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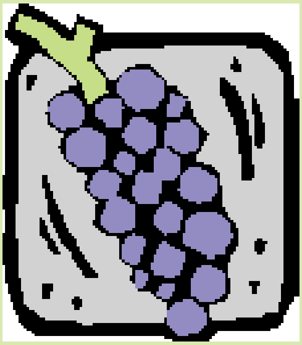

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SUMMARY

Growers generally use herbicides to efficiently produce high-quality fruit and vegetables for processing or fresh market sales. Because of the smaller acreage of these crops compared with major field crops, fewer herbicides are registered for use in fruit and vegetable crops than for field crops. Each year, new herbicides are evaluated under Arkansas growing conditions with the objective of improving the herbicide technology for the grower, processor, and ultimately the consumer. This report includes studies on the control of many of the more serious weed problems in important crops of this region, including snapbeans, spinach and other greens, southernpeas, tomatoes, and grapes.

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UNIVERSITY OF ARKANSAS

DIVISION OF AGRICULTURE

FIELD EVALUATION OF HERBICIDES ON SMALL FRUIT, VEGETABLE, AND ORNAMENTAL CROPS, 1999

R.E. Talbert, L.A. Schmidt, M.L. Lovelace, and E.F. Scherder

INTRODUCTION

Field evaluations of herbicides provide the chemical industry, governmental agencies such as IR-4, and the Arkansas Agricultural Experiment Station with an evaluation of herbicide performance on small fruit, vegetable, and ornamental crops grown under Arkansas conditions. This report also provides a means for disseminating information to interested private and public service weed scientists.

Experiments at the Arkansas Agricultural Research and Extension Center (AAREC) in Fayetteville were conducted on grape, tomato, and southernpea. At the Vegetable Substation near Kibler, experiments were conducted on Arkansas greens and over-wintered spinach. A snapbean trial was conducted on a private farm near Lowell, Ark.

The chemical names and formulations of the herbicides used in these experiments are listed in Appendix Table 1. A table for converting metric units to English units can be found on page 24.

At AAREC, trials were conducted on a Captina silt loam with 1% organic matter and pH of 5.9. Soil at Lowell, Ark., was a Perridge silt loam with 0.5% organic matter and pH of 5.3. At the Vegetable Substation at Kibler, trials were conducted on a Roxana silt loam with 1% organic matter and pH of 6.9. Unless stated otherwise, the experimental design for all experiments was a randomized complete block with four replications. Preplant-incorporated, preemergence, postemergence, and postemergence-directed treatments were applied in 187 L/ha of water. Liquid herbicides were applied with a hand-held, carbon-dioxide pressurized sprayer.

Treatments involving timing and incorporation were (1) preplant-incorporated (PPI), applied to the soil and incorporated prior to planting; (2) preemergence (PRE), applied to the soil surface soon after planting; and (3) postemergence (POST). Environmental conditions of air temperature (centigrade); soil temperature (centigrade) at 8 cm deep; soil surface moisture as wet, moist, or dry; and percent relative humidity (RH) were recorded at each application.

Percentage of weed control by species was visually estimated: 0 represents no effect, and 100 represents complete control. Ranges for weed control are as follows: 70 to 79%, fair; 80 to 89%, good; and 90 to 100%, excellent. Weed control of less than 70% is considered to be poor. Crop injury was assessed by visual estimation of percent injury: 0 represents no effect, and 100 represents complete plant kill. Crop injury ratings of less than 30% indicate crop tolerance. Crop yields are reported in metric tons per hectare unless stated otherwise. Least Significant Difference (LSD) values at the 0.05 level of significance were calculated for each set of treatment means.

Climatological data for 1999 for AAREC are presented in Appendix Table 2 and for the Vegetable Substation in Appendix Table 3. Standardized Plant (Bayer) Codes, as recognized by the Weed Science Society of America, for weeds appearing in this report are presented in Appendix Table 4.

METHODS AND RESULTS

Pertinent experimental details and a brief discussion of the results of these studies follow, and tabulated results are shown in Tables 1 to 6. Additional abbreviations used in the tables are: cm, centimeter; COC, crop oil concentrate; cv, cultivar; *fb*, followed by; kg/ha, kilograms of active ingredient per hectare; NS, not significant; pl, plants; TM, tank mix; V2, first trifoliolate stage of legume; v/v, volume per volume; WA, wetting agent; wk, week(s).

Evaluation of Herbicides in Snapbeans (*Phaseolus vulgaris*), Lowell (Table 1).

Snapbeans (cv. Roma II) were planted 3 May in plots 3 by 5.5 m with four rows spaced 76 cm apart. PPI and PRE treatments were applied the same day as planting (air 23°C; soil 22°C, moist; RH 74%). PPI treatments were incorporated in two directions with a tractor-drawn disk. POST treatments were applied 27 May (air 26°C; soil 23°C, moist; RH 68%). Weed control and crop injury evaluations were made at 6 and 8 wk after planting (2 and 6 wk after POST applications). No yield data were taken because of poor and variable crop stands.

Weeds present at this location included common lambsquarters and goosegrass. PRE applications of lactofen or fomesafen at 0.22 kg/ha tank-mixed with clomazone at 0.56 kg/ha or *S*-metolachlor at 0.75 kg/ha provided excellent season-long control of the weed spectrum present. These applications were also tolerated by snapbeans very well. The standard programs of trifluralin at 0.56 kg/ha, PPI, followed by POST applications of bentazon at 0.84 kg/ha + imazethapyr at 0.03 kg/ha or fomesafen at 0.22 kg/ha continued to provide excellent season-long weed control and snapbean tolerance. Other herbicides that were screened and showed promise for use in snapbeans included halosulfuron at 0.03 kg/ha, POST; flufenacet at 0.34 or 0.67 kg/ha, PRE; cloransulam-methyl at 0.02 kg/ha, POST; imazamox at 0.03 kg/ha, POST; flumiclorac at 0.03 kg/ha, POST; diclosulam at 0.04 kg/ha, PRE; and dimethenamid at 1.12 kg/ha, PRE.

Evaluation of Herbicides in Arkansas Greens (*Brassica* spp.), Kibler (Tables 2a and 2b).

