

## Weed Control Studies in Transplanted Bell Peppers with Preemergence Herbicides

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### INTRODUCTION

Peppers are long-season vegetables that have several weed control challenges: They compete weakly with weeds for the first 40 to 60 days following transplanting. They are a long-season crop in many production districts that can be subject to flushes of both winter and summer weeds over the course of their growing cycle. The preemergence herbicides registered for peppers have gaps in the spectrum of weeds that they control (Smith et al., 2003). As a result, growers may spend from \$200 to \$350/acre (Klonsky et al., 1997) on weed management. Field selection, field sanitation, cultivation and the use of plastic mulches are cultural practices that reduce weed pressure in production fields. Fumigation provides substantial weed control and is frequently used in conjunction with plastic mulches which improves the level of weed control provided by both techniques. Goal Tender was registered in California in 2004 for use with plastic mulch and provides control of Little Mallow (*Malva parviflora*) which is only partially controlled by fumigants and other preemergence herbicides registered for use on peppers. However, many acres of peppers are not grown with plastic mulch, and weed control is a challenge. Devrinol, Prefar and Treflan are registered preemergence herbicides in peppers. Dual Magnum is registered under a 24C and provides good control of hairy nightshade (*Solanum sarrachoides*) and yellow nutsedge (*Cyperus esculentus*) which are not controlled by the other preemergent materials. Late season weed control is also an important issue in this crop. The objective of these studies was to examine at transplant and layby herbicide combinations for peppers that can provide long-term and economical weed control for peppers grown without plastic mulch. The herbicides tested included: Dual Magnum 7.62 (s-metolachlor), Goal Tender 4F (oxyfluorfen), Outlook 6.0 (dimethenamid), flumioxazin (Chateau) impregnated on fertilizer, and Dacthal 75W (DCPA).

### METHODS

Field trials were conducted on the Central Coast (Monterey and Santa Clara Counties) and Fresno County in 2005 to provide an evaluation of the test herbicides over a wider range of growing conditions and weed spectra.

**Central Coast study:** The trial was conducted with a cooperating grower in Gilroy. Goal Tender treatments were applied onto shaped beds two weeks prior to transplanting the peppers on April 28. The field was transplanted on May 13. The at-planting treatments were applied over-the-top of the plants immediately following transplanting. Sprinkler irrigation was started 5 hours following transplanting applying 0.38 inch of water. Layby applications were made on June 16 and the material was incorporated with the last sprinkler irrigation before the field was switched to drip irrigation. The plots were hand weeded on June 3 and the July 1 weed evaluations reflect newly sprouted weeds following the layby application. The plots were not cultivated prior to the July 1 weed evaluation. Each plot was one 40-inch bed wide by 25 feet long and replicated four times in a randomized complete block design (RCBD). All sprayed treatments were applied to the entire bed in 74 gallons of water per acre with two passes of a one nozzle wand with an 8008E teejet nozzle at 30 psi. Flumioxazin on fertilizer granules

was spread by hand on the bed top immediately following transplanting. Soil type was Pacheco silt loam and the variety was Baron (planted in greenhouse on March 17).

**Fresno County Trial:** The field trial was conducted on a Panoche clay loam soil at the UC West Side Research and Extension Center (WSREC) near Five Points. On June 7 the bell pepper variety “Jupiter” was transplanted in single rows into 40” beds. Within row plant spacing was 10”. Plot size was two 40-inch beds x 70 feet of row length and replicated 4 times in a RCBD. Preplant applications of Goal Tender were made onto shaped beds on May 10, 28 days prior to transplanting the peppers and incorporated with 0.50 inches of rainfall. The at-planting treatments of Dual Magnum, Outlook and flumioxazin were applied over the top of the plants and the field was sprinkler irrigated applying 0.50 inches of water immediately following transplanting. Sprinkler irrigation continued as needed for a few weeks and then switched to furrow irrigation. On July 25 the field was machine cultivated before layby applications of the herbicides were made as a directed spray to the base of the plants. These applications were incorporated by sprinkler irrigation. All sprayed treatments were applied to the entire plot in 30 gallons of water per acre using a CO<sub>2</sub> backpack sprayer @30 psi and a 2 nozzle boom with 8003evs tips. Flumioxazin on fertilizer granules was hand broadcast over the top of the peppers. There were two untreated checks: one was handweeded twice in addition to layby cultivation and the other was allowed to grow weedy all season.

