CABBAGE, MUSTARD GREENS, AND TURNIP GREENS HERBICIDE SCREENING STUDY

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Introduction

Cabbage, mustard greens, and turnip greens are important crops in Georgia with production exceeding 22,000 acres and 71 million dollars in value during 2005 (Boatwright and McKissick 2006). Limited herbicide options are available for these crops making weed control challenging. The objective of this experiment was to determine cabbage, mustard greens, and turnip greens tolerance to numerous herbicides applied preemergence and postemergence in Southern Georgia.

Materials and Methods

Two studies were conducted (Fall 2005 and Spring 2006) at the Ponder Research Farm in TyTy, Georgia. In the fall of 2005, the study consisted of 'Bravo' cabbage and 'Southern Giant Curled' mustard green being exposed to 24 herbicide treatments plus two non-treated controls (Tables 1 and 2) while in the spring of 2006 'Bravo' cabbage and 'White Globe Turnip Top' turnip greens were exposed to 23 herbicide treatments plus a non-treated control (Tables 3 and 4). Studies were arranged in a randomized complete block design with four replications. Plots were one bed wide (6 ft) by 15 ft in length. To determine crop tolerance without interference of weeds, 10 ft of the plot was maintained weed-free while the remaining 5 ft was used to evaluate weed efficacy. In the Fall of 2005, pre-plant incorporated (PPI) treatments were applied to preformed beds and incorporated using a KMC rototiller to a depth of 2 inches. Using a Monosem vacuum planter, a single row of mustard greens were seeded on one side of the 6 foot wide bed while cabbage was hand-transplanted on the other side of the bed, a distance of 3 ft from the greens. After seeding of the greens and immediately prior to transplanting of the cabbage, preemergence (PRE) treatments were applied followed by 0.35 inches of irrigation for activation of the residual products. Two wks after planting, the postemergence (POST) treatments were applied. In the Spring of 2006, the same process was followed except for the planting of turnip greens instead of mustard greens. All applications were made using a CO_2 pressurized backpack sprayer calibrated to deliver 14.8 gallons per acre at 3 mph using TeeJet 11002XR nozzles at 23 psi. Data collected consisted of visual injury (0 to 100 scale where 0 = no injury and 100 = complete crop death), weed efficacy (0 to 100 scale where 0 = no control and 100 = complete weed death), stand counts, plant heights, and yield. Due to poor germination of mustard greens, no stand counts or yield data were collected.

Results and Discussion

Cabbage. In the Fall of 2005, flumioxazin at 0.016, 0.032, 0.048, and 0.064 lbs/A caused 10, 33, 53, and 66% injury, respectively, 4 wks after planting (WAP) (Table 1). Cabbage height was reduced 3 WAP with flumioxazin at 0.032 lbs/A or greater. The 0.048 and 0.064 lbs/A rates of flumioxazin caused a reduction in cabbage stand, however, no rate of flumioxazin reduced total yield of cabbage. No yield reduction from flumioxazin is understandable since those plants that survived treatment had less competition for resources, resulting in cabbage heads larger than marketable size. In the Spring of 2006 similar results were observed with no rate of flumioxazin reducing yield yet causing 18 to 64% injury 4 WAP (Table 3). No reduction in stand was observed in 2006, however, all rates of flumioxazin reduced plant height 7 WAP. Cabbage head formation was variable with flumioxazin treatments making a once over harvest impossible in production fields. Despite

no reduction in yield, Georgia growers would be unwilling to accept this lack of uniformity in cabbage head size along with the level of injury sustained from a PRE application of flumioxazin.

In 2005 and 2006, all treatments containing metolachlor POST caused 8% or less injury 4 WAP and had yields similar to the non-treated control (Tables 1 and 3). Metolachlor PRE caused 11 to 23% injury 4 WAP. In 2005, dimethenamid POST caused 2 to 3% injury to cabbage 4 WAP while PRE applications caused 21 to 28% injury (Table 1). All applications of dimethenamid had yields similar to the non-treated control, however, yield was greater with POST applications of dimethenamid than with PRE applications. In 2006, dimethenamid PRE and POST caused 36 to 38 and 4 to 10% injury to cabbage, respectively, 4 WAP (Table 3). Yield was reduced with PRE applications of dimethenamid.

