	1651 h	2666 e
Racer 15%	Yes	2563 d	3932 b
Weedy-Check	No	2305 f	2675 e
Weed-Free	Yes	4217 a	4872 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.

Conclusions: This research indicates that broadcast applications of Racer at 7.5 and 10% produced poor (45% or less) broadleaf weed control, while Racer at 15% provided good (≥80%) weed control. Onion injury increased as Racer application rates increased with no visual injury by 18 DAT. Although, crop injury and lack of weed control from Racer did reduced crop yields, Racer at the lowest rate produced a yield advantage 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 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 Tony Goodson, Zach Berry, Tanner Jones, Brooke Jones, and Taylor Runyan 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. 2006.

Scythe (57% Pelargonic Acid) Broadcast Application for Broadleaf Weed Control in Spring-Transplanted Onions

Charles L. Webber III[a] and James W. Shrefler[b]
[a]USDA, ARS, South Central Agricultural Research Laboratory, Lane, Oklahoma
[b]Oklahoma State University, Lane, 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.

Although previous studies yielded important information concerning use of pelargonic acid as a potential organic herbicide, further research is indicated in order to increase the understanding of the relationship among application volumes, 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 volume and broadcast application of pelargonic acid on weed control efficacy, crop injury and yields.

Materials and Methods: The field experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2008 into 2 rows per 6 ft-wide raised beds. Each research 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 pelargonic acid on the broadleaf weeds. Scythe[10,11] (57% pelargonic acid) was applied at three rates, 3, 5, and 7% v/v, over-the-top broadcast application on May 3, 2008, 44 days after transplanting (DATr) using a tractor mounted CO_2 sprayer equipped with four extended range, stainless steel, 0.20 gallons/min nozzles[12] on 20-inch spacings at a spraying height of 19 inches at 100 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, 14, 27, and 34 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

Onions were harvested on June 09, 2008, 81 days after transplanting (38 DAT), 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. All data were subjected to ANOVA[13] and mean separation using LSD with P=0.05.

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[10] Scythe, 57% pelargonic acid, Mycogen Corp., 5501 Oberlin Drive, San Diego, CA 92121
[11] 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.

[12] XR TeeJet, XR8002VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

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

Results and Discussions:

Rainfall
Rainfall during the 2008 growing season, from transplanting to harvest (81 days), was 13.87 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 9) is 13.77 inches.

Weed Control
The experiment had very high weed densities with multiple broadleaf species. The 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 vinegar 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 here.

Total broadleaf weed control for the all application rates remained good (≥80%) until 18 DAT (Table 1). Scythe applied at 5 and 7% was 89% or greater until harvest. Weed control with 3% Scythe was less than 5 and 7% Scythe at 10, 18, and 33 DAT.

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

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Scythe* 3%	No	93 a**	85 b	83 b	69 c
Scythe 3%	Yes	100 a	100 a	100 a	100 a
Scythe 5%	No	98 a	96 a	94 a	89 b
Scythe 5%	Yes	100 a	100 a	100 a	100 a
Scythe 7%	No	99 a	97 a	96 a	93 ab
Scythe 7%	Yes	100 a	100 a	100 a	100 a
Weedy-Check	No	0 b	0 c	0 c	0 d
Weed-Free	Yes	100 a	100 a	100 a	100 a

*Scythe 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. The greatest onion injury was recorded 2 DAT for 5 and 7% Scythe, and at 10 DAT for 3% Scythe (Table 2). Scythe crop injury increased as application rate increased and decreased to 0% injury at 18 DAT.

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

Weed Control Treatment	Hand-Weeded	2 DAT	10 DAT	18 DAT
		%	%	%
Scythe* 3%	No	3 c**	7 c	0 a
Scythe 3%	Yes	3 c	6 c	0 a
Scythe 5%	No	50 b	24 b	0 a
Scythe 5%	Yes	50 b	24 b	0 a
Scythe 7%	No	93 a	40 a	0 a
Scythe 7%	Yes	93 a	40 a	0 a
Weedy-Check	No	0 c	0 c	0 a
Weed-Free	Yes	0 c	0 c	0 a

*Scythe 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
Yield data in this presentation will include only the total marketable yield combined across the 4 onion grades. Split and decomposed onions were placed in the unmarketable group. There were significant yield differences between cultivars and among weed control treatments (Table 3). Application of Scythe decreased onion yields compared to the untreated weed-free control. 'Cimarron' and 'Candy' yields were greater than the untreated weedy-check when Scythe was applied at 3 and 5%. Scythe applied at 7% reduced yields equal to or less than the untreated weedy-check.