Greens [kale *(Brassica oleracea* cv. Premier), turnip greens *(Brassica rapa* cv. Alamo), and mustard greens *(Brassica juncea* cv. Savannah)] were planted 26 March into plots 1.8 by 4.8 m in rows spaced 46 cm apart. PPI and PRE applications were applied the same day (air 18°C; soil 22°C, moist; RH 60%). POST applications were applied 19 April (air 26°C; soil 26°C, moist; RH 43%). Ratings were taken at 2, 5, and 7 wk after planting. Greens were harvested at 8 wk on 15 May.

Weed pressure at this location included cutleaf eveningprimrose, pineappleweed, and goosegrass, with cutleaf eveningprimrose being the most prevalent. Cutleaf eveningprimrose was controlled ≥81% at 7 wk with *S*-metolachlor at 1.5 kg/ha, PRE; oxysulfuron at 0.28 kg/ha, POST; sulfentrazone at 0.11 and 0.22 kg/ha, POST; halosulfuron at 0.03 and 0.07 kg/ha, POST; triasulfuron at 0.01 and 0.02 kg/ha, POST; and pyridate at 0.56 and 1.12 kg/ha, POST. All herbicide applications provided ≥88% control of pineappleweed by 7 wk. All herbicides except halosulfuron at 0.03 and 0.07 kg/ha and carfentrazone at 0.02 kg/ha provided ≥80% control of goosegrass.

Poor germination and seedbed conditions resulted in reduced crop stands, which caused inconsistent crop injury ratings. Several POST treatments caused complete desiccation of all greens: halosulfuron at 0.03 and 0.07 kg/ha, triasulfuron at 0.01 and 0.02 kg/ha, and carfentrazone at 0.02 and 0.03 kg/ha.

Promising treatments based on tolerable crop injury with good yields of all three crops include *S*-metolachlor PRE at 0.75 kg/ha, dimethenamid PRE at 0.56 kg/ha, oxyfluorfen POST at 0.14 kg/ha, clopyralid POST at 0.11 to 0.22 kg/ha, and sulfentrazone PRE and POST at 0.11 kg/ha. Pyridate POST at 0.56 and 1.12 kg/ha was promising on turnip and mustard greens.

Herbicide Evaluation in Over-wintered Spinach (*Spinachia oleracea*), Kibler (Tables 3a and 3b).

Spinach (cv. F-380) was planted 21 October 1999 in plots 1.3 by 5 m, with six rows spaced 23 cm apart. PRE treatments were applied the same day (air 23°C; soil 26°C, moist; RH 62%). POST treatments were applied 11 November (air 20°C; soil 22°C, moist; RH 74%). Plots will be harvested in the spring.

Weed species present at Kibler included henbit, sibara, annual bluegrass, and pineappleweed. The 1.12 or 2.24 kg/ha rates of metolachlor were comparable to the respective 0.56 or 1.12 kg/ha rates of *S*-metolachlor (new formulation containing the active isomer) when applied PRE. Both formulations, regardless of rate, were very effective in controlling the weed species present at this location. The PRE application of metolachlor at 1.12 kg/ha followed by a POST application of clopyralid at 0.08 kg/ha continued to be an excellent treatment in our studies.

New herbicides not labeled in spinach were also evaluated. Dimethenamid at 0.56 kg/ha and the newer formulation, a-dimethenamid X2 at 0.28 kg/ha showed promise for use in spinach although higher rates of each herbicide caused excessive injury. Both formulations at 4 wk after PRE application provided ≥93% control of the weed species present without causing significant injury to spinach at the lower rate tested. Other herbicide treatments showing promise in spinach included linuron or diuron at 0.17 kg/ha applied PRE. Both herbicides showed marginal crop tolerance (the higher rates caused excessive injury) but provided ≥89% control of the weeds present except for henbit at 4 wk.

Spinach showed poor tolerance to all POST applications: fluroxypyr at either 0.1 or 0.2 kg/ha, triflusulfuron at 0.02 kg/ha, and phenmedipham at 0.56 kg/ha.

Herbicide Evaluation in Southernpeas [*Vigna unguiculata* (L.)], Fayetteville (Tables 4a and 4b).

Southernpeas (cv. Coronet) were planted 23 July in plots 2 by 6 m, with two rows spaced 1 m apart. PRE treatments were applied the same day as planting (air 34°C; soil 38°C, dry; RH 54%). POST treatments were applied 9 August (air 35°C; soil 40°C, moist; RH 56%). Weed control and crop injury evaluations were made at 3, 5, 8, and 10 wk after planting. Plots were harvested on 2 October.

Weed control in southernpeas was dependent on the weed species present and the herbicide used. PRE applications providing adequate broad-spectrum control of the weed species present without excessive southernpea injury included diclosulam at 0.03 kg/ha and *S*-metolachlor at 1.4 kg/ha + flumetsulam at 0.07 kg/ha. Both *S*-metolachlor at 1.4 kg/ha and dimethenamid at 1.12 kg/ha applied PRE provided excellent control of smooth pigweed and good control of cutleaf groundcherry. Halosulfuron applied either PRE or POST at 0.03 kg/ha gave good control of yellow nutsedge and provided excellent control of smooth pigweed. An increase in spotted spurge control was noticed when the POST application of halosulfuron was applied following a PRE application of clomazone at 1.12 kg/ha. Flufenacet at 0.28 kg/ha applied PRE gave poor control of yellow nutsedge but provided good control of the other weed species present. POST applications of imazapic at 0.07 kg/ha and imazamox at 0.04 kg/ha provided excellent control of smooth pigweed, cutleaf groundcherry, and spotted spurge; imazapic gave 84% and imazamox gave 56% control of yellow nutsedge. Cloransulam at 0.02 kg/ha applied POST was effective only in controlling cutleaf groundcherry.

Southernpea showed excellent tolerance to all PRE herbicides evaluated. Yield reductions occurring from PRE applications coincided with the lack of weed control achieved. The most promising treatments based on southernpea tolerance, yield, and weed control were diclosulam PRE at 0.04 kg/ha, halosulfuron PRE at 0.03 kg/ha, *S*-metolachlor + flumetsulam at 0.4 + 0.06 kg/ha, and cloransulam POST at 0.002 kg/ha. Treatments showing adequate southernpea tolerance but less than adequate broad-spectrum weed control were *S*-metolachlor, dimethenamid, and flufenacet.