Plots were evaluated for phytotoxicity to the peppers and weed control on July 1, July 22, and August 12. Pepper stand counts were made on July 13. A portion of each plot (25’ row) was hand harvested on August 23 (west bed) and on September 8 (east bed) and the yields were combined for total yield. See tables 2 and 3 for treatments and evaluations.

## **RESULTS AND DISCUSSION**

**Central Coast:** Hairy Nightshade was the dominant weed at this site. The best weed control was provided by Outlook, then by Dual Magnum and Goal Tender on the 21 days after treatment (DAT) (Table 1). Flumioxazin impregnated on fertilizer provided good weed control in two treatments, but not on one. This may be due to problems with obtaining an even distribution of this dry granular material on the top of the bed. Devrinol was at a distinct disadvantage at this site because Hairy Nightshade was the main weed at this site and it did not control it. Outlook caused stunting of the plants 21 DAT, and while the stunting was reduced 28 DAT, it was still quite noticeable. There was no difference in the stand among treatments, but there were some instances of burned pepper plants in the flumioxazin treatment, presumably where a prill of the material lodged against the stem of a plant. All herbicides except Devrinol reduce time to weed the plots, but Goal and flumioxazin on fertilizer tended to take more time than Dual Magnum and Outlook. There were no differences in weed control among the layby applications (data not shown) and this test did not provide a good opportunity to evaluate the long-term weed control system for peppers. There were no significant differences in yield among the treatments (data not shown) which indicates that the initial phytotoxicity observed on the Outlook treatments did not translate to reduced yield.

**Fresno County Trial:** Because of excessive rainfall many weed seeds germinated in the untreated area of the field after the preplant treatments of Goal Tender but before the peppers were transplanted. Goal Tender was extremely effective in controlling all of the weeds (see photo). However, prior to

transplanting it was necessary to cultivate and reshape the beds, thus destroying the herbicide layer and the effectiveness of Goal Tender. Weed control ratings on July 1 and July 22 (a few days before layby) showed how Goal Tender was no longer effective (Table 3).

Weeds were vigorous and abundant throughout the season and included several broadleaf species and virtually no grasses except for occasional jungle rice (*Echinochloa colonum*). The major broadleaf weeds were prostrate, tumble, and redroot pigweeds (*Amaranthus blitoides*, *A. albus*, and *A. retroflexus*); primarily black nightshade (*Solanum nigrum*), but also some hairy nightshade (*S. sarrachoides*) and lanceleaf groundcherry (*Physalis lanceifolia*); common lambsquarters (*Chenopodium album*); and purslane (*Portulaca oleracea*). Mustards, shepherds-purse (*Capsella bursa-pastoris*) and London rocket (*Sisymbrium irio*), were initially present prior to layby, but were taken out with the layby cultivation and were not serious competitors. Puncturevine (*Tribulus terrestris*) was also scattered throughout the experimental site but was not included in the weed counts because its populations were too random.

At planting applications: Although weed control was initially excellent, Outlook really hurt the peppers with an over the top application and many plants remained stunted for the entire season. Pepper yields were extremely reduced. As the season progressed weeds germinated and the small pepper plants offered little competition. Flumioxazin provided good weed control and only slight pepper phytotoxicity was observed using the dry granular formulation, although some care was given to try to keep the prills off of the pepper plants during the broadcast application. Weed control is probably compromised by this method of application due to the difficulty of obtaining uniform coverage. Dual Magnum provided the best weed control. A little damage was seen on the peppers, but yields were not affected.