Pendimethalin caused 8 and 14% or less injury in 2005 and 2006, respectively, while having yields similar to the non-treated control (Tables 1 and 3). Sulfentrazone PRE and POST caused 3 to 9% injury to cabbage in 2005 and did not reduce yield (Table 1). Similar results were observed in 2006 with no yield reduction observed despite greater injury ranging from 18 to 19% (Table 3). Flufenacet PRE caused 53 and 34% injury to cabbage in 2005 and 2006, respectively, with POST applications causing 4 to 11% injury (Tables 1 and 3). No reduction in yield was observed with flufenacet, however, PRE applications reduced plant height in both years tested.

Mustard Greens. Flumioxazin caused severe injury (98% or greater 4 WAP) and crop death (Table 2). Metolachlor caused 2 to 13% injury to mustard greens with dimethamid causing similar injury (2 to 16%), 4 WAP (Table 2). Pendimethalin at 0.356 lbs/A caused 10 and 5% injury while 0.712 lbs/A caused 25 and 18% injury, PRE and POST, respectively. Sulfentrazone PRE caused 6% injury, however applied POST, injury increased to 46%, 4 WAP. Flufenacet caused 21 and 14% injury PRE and POST, respectively.

Turnip Greens. Flumioxazin caused complete crop death at all rates (Table 4). All treatments containing trifluralin caused 1% or less injury, 4 WAP, and had yield similar to the non-treated control. Metolachlor alone caused 12 to 18% injury when applied either PRE or POST and yields were similar to the non-treated control. Dimethamid PRE caused 18 to 28% injury while POST applications caused 9 to 13% injury, 4 WAP. Dimethenamid PRE and POST at 0.375 lbs/A had yields similar to the non-treated control, however 0.562 lbs/A reduced yield of turnip greens. Pendimethalin PRE and POST at 0.356 lbs/A caused 9 and 16% injury, respectively, 6 WAP, and did not reduce yield. Pendimethalin at 0.712 lbs/A reduced yield of turnip greens and caused 75 and 34% injury 6 WAP when applied PRE and POST, respectively. Sulfentrazone PRE and POST caused 80 and 69% injury, respectively, 4 WAP, while reducing yield greater than 50%. Flufenacet reduced yield of turnip greens and caused almost complete crop death when applied PRE and 68% injury with a POST application.

Weed Efficacy. All treatments except for trifluralin PPI controlled henbit 87% or greater (Table 4). Weed emergence occurred after the application of the POST treatments resulting in greater control from these treatments than would be observed if weeds had emerged prior to an application of a residual product 2 WAP. Swinecress was controlled 100% with flumioxazin PRE and 97% with trifluralin PPI plus metolachlor POST at 0.714 lbs/A while pendimethalin PRE at 0.712 lbs/A provided 95% control. Swinecress was controlled 84 to 88% with flufenacet, dimethenamid POST at 0.562 lbs/A, and metolachlor POST at 0.714 lbs/A. Sulfentrazone provided 65% or less control of swinecress.

Acknowledgements: The authors wish to acknowledge partial financial support from U.S.D.A.'s IR-4 project.

Literature Cited:

Boatright S.R. and J.C. McKissick. 2005. Georgia farm gate vegetable report (Area Report No. 06-04). Center for Agribusiness and Economic Development,

University of Georgia, Athens, GA. Available online at http://www.caed.uga.edu/publications/2006/pdf/AR-06-04.pdf .

Table 1. Cabbage response to PRE and POST herbicide applications (Fall 2005).