Herbicide Evaluation in Grapes *(Vitis labrusca)*, Fayetteville (Tables 5a and 5b).

Grape (cv. Concord) plots were 1.5 by 4.5 m, with one vine per plot and four replications. Initial POST treatments were applied 28 May (air 26°C; soil 29°C, moist; RH 49%). The sequential treatments of sulfosate or glyphosate were applied 8 July (air 29°C; soil 28°C, moist; RH 78%). Small trees found in the plots were clipped and treated with glyphosate on each application date.

The standard treatment of simazine at 1.68 kg/ha + oryzalin at 3.36 kg/ha + glufosinate at 1.12 kg/ha was generally less effective than the other herbicide treatments evaluated. Azafeniden at either 0.42 or 0.84 kg/ha tank-mixed with glufosinate at 1.12 kg/ha provided season-long control of the weed species present, but did not control suckers. Thiazopyr at either 0.42 or 0.84 kg/ha tank-mixed with 1.12 kg/ha of glufosinate performed similarly to azafeniden in controlling the weeds present. Sequential applications of sulfosate and glyphosate were very similar in providing excellent control of the weed spectrum present and gave 78% and 86% control of suckers, respectively. None of the herbicide treatments caused injury to grape plants, and yields did not differ among treatments.

Herbicide Evaluation in Tomatoes (*Lycopersicon esculentum* Mill), Fayetteville (Table 6).

Tomatoes (cv. Mt. Supreme) were transplanted 4 June into 1- by 4-m plots (one row of eight plants per plot). Plants were spaced 46 cm apart. There were four replications. The entire plot area was sprayed with 0.28 kg/ha of metribuzin + 0.21 kg/ha of sethoxydim + COC at 1% v/v on 23 June. POST treatments of halosulfuron + sethoxydim and rimsulfuron were applied 9 July (air 27°C; soil 27°C, dry; RH 83%). The sequential POST treatment of rimsulfuron was applied 28 July (air 28°C; soil 28°C, moist; RH 80%). Ratings were taken 2, 4, and 6 wk after the initial POST applications. Plots were harvested 30 August.

Halosulfuron at 0.035 kg/ha + sethoxydim at 0.31 kg/ha provided 71% control of yellow nutsedge at 2 wk and ≥83% control throughout the remainder of the growing season. The sequential POST treatment of rimsulfuron at 0.035 kg/ha followed by 0.035 kg/ha 19 days later was less effective on yellow nutsedge, providing 69 to 75% control throughout the growing season. Tomatoes showed excellent tolerance to halosulfuron and rimsulfuron.

Table 1. Weed control and plant injury associated with various herbicides in snapbeans, Lowell, 1999.

	Weed control[a]						
	ELEIN		CHEAL		Snapbean injury		
Treatment description[b]	6 wk	8 wk	6 wk	8 wk	4 wk	6 wk	8 wk
(kg/ha)	(%)						
Untreated check	0	0	0	0	0	0	0
Clomazone, 0.56 + lactofen, 0.22, PRE	100	95	98	95	10	9	8
Clomazone, 0.56 + fomesafen, 0.22, PRE	100	96	100	96	6	0	0
S-metolachlor, 0.75 + lactofen, 0.22, PRE	100	94	98	90	18	23	14
S-metolachlor, 0.75 + fomesafen, 0.22, PRE	100	95	100	94	9	10	5
Diclosulam, 0.04, PRE	95	88	100	94	33	33	18
Dimethenamid, 1.12, PRE	99	96	100	91	20	28	15
Flufenacet, 0.34, PRE	98	91	95	79	29	21	5
Flufenacet, 0.67, PRE	100	97	89	90	16	16	9
Lactofen, 0.22, PRE *fb* sethoxydim, 0.45 + Agri-Dex (1%), POST	100	96	78	70	14	14	14
Lactofen, 0.22, PRE *fb* quizalofop-P, 0.07 + Agri-Dex (1%), POST	100	95	100	76	19	18	5
Trifluralin, 0.56, PPI *fb* halosulfuron, 0.03 + AG-98 (0.25%), POST	48	46	89	90	5	25	16
Trifluralin, 0.56, PPI *fb* imazethapyr, 0.03 + AG-98 (0.25%), POST	99	79	100	86	5	33	8
Trifluralin, 0.56, PPI *fb* fomesafen, 0.22 + AG-98 (0.25%), POST	89	81	100	94	5	13	9

continued

Table 1. Continued.

Treatment description[b]	Weed control[a]				Snapbean injury		
	ELEIN		CHEAL				
	6 wk	8 wk	6 wk	8 wk	4 wk	6 wk	8 wk
(kg/ha)	(%)						
Trifluralin, 0.56, PPI *fb* imazethapyr, 0.03 + bentazon, 0.84 + AG-98 (0.25%), POST	95	90	100	94	9	25	10
Trifluralin, 0.56, PPI *fb* bentazon, 0.47 + fomesafen, 0.22 + AG-98 (0.25%), POST	98	85	100	95	9	15	9
Trifluralin, 0.56, PPI *fb* cloransulam-methyl, 0.02 + Agri-Dex (1%), POST	89	84	89	86	14	29	15
Trifluralin, 0.56, PPI *fb* halosulfuron, 0.03 + bentazon, 0.84 + AG-98 (0.25%), POST	75	75	100	94	5	19	5
Trifluralin, 0.56, PPI *fb* imazamox, 0.03 AG-98 (0.25%), POST	66	56	100	90	10	24	15
Trifluralin, 0.56, PPI *fb* oxasulfuron, 0.08 AG-98 (0.25%), POST	95	87	100	94	5	68	76
Trifluralin, 0.56, PPI *fb* flumiclorac, 0.03 + Agri-Dex (1%), POST	89	78	100	95	3	21	10
LSD (0.05)[c]	14	12	8	12	9	12	7

[a] Evaluations were made 4, 6, and 8 wk after the PPI and PRE applications. The 6- and 8-wk evaluations correspond to 2 and 6 wk after the POST applications.
[b] PPI = preplant incorporated; PRE = preemergence; and POST = postemergence.
[c] LSD values may be used to compare means within a column.

Table 2a. Weed control associated with various herbicides in Arkansas greens, Kibler, 1999.