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
Scythe 3%*	No	3202 b**	2930 d
Scythe 3%	Yes	4024 a	2715 e
Scythe 5%	No	2572 c	3246 c
Scythe 5%	Yes	1914 f	3657 b
Scythe 7%	No	2110 e	2526 f
Scythe 7%	Yes	1450 g	2997 d
Weedy-Check	No	2452 d	2531 f
Weed-Free	Yes	4036 a	5334 a

*Scythe 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: Total broadleaf weed control for the all application rates remained good (≥80%) until 18 DAT. Scythe applied at 5 and 7% was 89% or greater until harvest. Weed control with 3% Scythe was less than 5 and 7% Scythe at 10, 18, and 33 DAT. The greatest onion injury was recorded 2 DAT for 5 and 7% Scythe, and at 10 DAT for 3% Scythe. Scythe crop injury increased as application rate increased and decreased to 0% injury at 18 DAT.
Application of Scythe decreased onion yields compared to the untreated weed-free control. 'Cimarron' and 'Candy' yields were greater than the untreated weedy-check when Scythe was applied at 3 and 5%. Scythe applied at 7% reduced yields equal to or less than the untreated weedy-check. When examining broadleaf weed control, crop injury, and yields the 5% Scythe application has the best potential for use in spring-transplanted onions.

Acknowledgements: The authors would like to thank Sam McClure, Spring Creek Ranch, Calvin, OK for supplying the onion transplants and 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 Tony Goodson, Zach Berry, Tanner Jones, Brooke Jones, and Taylor Runyan 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. 2006.

Vinegar (20% Acetic Acid) Broadcast Application for Broadleaf Weed Control in Spring-Transplanted Onions

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[a]USDA, ARS, South Central Agricultural Research Laboratory, Lane, Oklahoma
[b]Oklahoma State University, Lane, 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.

Although previous studies yielded important information concerning use of vinegar as an organic herbicide, further research is indicated in order to increase the understanding of the relationship among application volumes, 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 volume and broadcast application of acetic acid on weed control efficacy, crop injury and yields.

Materials and Methods: The field experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2008 into 2 rows per 6 ft-wide raised beds. Each research plot consisted of two onion rows per 10 ft length of bed. The experiment included 6 weed control treatments (2 application volumes, 2 hand-weeding levels, 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 acetic acid on the broadleaf weeds. Vinegar[14, 15] (20% acetic acid) was applied as an over-the-top broadcast application on May 2, 2008, 43 days after transplanting (DATr) using a tractor mounted CO_2 sprayer equipped with four extended range, stainless steel, 0.20 gallons/min nozzles[16] on 20-inch spacings at a spraying height of 19 inches. The 50 and 100 gpa sprayer application volumes were achieved by adjusting travel speed to 1.2 or 0.6 mph, respectively, and holding all other variables (nozzle size, pressure, and mixture volumes) constant. The two weed control treatments within each application volume (50 and 100 gpa) involved either 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, 14, 27, and 34 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

[14] 20% Vinegar, Nature's Guide, Manufactured by Creole Fermentation, Abbeyville, LA, and Distributed by Marshall Distributing Company, 2224 E. Lancaster Ave., Fort Worth, TX 76103-2299. Vinegars with acetic acid concentrations of 11% or greater are available commercially, but these products can burn the skin and cause serious to severe eye injury, including blindness. Protective clothing that includes eye protection and gloves should be used.

[15]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.

[16] XR TeeJet, XR8002VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

Onions were harvested on June 09, 2008, 81 days after transplanting (38 DAT), 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. All data were subjected to ANOVA[17] and mean separation using LSD with P=0.05.

Results and Discussions:

Rainfall

Rainfall during the 2008 growing season, from transplanting to harvest (81 days), was 13.87 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 9) is 13.77 inches.

Weed Control

The experiment had very high weed densities with multiple broadleaf species. The 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 vinegar 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 here.

