California Melon Board Report – Dec 1, 2013

I. Project Title:

Melon tolerance and weed control with new herbicides

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IV. Project Objectives:

The objective of this current study was to evaluate the effects of prospective and existing pre-emergence (PRE) herbicides on cantaloupe and honeydew safety and season-long weed control.

V. Summary of Research Results:

Successful weed management is vital for the production of quality melons. Weed control in melons is difficult due to the vining nature of the crop (which can prohibit mechanical cultivation) and the limited availability of safe and selective herbicides (particularly for the control of broadleaf species). In 2013 and 2014, research trials were initiated to compare PRE-applications of Dual Magnum (*S*-metolachlor) and Zeus (sulfentrazone) to Curbit (ethalfluralin), Sandea (halosulfuron), Command (clomazone), and Strategy (ethalfluralin + clomazone) with respect to crop safety and weed control. Dual Magnum and Zeus were effective at controlling small-seeded broadleaf weed species as well as, or better than, Curbit, Sandea, and Strategy, although early-season crop injury was observed. Yields in herbicide-treated plots were generally higher than those for the untreated checks. Results also suggest that weed control and herbicide efficacy are significantly affected by the type, timing, and amount of irrigation. Although the 2013-2014 trials were not designed to evaluate the specific effects of irrigation on herbicide activation, activity, and retention, the data indicate the performance of the tested products may

vary, wildly. The 2014 trial was pre-irrigated 5-7 days before planting/herbicide applications; in contrast the 2013 trial received a pre-irrigation event 48-72 hours before melon seeding. Reduced herbicide efficacy in 2014, as compared to 2013, may have been due to emerging weed seedlings that were less likely to be controlled by the PRE-applied products evaluated in these trials. The primary field trials conducted in 2013 and 2014 were irrigated with 0.5" of water after planting to activate residual herbicides, then furrow irrigated until melon maturity. Herbicide injury was transient. A secondary study evaluated melon injury where only sprinklers were used for up to 8 weeks. Herbicide injury in response to overhead watering (and, presumably, herbicide movement into the seedline/seedling root zone) was decidedly more severe. Future research trials to evaluate the efficacy and safety of potential herbicides for use in melon systems should endeavor to evaluate all products under differing irrigation regimes (type of irrigation and quantity of water applied).

VI. Research Procedures:

In June 2013 and 2014, research trials to evaluate the safety and efficacy of PRE herbicides were established at a research farm on the University of California – Davis campus. Soil at the site is a fine, silty loam (Yolo series, 1.5-3% OM, pH 6.7-7.0). Cantaloupe ('Oro Rico' and either 'Mercedes' (2013) or 'Yosemite' (2014)) and honeydew ('Saturno') melons were included in the study. Melons were direct-seeded into raised beds that had been pre-irrigated 2-7 days prior to planting. Each individual melon plot was 30 feet in length and two rows in width. Rows were on 60 inch spacing; every other bed was planted, thus allowing for 120 inches between seed lines. Following seedling emergence, melons were thinned to a density of one melon plant per foot of row.

Pre-emergence herbicides were applied post-plant (using a CO2-pressurized backpack sprayer calibrated to 20 GPA), but prior to crop emergence, directly to the bed surfaces. Herbicide treatments included: Command (clomazone) at 0.5 pt/A, Curbit (ethalfluralin) and Strategy (clomazone + ethalfluralin) at 4 pt/A, Sandra (halosulfuron) at 1 oz/A, Dual Magnum (S-metolachlor) at 1.3 pt/A, Zeus (sulfentrazone) at3.2 oz/A. *NOTE: COMMAND, DUAL MAGNUM, STRATEGY and ZEUS are NOT LABELED for use in melons in California.* Herbicides were sprinkler incorporated with 0.5" irrigation water immediately following application. Each unique melon by herbicide treatment combination, including the control, was replicated three times. Irrigation (furrow), fertilization and insect/disease management schedules were set according to guidelines developed by University of California cooperative extension. Melon injury and weed cover were evaluated throughout the growing season.

Results:

The 2013-2014 field sites were dominated by a mixture of small seeded broadleaf species: common purslane (*Portulaca oleracea*), common lambsquarters (*Chenopodium album*), and pigweeds (a mixture of *Amaranthus blitoides* – prostrate pigweed and *A. retroflexus* – redroot pigweed.

Early-season weed control (purslane, pigweeds and common lambsquarters) in the 2013 trial was best in the Zeus, Dual Magnum, Strategy and Sandea treatments (1-4% weed cover),

followed by Curbit (5-11% weed cover) and Command (5-18% weed cover); weed control in the untreated check plots ranged between 50% and 80% (Figure 1) (Data averaged over all melon varieties). Most residual herbicides began to break at around four weeks after planting. Pigweeds and common lambsquarters that did escape PRE control measures were able to outgrow and overshadow the melon crop.