	Weed control[a]							
	OEOLA			MATMT			ELEIN	
Treatment description[b]	2 wk	5 wk	7 wk	2 wk	5 wk	7 wk	5 wk	7 wk
(kg/ha)	(%)							
Untreated check	0	0	0	0	0	0	0	0
Trifluralin, 0.56, PPI	83	69	43	91	89	93	91	91
S-metolachlor, 0.75, PRE	86	74	55	93	90	92	95	96
S-metolachlor, 1.5, PRE	91	85	8	95	95	92	94	98
Dimethenamid, 0.56, PRE	85	84	76	93	91	93	90	97
Dimethenamid, 1.12, PRE	89	71	51	96	94	94	89	97
Sulfentrazone, 0.11, PRE	95	89	79	97	95	98	93	97
Oxyfluorfen, 0.14, POST	0	68	71	0	86	95	93	96
Oxyfluorfen, 0.28, POST	0	88	94	0	88	97	97	98
Clopyralid, 0.11, POST	0	41	45	0	86	94	91	93
Clopyralid, 0.22, POST	0	66	50	0	88	95	89	89
Sulfentrazone, 0.11, POST	0	86	88	0	79	97	91	97
Sulfentrazone, 0.22, POST	0	85	97	0	86	99	97	99
Halosulfuron, 0.03, POST	0	94	99	0	88	97	87	79
Halosulfuron, 0.07, POST	0	88	98	0	88	99	78	73
Triasulfuron, 0.01, POST	0	94	98	0	91	99	85	91
Triasulfuron, 0.02, POST	0	94	99	0	90	99	86	88
Carfentrazone, 0.02, POST	0	74	62	0	81	88	64	73
Carfentrazone, 0.03, POST	0	75	71	0	89	89	69	80
Pyridate, 0.56, POST	0	90	96	0	89	96	76	86
Pyridate, 1.12, POST	0	95	99	0	93	99	89	93
LSD (0.05)[c]	6	10	13	2	6	5	7	6

Table 2b. Plant injury and yield associated with various herbicides in Arkansas greens.

	Effect on kale				Effect on turnip				Effect on mustard			
	Injury				Injury				Injury			
Treatment description[b]	2 wk	5 wk	7 wk	Yield	2 wk	5 wk	7 wk	Yield	2 wk	5 wk	7 wk	Yield
(kg/ha)	(%)			(mt/ha)	(%)			(mt/ha)	(%)			(mt/ha)
Untreated check	0	0	0	20.1	0	0	0	47.6	0	0	0	36.1
Trifluralin, 0.56, PPI	33	21	18	5.2	34	33	16	44.8	28	19	19	30.6
S-metolachlor, 0.75, PRE	36	31	26	7.8	19	14	9	41.4	18	11	6	32.9
S-metolachlor, 1.5, PRE	39	29	28	5.7	46	38	36	3.0	30	25	24	6.8
Dimethenamid, 0.56, PRE	33	25	18	15.4	19	25	25	23.2	15	20	9	36.5
Dimethenamid, 1.12, PRE	40	39	35	6.0	36	29	24	20.9	41	26	28	16.1
Sulfentrazone, 0.11, PRE	34	30	28	14.2	40	33	28	12.8	41	36	24	25.0
Oxyfluorfen, 0.14, POST	0	24	30	12.4	0	20	33	23.0	0	31	38	24.7
Oxyfluorfen, 0.28, POST	0	33	34	10.7	0	28	39	6.1	0	34	39	5.6
Clopyralid, 0.11, POST	0	26	23	26.8	0	33	38	24.1	0	26	33	26.9
Clopyralid, 0.22, POST	0	25	24	15.5	0	16	18	40.5	0	28	26	29.3
Sulfentrazone, 0.11, POST	0	11	13	20.6	0	14	9	52.2	0	11	8	33.9
Sulfentrazone, 0.22, POST	0	31	34	4.5	0	28	33	14.5	0	29	38	4.3
Halosulfuron, 0.03, POST	0	71	100	0.0	0	83	100	0.0	0	74	100	0.0
Halosulfuron, 0.07, POST	0	83	100	0.0	0	76	100	0.0	0	74	100	0.0
Triasulfuron, 0.01, POST	0	78	100	0.0	0	81	100	0.0	0	71	100	0.0
Triasulfuron, 0.02, POST	0	71	100	0.0	0	74	100	0.0	0	74	100	0.0
Carfentrazone, 0.02, POST	0	68	95	1.1	0	63	94	2.6	0	55	94	14.2
Carfentrazone, 0.03, POST	0	58	95	0.0	0	73	95	0.0	0	61	96	0.0
Pyridate, 0.56, POST	0	30	25	2.6	0	4	8	57.4	0	5	11	34.4
Pyridate, 1.12, POST	0	31	36	0.1	0	20	18	47.4	0	8	14	30.9
LSD (0.05)[c]	4	9	6	3.8	4	8	9	14.8	4	9	9	8.5

[a] Evaluations were made 2, 5, and 7 wk after PRE and PPI applications. The 5- and 7-wk evaluations correspond to 2 and 4 wk after POST applications.

[b] PPI = preplant incorporated; PRE = preemergence; and POST = postemergence.

[c] LSD values may be used to compare means within the same column.

Table 3a. Weed control associated with various herbicides in over-wintered spinach, Kibler, 1999.