Total broadleaf weed control for the 50 and 100 gpa application volumes without hand-weeding peaked at 3 DAT with 95% and 97.5 % control (Table 2). Although there were no significant differences between the 50 and 100 gpa vinegar treatments without hand-weeding at 3 DAT, these treatments were significantly different at 14, 27, and 34 DAT applications. Weed control decreased over time for these treatments, but the decrease was greater for the 50 gpa volume than the 100 gpa application volume.

Table 1. Total broadleaf weed control percentage at 3, 14, 27 and 34 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	14 DAT	27 DAT	34 DAT
		%	%	%	%
Vinegar* (50 gpa)	No	95 a**	76.25 c	73.75 c	46.25 c
Vinegar (50 gpa)	Yes	100 a	100 a	100 a	100 a
Vinegar (100 gpa)	No	97.5 a	87.5 b	88.75 b	76.25 b
Vinegar (100 gpa)	Yes	100 a	100 a	100 a	100 a
Weedy-Check	No	0 b	0 d	0 d	0 d
Weed-Free	Yes	100 a	100 a	100 a	100 a

*Vinegar with 20% acetic acid 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. The greatest onion injury was recorded 3 DAT, averaging 75% and 90% for the 50 and 100 gpa applications, respectively (Table 2). Visual crop injury due to vinegar decreased to an average of 25% (50 gpa) and 26.88% (100 gpa) by 14 DAT. At 19 DAT, crop injury decreased to 2% (50 gpa) and 5% (100 gpa) and then to 0% injury for the remainder of the growing season.

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

Table 2. Crop injury averaged across onion varieties at 3, 10, and 19 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	10 DAT	19 DAT
		%	%	%
Vinegar* (50 gpa)	No	75 b**	21.25 a	2 a
Vinegar (50 gpa)	Yes	75 b	28.75 a	2 a
Vinegar (100 gpa)	No	90 a	25 a	5 a
Vinegar (100 gpa)	Yes	90 a	28.75 a	5 a
Weedy-Check	No	0 c	0 c	0 a
Weed-Free	Yes	0 c	0 c	0 a

*Vinegar with 20% acetic acid 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

Yield data in this presentation will include only the total marketable yield combined across the 4 onion grades. Split and decomposed onions were placed in the unmarketable group. There were significant yield differences between cultivars and among weed control treatments (Table 3). Application of vinegar decreased onion yields compared to the untreated weed-free control. 'Cimarron' yields were significantly better when applying vinegar than the weedy-check (2264 lb/a). 'Candy' yields for plants in vinegar treated plots without hand-weeding, were less than, or not different from 'Candy' in the weedy-check control plots (3154 lb/a). For the non hand-weeded vinegar treatments, yields were significantly better when vinegar was applied at 100 gpa vs. 50 gpa.

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
Vinegar* (50 gpa)	No	2393 c**	2894 e
Vinegar (50 gpa)	Yes	2540 b	4336 b
Vinegar (100 gpa)	No	2582 b	3144 c
Vinegar (100 gpa)	Yes	2519 b	3031 d
Weedy-Check	No	2264 d	3154 c
Weed-Free	Yes	3891 a	4769 a

*Vinegar with 20% acetic acid 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: This research indicates that broadcast applications of 50 and 100 gpa of 20% acetic acid (vinegar) initially provided excellent (>95%) weed control, but decreased over time, especially for the 50 gpa application volume. Crop injury at 3 DAT was significantly greater for the 100 gpa compared to the 50 gpa application volume, but not significantly different at the latter evaluation dates. Broadcast applications of vinegar and the resulting crop injury significantly reduced yields for both cultivars compared to the untreated weed-free control indicating that it should be applied with caution.

Acknowledgements: The authors would like to thank Sam McClure, Spring Creek Ranch, Calvin, OK for supplying the onion transplants and 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 Tony Goodson, Zach Berry, Tanner Jones, Brooke Jones, and Taylor Runyan 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. 2006.

Pepper Preemergence Study

Spring 2008
Lynn Brandenberger, Lynda Carrier
Oklahoma State University
Cooperating with Dean Smith SS Farms

Introduction and objective: Results from 2007 indicated that lower rates of Spartan would possibly be less damaging to a commercial pepper crop and that Valor may have potential for use in peppers. The objective of this study was to determine the crop safety and efficacy of several preemergence treatments for control of Palmer amaranth (*Amaranthus palmeri* S. Watts).