Layby applications: After layby there was not a lot of new weeds that germinated however, weeds that were missed by cultivations continued to grow. Dual, Outlook, and Dacthal all provided good to excellent weed control when applied at layby. All of the Goal Tender preplant plots and the flumioxazin at planting plots were improved with the layby applications. Dual, Outlook, and flumioxazin were effective on nightshades, and reduced pigweeds, purslane, and lambsquarters populations to varying degrees, although none of these products provided complete control of these weeds in this experiment. Still a hand weeding crew would have been able to clean up the field in a relatively short time, if the pepper field had been treated with almost any of these combinations.

## **CONCLUSION**

The Central Coast trial provided evidence that Goal Tender applied to shaped beds prior to transplanting (and subsequently not worked prior to transplanting) provided acceptable safety to the peppers and good weed control. This use pattern could provide an alternative “at planting” treatment and can provide weed control for the first 30 days following transplanting. Outlook was applied over-the-top in both trials, but was more damaging to the peppers in the Fresno trial. This material did not reduce yields in the Central Coast trial and should be further examined as a pretransplant application. Both trials showed that flumioxazin impregnated on fertilizer has promise as a post transplant application on peppers. The Fresno Trial showed that Dual Magnum, Outlook and Dacthal all provided good layby weed control. Dacthal is already registered for this use, but the Dual Magnum label would need to be adjusted to allow this use. In summary, these trials showed promise for developing a weed control system to provide early and late season weed control for peppers grown without plastic.

## LITERATURE CITED

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Fresno: June 1, 2005 - Goal Tender provided very good weed control prior to transplanting peppers.

**Table 1. Central Coast Trial. Post transplant evaluations: Number of weeds (per 6ft<sup>2</sup>), and phytotoxicity (two dates), stand count and time of weed evaluations.**

TRT Code	Applications	Lbs a.i./A	Material/A	Nightshade	Total Weeds	Phyto	Phyto	Plants per plot	Time to weed
				21 DAT	21 DAT	21 DAT	28 DAT	21 DAT	(hrs/A) 21 DAT
1	Dual Magnum 7.62 <i>Fb</i> * Dual Magnum 7.62	1.43 1.43	1.50 pts 1.50 pts	0.5	0.5	0.3	0.0	36.8	1.6
2	Dual Magnum 7.62 <i>Fb</i> Outlook 6.0	1.43 0.60	1.50 pts 0.80 pt	0.8	0.8	0.8	0.3	35.5	1.3
3	Dual Magnum 7.62 <i>Fb</i> Dacthal 75W	1.43 7.00	1.50 pts 9.3 lbs	1.3	1.3	0.3	0.1	36.0	1.3
4	Goal Tender 4F <sup>1</sup> <i>Fb</i> Dual Magnum 7.62	0.50 1.43	1.00 pt 1.50 pts	2.3	3.3	0.8	0.4	35.3	3.6
5	Goal Tender 4F <sup>1</sup> <i>Fb</i> Outlook 6.0	0.50 0.60	1.00 pt 0.80 pt	2.5	2.8	0.3	0.0	35.0	3.3
6	Goal Tender 4F <sup>1</sup> <i>Fb</i> Dacthal 75W	0.50 7.00	1.00 pt 9.3 lbs	2.3	2.3	0.5	0.0	35.8	2.8
7	Outlook 6.0 <i>Fb</i> Dual Magnum 7.62	0.60 1.43	0.80 pt 1.50 pts	0.3	0.3	1.0	1.3	34.8	1.2
8	Outlook 6.0 <i>Fb</i> Outlook 6.0	0.60 0.60	0.80 pt 0.80 pt	0.3	0.3	1.5	0.8	35.3	1.2
9	Outlook 6.0 <i>Fb</i> Dacthal 75W	0.60 7.00	0.80 pt 9.3 lbs	0.5	0.5	1.3	0.8	36.5	1.1
10	Flumioxazin impregnated on fertilizer <i>Fb</i> Dual Magnum 7.62	0.094 1.43	188 lbs 1.50 pts	1.0	1.3	1.3	1.0	35.0	2.2
11	Flumioxazin impregnated on fertilizer <i>Fb</i> Outlook 6.0	0.094 0.60	188 lbs 0.80 pt	1.0	1.0	1.5	1.0	35.5	2.2
12	Flumioxazin impregnated on fertilizer <i>Fb</i> Dacthal 75W	0.094 7.00	188 lbs 9.3 lbs	4.0	4.0	0.8	0.5	36.5	3.4
13	Devrinol <i>Fb</i> Dacthal 75W	1.50 7.00	3.0 lbs 9.3 lbs	11.8	12.0	0.0	0.0	35.8	8.4
14	Untreated	---	---	11.8	13.3	0.0	0.0	36.3	7.7
	LSD (0.05)			3.8	3.7	1.4	1.0	NS	2.5