Treatment[z]	Rate	Timing[y]	Cabbage									
			Injury				Stand		Height		Harvest	
			4 WAP[x]		7 WAP		14 WAP		3 WAP		14 WAP	
	lbs ai/A		——— % ———				# / 7ft		cm		1000 lbs/A	
Flumioxazin	0.016	PRE	10	fg[w]	5	e-i	6.3	a	16.5	a-f	32.0	ab
	0.032	PRE	33	c	22	c	6.3	a	12.8	hij	33.5	a
	0.048	PRE	53	b	29	b	5.0	bc	10.9	jk	24.5	a-f
	0.064	PRE	66	a	40	a	4.5	c	9.4	k	31.5	abc
Trifluralin	0.25	PPI	3	gh	4	f-j	7.0	a	17.2	a-d	20.7	d-g
Trifluralin + Metolachlor	0.25 + 0.476	PPI + POST	0	h	0	j	7.0	a	17.7	a-d	18.2	d-h
Non-treated			0	h	0	j	6.8	a	17.1	a-e	16.9	d-h
Trifluralin + Metolachlor	0.25 + 0.714	PPI + POST	3	gh	0	j	6.8	a	16.3	a-f	22.9	b-g
Metolachlor	0.476	PRE	16	ef	9	de	7.0	a	14.6	fgh	14.5	fgh
	0.714	PRE	11	efg	8	def	6.8	a	14.9	e-h	19.0	d-h
	0.476	POST	4	gh	5	e-i	6.8	a	16.3	a-f	16.5	d-h
	0.714	POST	8	fgh	2	ij	6.5	a	16.9	a-e	15.9	e-h
Dimethenamid	0.375	PRE	21	de	13	d	6.5	a	15.7	d-g	13.4	gh
	0.562	PRE	28	cd	24	c	6.3	a	14.1	ghi	9.8	h
	0.375	POST	2	gh	0	j	7.0	a	18.2	abc	23.2	b-g
	0.562	POST	3	gh	6	e-i	7.0	a	16.2	b-g	26.5	a-d
Pendimethalin	0.356	PRE	4	gh	4	g-j	7.0	a	18.4	ab	21.3	d-g
	0.712	PRE	8	fgh	8	efg	7.0	a	16.8	a-e	17.4	d-h
	0.356	POST	4	gh	4	g-j	6.3	a	17.3	a-d	14.4	gh
	0.712	POST	5	gh	7	e-h	6.3	a	17.8	a-d	21.7	c-g
Sulfentrazone	0.1	PRE	3	gh	2	ij	6.0	ab	17.2	a-d	22.7	b-g
	0.15	PRE	5	gh	3	hij	6.5	a	16.7	a-f	21.4	d-g
	0.1	POST	9	fgh	0	j	7.0	a	16.2	c-g	24.7	a-e
Flufenacet	0.375	PRE	53	b	30	b	7.0	a	11.9	ij	9.9	h
	0.375	POST	11	fg	13	d	6.0	ab	15.9	d-g	18.3	d-h
Non-treated			0	h	0	j	7.0	a	18.4	a	17.7	d-h

[z] Flumioxazin, Chateau®; trifluralin, Treflan HFP®; metolachlor, Dual Magnum®; dimethenamid, Outlook®; pendimethalin, Prowl H_2O®; sulfentrazone, Spartan®; flufenacet, Define®.

[y] PPI (pre-plant incorporated to 2 inches); PRE (preemergence); POST (postemergence, 2 wks after planting)

[x] WAP = wks after planting

[w] Means within a column followed by a common letter are not different according to LSD separation procedures at $p \leq 0.05$

Table 2. Mustard Greens response to PRE and POST herbicide applications (Fall 2005).

Treatment[z]	Rate	Timing[y]	Mustard Greens					
			Injury				Height	
			4 WAP[x]		7 WAP		3 WAP	
	lbs ai/A		---------- % ----------				cm	
Flumioxazin	0.016	PRE	98	a[w]	75	b	0.3	f
	0.032	PRE	99	a	96	a	0.2	f
	0.048	PRE	99	a	96	a	0.2	f
	0.064	PRE	100	a	100	a	0.0	f
Trifluralin	0.25	PPI	6	g-j	7	f-i	3.7	a-d
Trifluralin + Metolachlor	0.25 + 0.476	PPI + POST	7	f-j	7	f-i	4.0	a
Non-treated			0	j	0	i	3.5	a-d
Trifluralin + Metolachlor	0.25 + 0.714	PPI + POST	12	d-i	4	ghi	2.6	cde
Metolachlor	0.476	PRE	7	f-j	3	ghi	3.4	a-d
	0.714	PRE	8	e-j	0	i	3.2	a-e
	0.476	POST	2	ij	2	hi	3.9	ab
	0.714	POST	13	d-h	4	ghi	3.0	a-e
Dimethenamid	0.375	PRE	3	hij	3	hi	3.1	a-e
	0.562	PRE	16	c-f	4	ghi	2.6	b-e
	0.375	POST	2	ij	2	hi	3.8	abc
	0.562	POST	9	e-j	14	ef	3.4	a-d
Pendimethalin	0.356	PRE	10	e-j	11	efg	3.6	a-d
	0.712	PRE	25	c	29	d	3.1	a-e
	0.356	POST	5	g-j	5	ghi	3.6	a-d
	0.712	POST	18	cde	19	e	2.9	a-e
Sulfentrazone	0.1	PRE	6	g-j	3	ghi	3.7	a-d
	0.15	PRE	6	f-j	7	f-i	3.9	ab
	0.1	POST	46	b	50	c	2.0	e
Flufenacet	0.375	PRE	21	cd	1	i	3.2	a-e
	0.375	POST	14	d-g	10	fgh	2.4	de
Non-treated			0	j	0	i	4.0	a