Methods: The study was completed in a commercial pepper field of OSU 'Super Hot' that was transplanted on 4/29/08 in Caddo County, Oklahoma at SS Farms. Plants were in rows with 3 foot row centers and spaced approximately 2.5 feet apart in the row. Plots were arranged in a randomized block design with three replications, each plot being 6 x 20 feet. Ten treatments and an untreated check were included in the study (Table 1). Herbicide treatments included one rate of Dual Magnum (S-metolachlor), Outlook (dimethenamid-P), Nortron (ethofumesate), two rates of Spartan (sulfentrazone), and Goal (oxyfluorfen), and three rates of Valor (chlorimuron). Preemergence and preplant treatments were applied on 4/29/08 utilizing a CO_2 research sprayer with a 6 foot wide hand-held spray-boom at an overall rate of 25 gallons/acre (GPA). Number of pepper plants, Palmer amaranth (*Amaranthus palmeri*) and crop injury ratings were recorded on 5/28/08 for each plot, fresh plant weights were recorded for five random plants per plot on 9/26/08.

Results and discussion: The number of pepper plants per plot was lowest for both Goal treatments and Spartan at 0.075 lbs ai/acre (Table 1). These treatments had three, seven, and nine plants/plot, respectively, compared to the next lowest of 17 plants/plot. Crop injury was observed as stunting (fewer and shorter internodes) and was highest for both Goal treatments and Spartan at 0.075 lbs ai/acre. Goal at 0.25 and 0.5 lbs ai/acre had 82 and 68% stunting while Spartan at 0.075 lbs ai/acre had 42% stunting. All herbicide treatments had significant lower numbers of Palmer amaranth then the untreated check which had 15 compared to 0 to 5 for the herbicide treatments. Plant weights varied from a high of 8.7 lbs/5 plants for Outlook to a low of 3.1 lbs/5 plants for Goal at 0.25 lbs ai/acre, even Spartan at 0.75 lbs ai/acre was not different in plant weight than other treatments or the untreated check.

The authors would conclude that all herbicide treatments in the study helped reduce the number of Palmer amaranth to manageable levels. Goal should be dropped from future efforts due to the high level of crop injury sustained from its use. Promising compounds would include Outlook, Spartan, and Valor due to low or manageable levels of injury and their ability to control Palmer amaranth.

Acknowledgements: The authors wish to thank Dean Smith for supplying labor and crop inputs to make this study successful.

Table 1. 2008 Pepper herbicide study, Hinton, OK.

Treatment lbs ai/acre	Number of plants	% stunting	Number of Palmer amaranth	Yield lbs. (weight of 5 plants)
Untreated check	19 a-b	13 c	15 a	8.3 a
Dual Magnum 0.65 pre	20 a	17 c	1 b	7.5 a
Outlook 0.5 pre	17 a-b	22 c	0 b	8.7 a
Nortron 1.0 pre	20 a	18 c	5 b	7.1 a
Spartan 0.05 pre	19 a-b	23 c	1 b	8.2 a
Spartan 0.075 pre	9 b-c	42 b-c	0 b	6.0 a-b
Goal 1.6EC 0.25 pre	3 c	82 a	1 b	3.1 b
Goal 1.6Ec 0.5 pre	7 c	68 a-b	1 b	4.9 a-b
Valor 0.032 pre plant	19 a-b	18 c	0 b	7.7 a
Valor 0.064 pre plant	19 a-b	23 c	0 b	7.8 a
Valor 0.096 pre plant	17 a-b	30 c	0 b	6.8 a

[z] Number of plants, % stunting, number of Palmer amaranth per plot, ratings on 5/28/08
[y] Yield=weight in lbs. of 5 plants per plot on 9/26/08
[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.

Racer Efficacy Study

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Introduction and objective: Research in 2007 demonstrated the effectiveness of Racer (ammonium nonanoate) for burn-down control of several weed species. Racer has been labeled by EPA in the past year for burn-down weed control in food crops and is close to receiving approval for use by organic producers. The objective of this study was to verify results from the 2007 study regarding the effectiveness of Racer for control of several weed species.