1 – applied 16 days prior to transplanting. \* *Fb* = Followed by

**Table 2. Fresno Trial. Weed control ratings and Weed counts.**

TRT Code	Applications			Weed CONTROL Ratings *			Weed Counts per plot				
	Preemergence Herbicides	Lbs a.i. per Acre	Material per Acre	----- all broadleaf weeds -----			August 12, 2005* (67 DAT)				TOTAL Brdlvs
				24 DAT	45 DAT	67 DAT	Pig	Night	Purs	Lamb	
1	Dual Magnum 7.62 <i>Fb Dual Magnum</i>	1.43 1.43	1.5 pt 1.5 pt	9.8 a	9.2 a	9.6 ab	10.7	0.0	6.7	2.0	19.3 ab
2	Dual Magnum <i>Fb Outlook</i>	1.43 0.60	1.5 pt .75 pt	10.0 a	9.5 a	8.5 bc	15.0	0.3	3.7	3.0	22.0 ab
3	Dual Magnum <i>Fb Dacthal</i>	1.43 7.00	1.5 pt 9.5 lb	10.0 a	9.5 a	9.7 a	13.0	0.3	3.7	0.0	17.0 a
4	Goal Tender 4F <sup>1</sup> <i>Fb Dual Magnum</i>	0.50 1.43	1 pt 1.5 pt	1.3 c	4.0 c	8.7 abc	13.7	7.0	2.3	0.7	23.7 ab
5	Goal Tender <sup>1</sup> <i>Fb Outlook</i>	0.50 0.60	1 pt .75 pt	1.5 c	6.2 b	9.3 abc	6.0	2.3	2.7	1.7	12.7 a
6	Goal Tender <sup>1</sup> <i>Fb Dacthal</i>	0.50 7.00	1 pt 9.5 lb	1.0 c	4.0 c	8.8 abc	13.7	2.7	2.0	0.3	18.7 ab
7	Outlook 6.0 <i>Fb Dual Magnum</i>	0.60 1.43	.75 pt 1.5 pt	10.0 a	9.0 a	8.3 c	32.3	0.0	5.3	4.0	41.7 bc
8	Outlook <i>Fb Outlook</i>	0.60 0.60	.75 pt .75 pt	10.0 a	9.6 a	8.5 bc	21.7	0.0	3.7	5.7	31.0 ab
9	Outlook <i>Fb Dacthal</i>	0.60 7.00	.75 pt 9.5 lb	9.7 a	9.5 a	7.0 d	37.0	1.0	9.7	8.3	56.0 c
10	Flumioxazin impregnated on fertilizer <i>Fb Dual Magnum</i>	0.094 1.43	150 lbs 1.5 pt	7.7 b	8.3 a	9.0 abc	15.0	0.0	3.0	4.7	22.7 ab
11	Flumioxazin <i>Fb Outlook</i>	0.094 0.60	150 lbs .75 pt	9.7 a	8.7 a	8.8 abc	20.7	0.0	3.3	5.0	29.0 ab
12	Flumioxazin <i>Fb Dacthal</i>	0.094 7.00	150 lbs 9.5 lb	8.2 b	8.3 a	8.8 abc	18.3	1.3	4.7	2.0	26.3 ab
13	Untreated - weeded	--	--	0.7 c	8.3 a	6.7 d	32.3	19.7	3.3	1.7	57.0 c
14	Untreated - weedy	--	--	1.0 c	1.7 d	0.7 e	64.3	24.0	24.7	17.0	130.0 d
	LSD (0.05)			1.0	1.5	1.2	20.5	4.0	5.3	6.5	24.4

1- Applied 28 days prior to transplanting.