[z] Flumioxazin, Chateau®; trifluralin, Treflan HFP®; metolachlor, Dual Magnum®; dimethenamid, Outlook®; pendimethalin, Prowl H_2O®; sulfentrazone, Spartan®; flufenacet, Define®.

[y] PPI (pre-plant incorporated to 2 inches); PRE (preemergence); POST (postemergence, 2 wks after planting)

[x] WAP = wks after planting

[w] Means within a column followed by a common letter are not different according to LSD separation procedures at $p \leq 0.05$

Table 3. Cabbage response to PRE and POST herbicide applications (Spring 2006).

Treatment[z]	Rate	Timing[y]	Cabbage									
			Injury				Stand		Height		Harvest	
			4 WAP[x]		6 WAP		14 WAP		7 WAP		14 WAP	
	lbs ai/A		——— % ———				# / 7ft		cm		1000 lbs/A	
Flumioxazin	0.016	PRE	19	de[w]	12	f-i	7	a	16.4	e-h	44.6	abc
	0.032	PRE	18	de	18	efg	7	a	16.0	fgh	47.1	ab
	0.048	PRE	36	b	41	bc	7	a	14.0	hi	40.9	a-d
	0.064	PRE	64	a	55	a	7	a	11.4	j	34.9	b-e
Trifluralin	0.25	PPI	3	fg	0	j	7	a	18.6	a-e	35.4	b-e
Trifluralin + Metolachlor	0.25 + 0.476	PPI + POST	1	g	0	j	7	a	18.2	a-f	35.4	b-e
Non-treated			0	g	0	j	7	a	20.6	a	36.6	bcd
Trifluralin + Metolachlor	0.25 + 0.714	PPI + POST	1	g	0	j	7	a	19.9	ab	39.3	a-d
Metolachlor	0.476	PRE	19	de	21	def	7	a	15.4	gh	31.9	cde
	0.714	PRE	23	cd	31	cd	7	a	14.0	hi	29.6	def
	0.476	POST	0	g	3	ij	7	a	18.4	a-f	37.6	a-d
	0.714	POST	1	g	2	ij	7	a	19.4	abc	42.7	a-d
Dimethenamid	0.375	PRE	36	b	51	ab	7	a	11.5	ij	16.2	f
	0.562	PRE	38	b	57	a	7	a	10.0	j	22.0	ef
	0.375	POST	4	fg	0	j	7	a	17.6	b-g	36.2	bcd
	0.562	POST	10	efg	6	hij	7	a	18.5	a-f	37.5	a-d
Pendimethalin	0.356	PRE	6	fg	3	ij	7	a	19.2	a-d	39.1	a-d
	0.712	PRE	3	fg	4	ij	7	a	19.4	ab	45.6	abc
	0.356	POST	14	def	11	f-j	7	a	18.0	b-f	35.2	b-e
	0.712	POST	5	fg	6	ij	7	a	18.2	a-f	39.1	a-d
Sulfentrazone	0.1	PRE	18	de	18	e-h	7	a	16.6	d-g	34.3	b-e
	0.1	POST	19	de	7	g-j	7	a	18.7	a-e	37.3	a-d
Flufenacet	0.375	PRE	34	bc	39	c	7	a	12.4	ij	38.9	a-d
	0.375	POST	4	fg	24	de	7	a	16.8	c-g	50.5	a

[z] Flumioxazin, Chateau®; trifluralin, Treflan HFP®; metolachlor, Dual Magnum®; dimethenamid, Outlook®; pendimethalin, Prowl H_2O®; sulfentrazone, Spartan®; flufenacet, Define®.