Methods: The study was completed at the Oklahoma State University Vegetable Research station in Bixby, Oklahoma. Plots were arranged in a randomized complete block design with four replications, each plot consisted of an area 10 feet wide by 15 feet long. The entire experimental area was disk-harrowed then cultivated using a "Do-all" finish cultivator on 8/07/08. Treatments were applied on 8/28/08 using a tractor mounted CO_2 sprayer with 3 nozzles with a 20-inch nozzle spacing for a total spray width of 60 inches. To maintain the same spray pattern for each nozzle type, the nozzle pressure was held constant and tractor speed was adjusted to achieve different overall application rates i.e. 35 or 70 gallons per acre (GPA). Treatments included two nozzle types operated at recommended nozzle pressures (TeeJet XR8003 and TeeJet XR8005), three application concentrations of Racer (8.0, 11.2, and 14.4 lbs ai/a), and two application volumes (35 and 70 GPA) for a total of 12 treatments (Table 1). Plots were rated on 8/29/08, 9/02/08, and 9/04/08 for percent control of Palmer amaranth (*Amaranthus palmeri* S. Watts.) and carpetweed (*Mollugo verticillata* L.) on a 0 to 100% scale 0% = no weed control and 100% = complete control i.e. dead plants. Also included on the same dates were counts of live plants of the two weed species within a 1.1 ft^2 area that was flagged on the first date for each plot with successive counts taken at the same area within the plot. Live weed species were counted if there was any green tissue visible on the plants. Plants that exhibited no green tissue were not counted.

Results and discussion: In general, herbicidal activity on weed populations was observed as burning and subsequent necrosis of plant tissues that were present at the time of application. This is normal for contact herbicides that are used as "burn-down" materials. Depending on the weed species, some plants began to recover during the seven day period that plots were rated, but all weed species were adversely affected. Regarding rates of Racer, the lowest rate, 8.0 lbs ai/acre, did not perform as well as the higher rates of 11.2 and 14.4 lbs ai/acre (Tables 1 and 2). The 35 GPA spray volume generally resulted in higher control ratings than the 70 GPA spray volume. This was true for both weed species included in the study. Generally speaking, a greater number of 8005 nozzle treatments had higher levels of control than the 8003 treatments. The 8005-14.4-35 treatment had the highest rating for both Palmer amaranth and carpetweed control for each of the three rating dates.

In general, Racer proved to be an effective contact herbicide for controlling both weed species in the study. The two higher rates of Racer were more effective than the lower rate, although even the low rate resulted in higher levels of weed control than the untreated check. As in 2007, the overall spray application rate of 70 GPA appears to have diluted the active ingredient enough to reduce its effectiveness. Based upon these results, the authors would recommend rates of 11.2 and 14.4 lbs ai/acre for Racer and spray volumes of 35 GPA.

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Table 1. 2008 Racer study, efficacy for Palmer amaranth control, Bixby, OK

Nozzle type[z]	Racer rate	Spray volume	Palmer amaranth % Control 8/29/08	% Control 9/2/08	% Control 9/4/08	% Live 8/29/08	% Live 9/2/08	% Live 9/4/08
8003	8.0	35	58 a-c[x]	33 a	36 a	50 a	67 a	67 a
8003	8.0	70	20 c-d	13 a	13 a	84 a	57 a	57 a
8003	11.2	35	80 a-b	38 a	58 a	100 a	34 a	34 a
8003	11.2	70	41 b-c	13 a	21 a	92 a	53 a	53 a
8003	14.4	35	82 a	51 a	46 a	38 a	38 a	38 a
8003	14.4	70	63 a-b	58 a	60 a	100 a	0 a	0 a
8005	8.0	35	79 a-b	18 a	18 a	90 a	50 a	50 a
8005	8.0	70	45 a-c	32 a	30 a	75 a	100 a	100 a
8005	11.2	35	82 a	33 a	35 a	67 a	17 a	17 a
8005	11.2	70	73 a-b	47 a	62 a	50 a	0 a	0 a
8005	14.4	35	85 a	68 a	65 a	100 a	50 a	50 a
8005	14.4	70	83 a	51 a	53 a	35 a	30 a	30 a
Non treated check			0 d	0 a	0 a	100 a	100 a	100 a

[z] Nozzle type, Racer rate, Spray volume: Nozzle type is the TeeJet nozzle model number, Racer rate is given in lbs ai/acre, Spray volume is given in gallons per acre.
[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.