	Weed control[a]								
	LAMAM			SIBVI			POANN		
Treatment description[b] (kg/ha)	3 wk	4 wk	8 wk	3 wk	4 wk	8 wk	3 wk	4 wk	8 wk
	(%)								
Untreated check	0	0	0	0	0	0	0	0	0
Linuron, 0.34, PRE	46	60	79	89	99	93	85	98	93
Linuron, 0.17, PRE	21	16	46	90	98	86	86	89	78
Diuron, 0.17, PRE	30	45	75	90	97	91	90	89	95
Diuron, 0.34, PRE	70	93	92	91	99	94	91	99	97
Metolachlor, 1.12, PRE	84	96	90	88	96	88	91	96	95
S-metolachlor, 0.56, PRE	90	94	89	89	99	85	94	97	91
Metolachlor, 2.24, PRE	93	99	95	95	99	96	95	99	96
S-metolachlor, 1.12, PRE	93	99	95	93	99	94	93	99	97
Dimethenamid, 0.56, PRE	88	97	93	80	99	89	91	99	93
α-dimethenamid X2, 0.28, PRE	88	96	95	80	99	84	92	98	93
Dimethenamid, 1.12, PRE	95	99	95	88	99	92	95	99	95
α-dimethenamid X2, 0.56, PRE	91	99	97	88	99	97	93	99	97
Fluroxypyr, 0.1, POST	0	38	38	0	99	68	0	23	0
Fluroxypyr, 0.2, POST	0	36	68	0	98	59	0	36	10
Triflusulfuron, 0.02, POST	0	41	92	0	98	92	0	66	18
Phenmedipham, 0.56, POST	0	99	95	0	99	95	0	98	94
Phenmedipham, 0.56 + metolachlor, 1.12, POST	0	99	97	0	99	97	0	99	97
Phenmedipham, 0.56 + sethoxydim, 0.31, POST	0	99	96	0	99	94	0	99	85
Metolachlor, 1.12, PRE *fb* clopyralid, 0.08, POST	88	96	97	90	99	95	93	99	97
Metolachlor, 1.12, PRE *fb* phenmedipham, 0.56, POST	86	99	97	90	99	97	90	99	97
LSD (0.05)[c]	8	10	8	6	2	9	4	8	8

Table 3b. Weed control, plant injury, and yield associated with various herbicides in over-wintered spinach, Kibler, 1999.

	Weed control[a]				Effect on Spinach			
	MATMT			OEOLA	Spinach injury			
Treatment description[b]	3 wk	4 wk	8 wk	8 wk	3 wk	4 wk	8 wk	Yield
(kg/ha)	(%)							(mt/ha)
Untreated check	0	0	0	0	0	0	0	9
Linuron, 0.34, PRE	90	98	92	93	33	39	23	16
Linuron, 0.17, PRE	90	90	78	84	10	4	9	20
Diuron, 0.17, PRE	90	97	94	86	11	6	5	19
Diuron, 0.34, PRE	91	97	96	88	49	73	56	12
Metolachlor, 1.12, PRE	89	94	90	85	14	6	9	17
S-metolachlor, 0.56, PRE	93	87	85	86	14	5	11	18
Metolachlor, 2.24, PRE	94	99	96	95	34	19	18	16
S-metolachlor, 1.12, PRE	91	99	95	97	26	10	10	22
Dimethenamid, 0.56, PRE	91	93	86	88	23	14	9	18
α-dimethenamid X2, 0.28, PRE	90	94	84	91	25	21	6	17
Dimethenamid, 1.12, PRE	84	99	92	96	46	31	25	21
α-dimethenamid X2, 0.56, PRE	93	99	97	97	39	28	23	16
Fluroxypyr, 0.1, POST	0	79	36	60	0	44	35	4
Fluroxypyr, 0.2, POST	0	80	61	79	0	46	40	3
Triflusulfuron, 0.02, POST	0	92	93	92	0	46	90	1
Phenmedipham, 0.56, POST	0	99	95	95	0	74	40	16
Phenmedipham, 0.56 + metolachlor, 1.12, POST	0	21	99	97	97	0	73	21
Phenmedipham, 0.56 + sethoxydim, 0.31, POST	0	99	90	94	0	75	51	19
Metolachlor, 1.12, PRE *fb* clopyralid, 0.08, POST	88	98	97	95	11	13	6	20
Metolachlor, 1.12, PRE *fb* phenmedipham, 0.56, POST	89	99	97	97	16	76	41	20
LSD (0.05)[c]	8	8	11	10	11	15	15	8

[a] Evaluations were made 3, 4, and 8 wk after PRE applications. The 4- and 8-wk evaluations correspond to 1 and 7 wk after POST applications.
[b] PRE = preemergence; and POST = postemergence.
[c] LSD values may be used to compare means within the same column.

Table 4a. Weed control associated with various herbicides in southernpeas, Fayetteville, 1999.

	Weed Control[a]											
	CYPES				AMACH				PHYAN			
Treatment description[b]	3 wk	5 wk	8 wk	10 wk	3 wk	5 wk	8 wk	10 wk	3 wk	5 wk	8 wk	10 wk
(kg/ha)	(%)											
Untreated check	0	0	0	0	0	0	0	0	0	0	0	0
S-metolachlor, 1.4, PRE	61	58	51	45	93	94	91	86	90	88	84	79
Diclosulam, 0.04, PRE	86	83	86	80	98	96	96	93	96	93	90	90
Dimethenamid, 1.12, PRE	65	56	54	48	94	95	94	89	91	85	84	75
Flufenacet, 0.28, PRE	36	45	50	54	85	81	74	69	79	80	76	75
Halosulfuron, 0.03, PRE	80	83	79	69	90	90	88	84	76	70	59	49
S-metolachlor, 1.4 + flumetsulam, 0.06, PRE	81	85	88	85	96	95	98	94	97	96	97	95
Cloransulam-methyl, 0.02 + AG-98 (0.25%), POST	65	69	80	85	69	73	65	55	81	83	78	76
Imazapic, 0.07 + AG-98 (0.25%), POST	85	84	84	79	97	98	96	93	96	94	96	95
Imazamox, 0.04 + AG-98 (0.25%), POST	58	56	59	69	98	94	91	85	94	95	93	94
Halosulfuron, 0.03 + AG-98 (0.25%), POST	85	89	90	85	94	93	91	89	90	75	56	33
Clomazone, 1.12, PRE *fb* halosulfuron, 0.03 + AG-98 (0.25%), POST	88	90	89	84	95	94	91	86	85	75	67	63
LSD (0.05)[c]	12	7	7	9	7	4	5	6	7	6	8	11

Table 4b. Weed control, plant injury, and yield associated with various herbicides in southernpeas, Fayetteville, 1999.