[y] PPI (pre-plant incorporated to 2 inches); PRE (preemergence); POST (postemergence, 2 wks after planting)

[x] WAP = wks after planting

[w] Means within a column followed by a common letter are not different according to LSD separation procedures at $p \leq 0.05$

Table 4. Weed Efficacy and Turnip Greens response to PRE and POST herbicide applications (Spring 2006).

Treatment[z]	Rate	Timing[y]	Weed Control				Turnip Greens								
			Henbit		Swinecress		Injury				Stand		Height		Harvest	
			6 WAP[x]		6 WAP		4 WAP		6 WAP		3 WAP		7 WAP		8 WAP	
	lbs ai/A		%		%		%		%		# / 5ft		cm		lbs/A	
Flumioxazin	0.016	PRE	100	a[w]	100	a	100	a	100	a	0	e	0	l	0	k
	0.032	PRE	100	a	100	a	100	a	100	a	0	e	0	l	0	k
	0.048	PRE	100	a	100	a	100	a	100	a	0	e	0	l	0	k
	0.064	PRE	100	a	100	a	100	a	100	a	0	e	0	l	0	k
Trifluralin	0.25	PPI	48	d	29	k	1	i	0	i	22	a	11.5	abc	10788	ab
Trifluralin + Metolachlor	0.25 + 0.476	PPI + POST	100	a	74	fgh	1	i	0	i	23	a	12.9	a	11013	a
Non-treated			0	e	0	l	0	i	0	i	23	a	12.1	ab	8719	a-d
Trifluralin + Metolachlor	0.25 + 0.714	PPI + POST	99	ab	97	ab	3	ghi	1	i	19	abc	9.2	cde	9031	abc
Metolachlor	0.476	PRE	87	c	46	j	12	ef	19	g	21	a	6.6	f-i	7166	c-f
	0.714	PRE	98	ab	59	i	18	e	39	ef	17	bc	6.4	g-j	6207	d-g
	0.476	POST	99	ab	74	fgh	13	ef	15	gh	23	a	9.8	bcd	7979	cd
	0.714	POST	99	ab	86	cde	15	ef	14	gh	19	abc	7.6	d-g	6970	c-f
Dimethenamid	0.375	PRE	97	abc	68	ghi	18	e	49	e	17	bc	6.2	g-j	6512	c-f
	0.562	PRE	98	ab	74	fg	28	d	61	d	16	c	4.4	ijk	4697	fgh
	0.375	POST	98	ab	79	ef	9	fgh	16	gh	22	a	7.0	e-i	7442	cde
	0.562	POST	99	ab	88	bcd	13	ef	40	ef	20	abc	6.0	g-j	5184	e-h
Pendimethalin	0.356	PRE	98	ab	60	i	1	i	9	hi	23	a	10.8	abc	8342	bcd
	0.712	PRE	99	ab	95	abc	18	e	75	c	21	ab	3.9	jk	1735	ijk
	0.356	POST	93	abc	38	jk	11	efg	16	gh	22	a	9.1	c-f	8439	a-d
	0.712	POST	97	abc	68	ghi	2	hi	34	f	23	a	7.0	e-h	4966	e-h
Sulfentrazone	0.1	PRE	90	bc	38	jk	80	b	67	cd	5	d	4.8	h-k	3870	ghi
	0.1	POST	93	abc	65	hi	69	c	63	d	21	ab	3.9	jk	2988	hij
Flufenacet	0.375	PRE	95	abc	84	de	100	a	100	a	1	de	0.1	l	123	k
	0.375	POST	92	abc	84	de	68	c	86	b	22	a	2.7	k	1162	jk

[z] Flumioxazin, Chateau®; trifluralin, Treflan HFP®; metolachlor, Dual Magnum®; dimethenamid, Outlook®; pendimethalin, Prowl H_2O®; sulfentrazone, Spartan®; flufenacet, Define®.

[y] PPI (pre-plant incorporated to 2 inches); PRE (preemergence); POST (postemergence, 2 wks after planting)

[x] WAP = wks after planting

[w] Means within a column followed by a common letter are not different according to LSD separation procedures at $p \leq 0.05$