Table 2. 2008 Racer study, efficacy for Carpetweed control, Bixby, OK

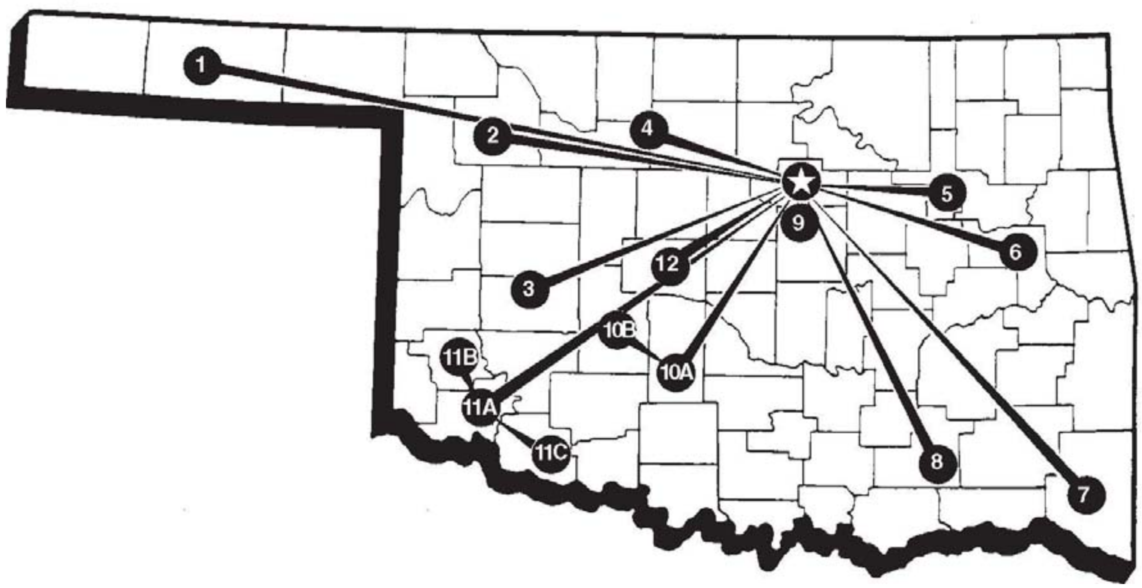
Nozzle type[z]	Racer rate	Spray volume	Carpetweed % Control 8/29/08	% Control 9/2/08	% Control 9/4/08	% Live 8/29/08	% Live 9/2/08	% Live 9/4/08
8003	8.0	35	75 a-b[x]	78 b	79 c-d	13 b-c	8 b-d	7 c
8003	8.0	70	75 a-b	81 a-b	79 c-d	27 b	13 b-d	17 b-c
8003	11.2	35	88 a-b	95 a-b	94 a-c	3 c	0 d	0 c
8003	11.2	70	69 b	82 a-b	83 b-d	30 b	19 b-c	19 b-c
8003	14.4	35	90 a	94 a-b	96 a-b	5 c	0 d	0 c
8003	14.4	70	86 a-b	83 a-b	89 a-c	5 c	2 c-d	3 c
8005	8.0	35	86 a-b	84 a-b	80 c-d	19 b-c	18 b-d	19 b-c
8005	8.0	70	79 a-b	78 b	69 d	30 b	25 b	27 b
8005	11.2	35	95 a	98 a	96 a-b	1 c	0 d	0 c
8005	11.2	70	91 a	95 a-b	94 a-c	2 c	2 c-d	2 c
8005	14.4	35	96 a	99 a	99 a	1 c	0 d	0 c
8005	14.4	70	91 a	97 a	95 a-c	2 c	1 d	1 c
Non treated check			0 c	0 c	0 e	100 a	100 a	100 a

[z] Nozzle type, Racer rate, Spray volume: Nozzle type is the TeeJet nozzle model number, Racer rate is given in lbs ai/acre, Spray volume is given in gallons per acre.
[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.

SI (METRIC) CONVERSION FACTORS

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

THE OKLAHOMA
AGRICULTURAL EXPERIMENT STATION
SYSTEM COVERS THE STATE



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

1. **Oklahoma Panhandle Research and Extension Center—*Goodwell***
2. **Southern Plains Range Research Station—*Woodward***
3. **Marvin Klemme Range Research Station—*Bessie***
4. **North Central Research Station—*Lahoma***
5. **Oklahoma Vegetable Research Station—*Bixby***
6. **Eastern Research Station—*Haskell***
7. **Kiamichi Forestry Research Station—*Idabel***
8. **Wes Watkins Agricultural Research and Extension Center—*Lane***
9. **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***