	Weed control[a]				Effect on southernpeas				
	EPHMA				Injury				
Treatment description[b]	3 wk	5 wk	8 wk	10 wk	3 wk	5 wk	8 wk	10 wk	Yield
(kg/ha)	(%)								(mt/ha)
Untreated check	0	0	0	0	0	0	0	0	0.6
S-metolachlor, 1.4, PRE	80	76	70	64	9	3	0	0	0.7
Diclosulam, 0.04, PRE	92	93	89	83	8	0	0	0	1.1
Dimethenamid, 1.12, PRE	85	80	70	59	3	0	0	0	0.7
Flufenacet, 0.28, PRE	88	85	84	81	4	0	0	0	0.5
Halosulfuron, 0.03, PRE	58	56	49	36	5	0	0	0	0.9
S-metolachlor, 1.4 + flumetsulam, 0.06, PRE	86	93	94	95	13	5	0	0	1.0
Cloransulam-methyl, 0.02 + AG-98 (0.25%), POST	73	65	55	46	36	24	18	18	0.9
Imazapic, 0.07 + AG-98 (0.25%), POST	93	94	91	90	71	59	54	43	0.3
Imazamox, 0.04 + AG-98 (0.25%), POST	94	95	94	93	36	33	19	15	0.8
Halosulfuron, 0.03 + AG-98 (0.25%), POST	56	55	43	36	75	68	60	53	0.0
Clomazone, 1.12, PRE *fb* halosulfuron, 0.03 + AG-98 (0.25%), POST	76	74	66	61	75	71	65	55	0.0
LSD (0.05)[c]	11	9	11	15	9	6	5	8	0.2

[a] Evaluations were made 3, 5, 8, and 10 wk after PRE applications. The 5-, 8-, and 10-wk evaluations correspond to 2, 5, and 7 wk after the POST applications.
[b] PPI = preplant incorporated; PRE = preemergence; and POST = postemergence.
[c] LSD values may be used to compare means within a column.

Table 5a. Weed control associated with various herbicides in grapes, Fayetteville, 1999.

	Weed control[a]								
	CYNDA			DIGSA			TAROF		
Treatment description[b]	2 wk	6 wk	9 wk	2 wk	6 wk	9 wk	2 wk	6 wk	9 wk
(kg/ha)	(%)								
Glufosinate, 1.12 + simazine, 1.68 + oryzalin, 3.36, POST	86	75	53	83	75	73	89	91	95
Glufosinate, 1.12 + azafenidin, 0.42, POST	90	89	91	88	91	95	93	90	98
Glufosinate, 1.12 + azafenidin, 0.84, POST	91	93	89	86	86	90	89	90	99
Glufosinate, 1.12 + thiazopyr, 0.42, POST	95	91	94	90	93	99	93	90	97
Glufosinate, 1.12 + thiazopyr, 0.84, POST	96	91	95	86	93	97	94	94	100
Sulfosate, 1.12, POST *fb* sulfosate, 1.12, POST	89	91	97	89	88	93	88	89	96
Glyphosate, 1.12, POST *fb* glyphosate, 1.12, POST	93	86	96	91	90	99	89	91	100
LSD (0.05)[d]	5	6	14	7	6	11	4	NS	NS

Table 5b. Weed control, sucker control, plant injury, and yield associated with various herbicides in grapes, Fayetteville, 1999.

	Weed control[a]			Effect on grapes						
	OEOLA			Sucker control			Injury			
Treatment description[b, c]	2 wk	6 wk	9 wk	2 wk	6 wk	9 wk	2 wk	6 wk	9 wk	Yield
(kg/ha)	(%)									(mt/ha)
Glufosinate, 1.12 + simazine, 1.68 + oryzalin, 3.36, POST	54	48	35	15	21	40	0	0	0	2.8
Glufosinate, 1.12 + azafenidin, 0.42, POST	91	91	99	28	31	30	0	0	0	5.1
Glufosinate, 1.12 + azafenidin, 0.84, POST	95	95	100	40	28	60	0	0	0	5.7
Glufosinate, 1.12 + thiazopyr, 0.42, POST	91	94	97	71	86	96	0	0	0	7.8
Glufosinate, 1.12 + thiazopyr, 0.84, POST	91	90	97	58	56	70	0	0	0	1.0
Sulfosate, 1.12, POST *fb* sulfosate, 1.12, POST	90	91	96	80	83	78	0	0	0	4.2
Glyphosate, 1.12, POST *fb* glyphosate, 1.12, POST	90	94	100	81	88	86	0	0	0	6.3
LSD (0.05)[d]	9	5	14	20	21	23	NS	NS	NS	NS

[a] Evaluations were made 2, 6, and 9 wk after initial POST applications. The 9-wk evaluation corresponds to 3 wk after the sequential POST application.
[b] POST = postemergence applied 28 May.
[c] Sequential POST applications were applied 8 July, 6 wk after the initial POST applications.
[d] LSD values may be used to compare means within the same column.

Table 6. Weed control, plant injury, and yield associated with various herbicides in tomatoes, Fayetteville, 1999.

	Weed control[a]			Effect on tomatoes			
	CYPES			Injury			
Treatment description[b, c]	2 wk	4 wk	6 wk	2 wk	4 wk	6 wk	Yield
(kg/ha)	(%)						(mt/ha)
Untreated check	0	0	0	0	0	0	87
Halosulfuron, 0.035 + sethoxydim, 0.31 + AG-98 (0.25%), POST	71	83	84	0	0	0	86
Rimsulfuron, 0.035 + AG-98 (0.25%), POST *fb* rimsulfuron, 0.035 + AG-98 (0.25%), POST	69	75	69	0	0	0	107
LSD (0.05)[c]	5	8	4	NS	NS	NS	15

[a] Evaluations were made 2, 4, and 6 wk after the initial POST application. The 4- and 6-wk evaluations correspond to 1 and 3 wk after the sequential POST applications.
[b] POST = postemergence.
[c] Sequential POST applications were made 19 days after the initial POST applications.
[d] LSD values may be used to compare means within the same column.

Appendix Table 1. Common, trade and chemical names of herbicides used.