\* July 1=24 DAT; July 22=45 DAT; Aug 12=67 DAT. August 12 evaluations are 18 days post layby application.

**Table 3. Fresno Trial. Pepper yield, Stand counts, and Phytotoxicity ratings (two dates)\*.**

TRT Code	Applications	Lbs a.i. per Acre	Material per Acre	Pepper Yield lbs/plot				Peppers/plot 36 DAT	Phytotoxicity	
				Good	Small	Sunburn	Total		24 DAT	67 DAT*
1	Dual Magnum 7.62 <i>Fb Dual Magnum</i>	1.43 1.43	1.5 pt 1.5 pt	77.6 ab	18.7	15.9	112.2 ab	186.0 bcd	1.3 b	0.0 d
2	Dual Magnum <i>Fb Outlook</i>	1.43 0.60	1.5 pt .75 pt	71.3 ab	18.4	13.9	103.5 ab	184.5 cd	1.5 b	3.5 bcd
3	Dual Magnum <i>Fb Dacthal</i>	1.43 7.00	1.5 pt 9.5 lb	61.0 ab	16.9	11.7	89.5 ab	194.5 abcd	1.0 b	0.0 cd
4	Goal Tender 4F <sup>1</sup> <i>Fb Dual Magnum</i>	0.50 1.43	1 pt 1.5 pt	62.6 ab	20.7	14.3	97.6 ab	186.5 bcd	0.2 b	0.3 d
5	Goal Tender <sup>1</sup> <i>Fb Outlook</i>	0.50 0.60	1 pt .75 pt	91.6 a	12.6	11.8	116.0 a	196.5 abc	0.5 b	0.0 d
6	Goal Tender <sup>1</sup> <i>Fb Dacthal</i>	0.50 7.00	1 pt 9.5 lb	66.0 ab	12.9	10.2	89.1 ab	200.0 ab	0.2 b	0.0 d
7	Outlook 6.0 <i>Fb Dual Magnum</i>	0.60 1.43	.75 pt 1.5 pt	47.2 bc	8.9	9.5	65.5 bc	190.5 abcd	3.7 a	6.0 ab
8	Outlook <i>Fb Outlook</i>	0.60 0.60	.75 pt .75 pt	41.8 bc	10.7	13.7	66.2 bc	187.0 bcd	3.7 a	2.0 abc
9	Outlook <i>Fb Dacthal</i>	0.60 7.00	.75 pt 9.5 lb	21.0 c	7.1	3.7	31.9 c	188.0 bcd	5.2 a	6.5 a
10	Flumioxazin impregnated on fertilizer <i>Fb Dual Magnum</i>	0.094 1.43	150 lbs 1.5 pt	57.5 abc	15.5	11.3	84.4 ab	182.0 cd	1.0 b	1.0 cd
11	Flumioxazin <i>Fb Outlook</i>	0.094 0.60	150 lbs .75 pt	79.4 ab	15.4	17.6	112.3 ab	194.0 abcd	0.5 b	0.5 d
12	Flumioxazin <i>Fb Dacthal</i>	0.094 7.00	150 lbs 9.5 lb	65.3 ab	16.3	7.3	89.0 ab	203.5 a	1.5 b	2.0 bcd
13	Untreated – weeded	--	--	78.4 ab	19.2	10.0	107.5 ab	181.5 d	0.3 b	0.3 d
14	Untreated – weedy	--	--	20.9 c	6.2	4.5	31.5 c	182.5 cd	0.0 b	0.0 d
	LSD (0.05)			39.8	8.8	9.1	47.4	14.6	1.9	2.8

1- Applied 28 days prior to transplanting.

\* July 1=24 DAT; July 13=36 DAT; Aug 12=67 DAT. August 12 evaluations are 18 days post layby application.