Designation and trade names	Chemical name, formulation, and manufacturer
α-dimethenamid (Frontier X2®)	Isomer of dimethenamid, 720 g/L EC (BASF)
azafenidin (Milestone®)	2-[2,4-dichloro-5-(2-propynyloxy)phenyl]-5,6,7,8-tetrahydro-1,2,4-triazolo[4,3-a]pyridin-3(2*H*)-one, 80% DF (DuPont)
bentazon (Basagran®)	3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide, 480 g/L (BASF)
carfentrazone (Aim®)	α,2-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]-4-fluorobenzenepropanoic acid, 40% DF (FMC)
clomazone (Command®)	2-[(2-chlorophenyl)methyl]-4,4-dimethyl-3-isoxazolidinone, 360 g/L (FMC)
clopyralid (Stinger®)	3,6-dichloro-2-pyridinecarboxylic acid, 360 g/L (Dow AgroSciences)
cloransulam (FirstRate®)	3-chloro-2-[[(5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-c]pyrimidin-2yl)sulfonyl]amino]benzoic acid, 84% DF (Dow AgroSciences)
diclosulam (Strongarm®)	*N*-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-c]pyrimidine-2-sulfonamide, 84% DF (Dow AgroSciences)
dimethenamid (Frontier®)	2-chloro-*N*-[(1-methyl-2-methoxy)ethyl]-N-(2,4-dimethyl-thien-3-yl)-acetamide, 720 g/L (BASF)
diuron (Karmex®)	*N*'-(3,4-dichlorophenyl)-*N*,*N*-dimethylurea, 80% WP (DuPont)
flufenacet	*N*-(4-fluorophenyl)-*N*-(1-methylethyl)-2-[[5-(trifluoromethyl)-1,3,4-thiadiazol-2-yl]oxy]acetamide, 60% DF (Bayer)
flumetsulam (Python®)	*N*-(2,6-difluorophenyl)-5-methyl[1,2,4]triazolo[1,5-a]pyrimidine-2-sulfonamide, 80% WDG (Dow AgroSciences)
flumiclorac (Resource®)	[2-chloro-4-fluoro-5-(1,3,4,5,6,7-hexahydro-1,3-dioxo-2*H*-isoindol-2-yl)phenoxy]acetic acid, 103 g/L EC (Valent)
fluroxypyr (Starane®)	[(4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]acetic acid, 200 g/L (Platte Chemical)
fomesafen (Reflex®)	5-[2-chloro-4-(trifluoromethyl)phenoxy]-*N*-(methylsulfonyl)-2-nitrobenzamide, 240 g/L (Zeneca)
glyphosate (Roundup Ultra®)	*N*-(phosphonomethyl)glycine, 360 g ae/L) (Monsanto)
glufosinate (Finale®)	2-amino-4-(hydroxymethylphosphinyl)butanoic acid, 120 g/L (AgrEvo)
halosulfuron (Permit®)	5-[2-chloro-6-fluoro-4-(trifluoromethyl)phenoxy]-*N*-(ethylsulfonyl)-2-nitrobenzamide, 75% W (Monsanto)
imazamox (Raptor®)	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecar- boxylic acid, 120 g/L SL (American Cyanamid)
imazapic (Cadre®)	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid, 70% DG (American Cyanamid)

continued

Appendix Table 1. Continued.

Designation and trade names	Chemical name, formulation, and manufacturer
imazethapyr (Pursuit®)	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid, 240 g/L (American Cyanamid)
lactofen (Cobra®)	(±)-2-ethoxy-1-methyl-2-oxoethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate, 240 g/L (Valent)
linuron (Lorox®)	*N*'-(3,4-dichlorophenyl)-*N*-methoxy-*N*-methylurea, 50% DF (DuPont)
metolachlor (Dual®)	2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide, 960 g/L (Novartis)
oryzalin (Surflan®)	4-(dipropylamino)-3,5-dinitrobenzenesulfonamide, 480 g/L (Dow AgroSciences)
oxyfluorfen (Goal 2XL®)	2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene, 240 g/L EC (Rhone Poulenc)
oxasulfuron (Expert®)	2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino]carboxy]amino]sulfonyl]benzoic acid, 57% (Novartis)
phenmedipham (Spin Aid®)	3-[(methoxycarbonyl)amino]phenyl(3-methylphenyl)carbamate, 156 g/L (AgrEvo)
pyridate (Tough®)	*O*-(6-chloro-3-phenyl-4-pyridazinyl) *S*-octyl carbonothioate, 600 g/L EC (Novartis)
quizalofop-P (Assure II®)	(*R*)-2-[4-[(6-chloro-2-quinoxalinyl)oxy]phenoxy]propanoic acid, 96 g/L (DuPont)
rimsulfuron (Shade-Out®)	*N*-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide, 25% DF (DuPont)
S-metolachlor (Dual Magnum®)	Isomer of metolachlor, 914 g/L EC (Novartis)
sethoxydim (Poast®)	2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one, 180 g/L (BASF)
simazine (Princep®)	6-chloro-*N*,*N*'-diethyl-1,3,5-triazine-2,4-diamine, 480 g/L F (Novartis)
sulfentrazone (Authority®)	*N*-[2,4-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1*H*-1,2,4-triazol-1-yl] phenyl]methanesulfonamide, 75% DF (DuPont)
sulfosate (Touchdown®)	trimethylsulfonium carboxymethylaminomethyl-phosphonate, 600 g/L SL (Zeneca)
thiazopyr (Visor®)	methyl 2-(difluoromethyl)-5-(4,5-dihydro-2-thiazolyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3-pyridine-carboxylate, 240 g/L EC (Rhone Poulenc)
triasulfuron (Amber®)	2-(2-chloroethoxy)-*N*-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulfonamide, 75% DF (Novartis)
trifluralin (Treflan®)	2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine, 480 g/L (Dow AgroSciences)
triflusulfuron (Upbeet®)	2-[[[[[4-(dimethylamino)-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl]-3-methylbenzoic acid, 50% DF (DuPont)

Appendix Table 2. Climatological data, AAREC, Fayetteville, 1999.

Day	April			May			June			July		
	Temperature		Rainfall	Temperature		Rainfall	Temperature		Rainfall	Temperature		Rainfall
	Max.	Min.		Max.	Min.		Max.	Min.		Max.		Min.
	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)
1	16	16		22	6		26	19	1.47	28	26	0.81
2	23	17		24	8		28	19		27	26	7.49
3	24	16	2.79	22	14		30	19		31	23	
4	21	7	2.54	23	14	1.68	30	21		31	20	
5	25	12	0.43	21	13	3.99	29	22		32	21	
6	22	7	0.76	24	8		30	22		31	20	
7	24	9		21	9		30	22		33	20	0.61
8	26	9		26	7		31	22		33	23	
9	24	11	0.43	27	10		31	23		33	23	
10	23	13		28	9		30	22		32	22	
11	24	8		28	7	5.94	29	19	1.30	25	24	3.25
12	20	7		26	16	3.86	29	14		26	23	
13	22	11		19	7		30	14		25	24	
14	22	11	1.93	23	9		28	16		28	24	
15	14	6	0.28	26	13		26	18		31	17	
16	12	2		27	14		26	22		31	13	
17	11	2		28	17	1.19	20	22	2.08	31	14	
18	15	2		19	10	1.47	23	21		32	18	
19	20	14		23	9		26	23	0.13	33	17	
20	26	8		25	13		26	22	1.78	32	18	
21	28	14		25	16	1.75	24	23	0.38	32	17	
22	27	17		23	16		28	23	0.74	32	18	
23	23	16	0.43	28	10	2.57	28	24	0.43	33	18	
24	19	14	0.03	24	9	2.57	27	23	1.02	34	21	
25	19	15		26	14		27	24	2.36	36	19	
26	19	13	2.06	23	14	1.47	31	26	0.23	36	15	
27	23	11	1.04	22	9		32	24		35	17	
28	23	9	0.25	24	11		31	24		35	19	
29	19	10		25	13		31	26	0.51	36	19	
30	21	8		23	16	0.13	27	26	7.49	37	19	
31				26	16	0.25				36	19	

Appendix Table 3. Climatological data, Vegetable Substation, Kibler, 1999.

	April			May			June			July		
	Temperature		Rainfall	Temperature		Rainfall	Temperature		Rainfall	Temperature		Rainfall
Day	Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)	(°C)	(°C)	(cm)
1	23	14		26	10		32	20	0.15	32	24	3.58
2	25	18		26	11		33	20	0.08	34	25	
3	22	14		27	15		34	23		34	25	
4	24	14		23	18	0.84	34	24		36	24	
5	23	14	4.90	27	15	1.84	34	23		36	24	
6	25	9		23	12	0.05	34	24		37	26	
7	28	12		25	9		37	23		36	26	
8	28	17		32	11		36	23	0.61	37	26	
9	26	12	0.15	33	15		34	23		37	26	
10	27	11		22	18	0.20	33	21		31	22	
11	24	11		27	18	3.35	32	21	3.38	29	21	0.25
12	27	8		21	14	3.51	33	21		30	20	
13	21	15		26	11		31	22		32	19	
14	16	13	0.20	28	14		29	19	1.93	36	20	
15	16	6	1.35	32	19		29	18		36	23	
16	15	4		33	22		24	18		36	22	
17	14	3		28	21	0.10	27	17		36	23	
18	23	2		27	14	6.48	28	14		36	23	
19	29	8		27	14		26	18		37	24	
20	33	12		29	16		29	20	1.17	37	24	
21	31	16		28	18	2.13	32	22		36	24	
22	27	21		33	19		33	22	0.20	36	24	
23	31	18		28	16		29	23	0.91	38	24	
24	20	15		29	14	3.02	33	22	3.30	40	24	
25	18	15		25	17		29	22		40	26	
26	23	15	1.83	26	16		33	23		39	27	
27	24	13	1.73	27	13		34	25		39	27	
28	24	12		28	14		32	27		39	26	
29	23	11		26	18		31	21	3.99	41	26	
30	24	12		29	21	1.17	28	21	4.85	39	25	
31				29	21	1.09				40	23	

Appendix Table 4. Standardized plant (Bayer) codes, Weed Science Society of America, for weeds appearing in this report.

Code	Scientific name	Common name
AMAAL	*Amaranthus albus* L.	tumble pigweed
AMACH	*Amaranthus hybridus* L.	smooth pigweed
CAPBP	*Capsella bursa-pastoris* L.	shepherdspurse
CHEAL	*Chenopodium album* L.	common lambsquarters
CMIRA	*Campsis radicans* (L.) seem. ex Bureau	trumpetcreeper
CONAR	*Convolvulus arvensis* L.	field bindweed
CYNDA	*Cynodon dactylon* (L.) Pers.	bermudagrass
CYPES	*Cyperus esculentus* L.	yellow nutsedge
DIGSA	*Digitaria sanguinalis* (L.) Scop.	large crabgrass
ERICA	*Conyza canadensis* (L.) Cronq.	horseweed
LAMAM	*Lamium amplexicaule* L.	henbit
MATMT	*Matricaria matricariodes* (Less.) C. L. Porter	pineappleweed
MOLVE	*Mallugo verticillata* L.	carpetweed
OEOLA	*Oenothera laciniata* Hill	cutleaf eveningprimrose
OXAST	*Oxalis stricta* L.	yellow woodsorrel
POANN	*Poa annua* L.	annual bluegrass
SIBVI	*Sibara virginica* (L.) Rollins	sibara
SOLCA	*Solanum carolinense* L.	horsenettle
TAROF	*Taraxacum officinale* Weber in Wiggers	dandelion

Conversion Table

		U.S. to Metric	Metric to U.S.		
to convert from	to	multiply U.S. unit by	to convert from	to	multiply metric unit by
length			**length**		
miles	kilometers	1.61	kilometers	miles	.62
yards	meters	.91	meters	yards	1.09
feet	meters	.31	meters	feet	3.28
inches	centimeters	2.54	centimeters	inches	.39
area and volume			**area and volume**		
sq yards	sq meters	.84	sq meters	sq yards	1.20
sq feet	sq meters	.09	sq meters	sq feet	10.76
sq inches	sq centimeters	6.45	sq centimeters	sq inches	.16
cu inches	cu centimeters	16.39	cu centimeters	cu inches	.06
acres	hectares	.41	hectares	acres	2.47
liquid measure			**liquid measure**		
cu inches	liters	.02	liters	cu inches	61.02
cu feet	liters	28.34	liters	cu feet	.04
gallons	liters	3.79	liters	gallons	.26
quarts	liters	.95	liters	quarts	1.06
fluid ounces	milliliters	29.57	milliliters	fluid ounces	.03
weight and mass			**weight and mass**		
pounds	kilograms	.45	kilograms	pounds	2.21
ounces	grams	28.35	grams	ounces	.04
temperature			**temperature**		
F	C	5/9(F-32)	C	F	9/5(C+32)