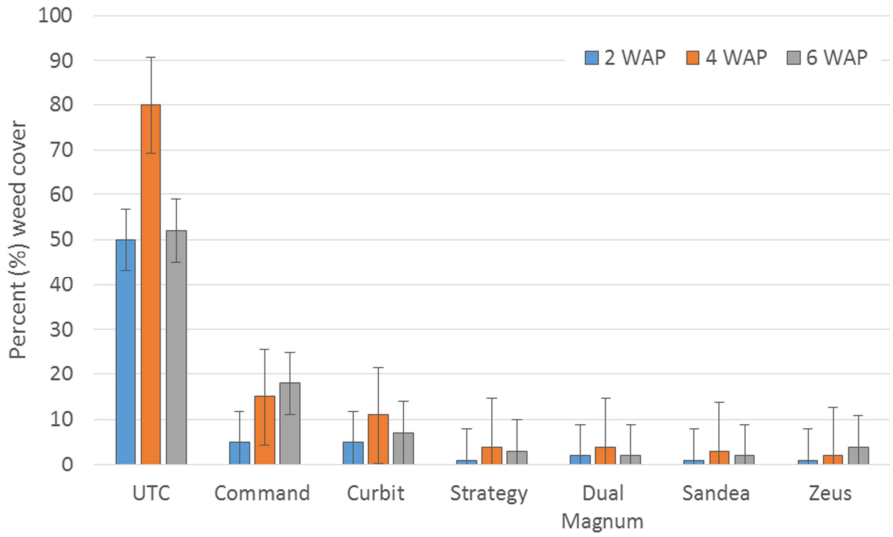

Figure 1. Percent (%) weed cover in melons in response to pre-plant applied herbicides in 2013.

In 2013, significant differences were observed among PRE herbicides with respect to crop injury. At approximately three and four weeks after emergence, melons in the plots that were treated with Sandea and Zeus (2-4" in height and 4-9" across) were smaller than the plants in the untreated check and the Command, Curbit, Dual Magnum and the Strategy plots (3-5" in height and 8-11" across) (Data averaged over all melon varieties). Injury was mostly transient and melon vigor improved, continuously, with time.

Melons were harvested between 9 September and 17 September, 2013. In general, mean total harvestable fruit numbers and total fruit weights were greater in the Curbit, Strategy, Sandea and Dual Magnum plots (82 to 118 fruits/plot and 301 to 498 lbs/plot), as compared to the control and Command plots (67 to 104 fruits/plot and 237 to 438 lbs/plot) (Data averaged over all melon varieties). Despite severe early season crop injury, the Zeus plots out-yielded the control plots (92 to 102 fruits/plot and 299 to 526 lbs/plot) (Data averaged over all melon varieties).

In the 2014 trial, melon beds were pre-irrigated five days prior to crop seedling and PRE herbicide applications; this delay allowed many small-seeded weeds to germinate and emerge before soil-applied herbicides could be activated post-planting (Figure 2). As a consequence, mean weed cover across all chemical treatments was greater in 2014 (10-35%), as compared to 2013 (1-15%) (Data averaged over all melon varieties). All herbicides reduced weed cover,

significantly, relative to the untreated check, in 2014, with Zeus providing the best level of weed control (Data averaged over all melon varieties).

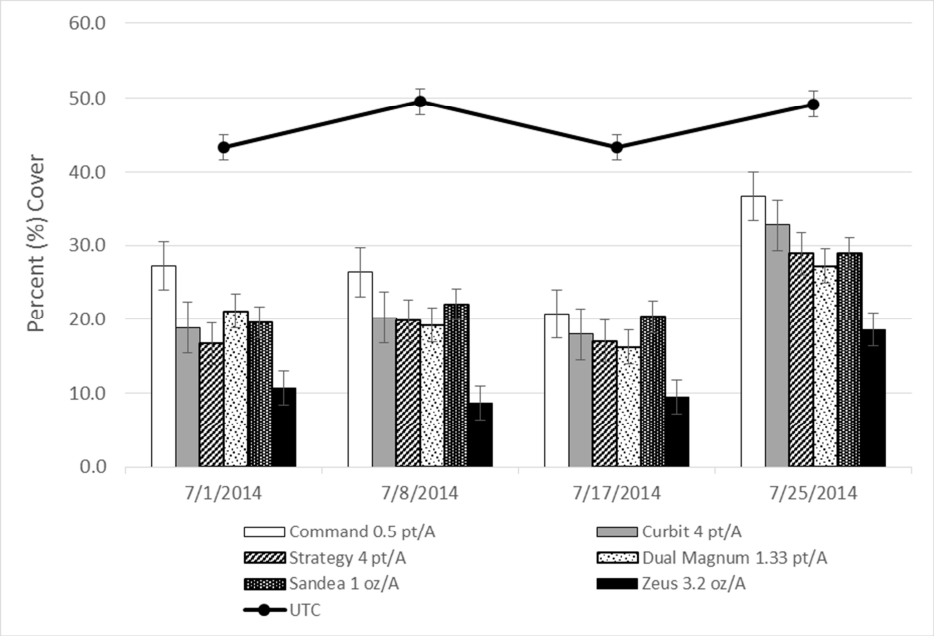

Figure 2. Percent (%) weed cover in melons in response to pre-plant applied herbicides in 2014.

The level of weed control observed in 2014 was significantly lower than what was observed in the preceding year (Figures1, 2). Reduced herbicide efficacy may have been due, in part, to the increase in elapsed time between pre-irrigation and herbicide application/activation (Figure 3). In 2013, this barrier was established no later than 72 hours after the field soil was pre-irrigated; weed seedlings that were stimulated to germinate were susceptible to the residual products. In 2014, the herbicides were applied and activated up to 168 hours after the pre-irrigation event; by this time, many weeds were probably close to breaking through the soil surface and, therefore, less likely to be controlled by soil-applied products. In hindsight, the use of a post-plant, but pre-melon-emergence, burn-down treatment would have helped with season-long weed control in 2014.

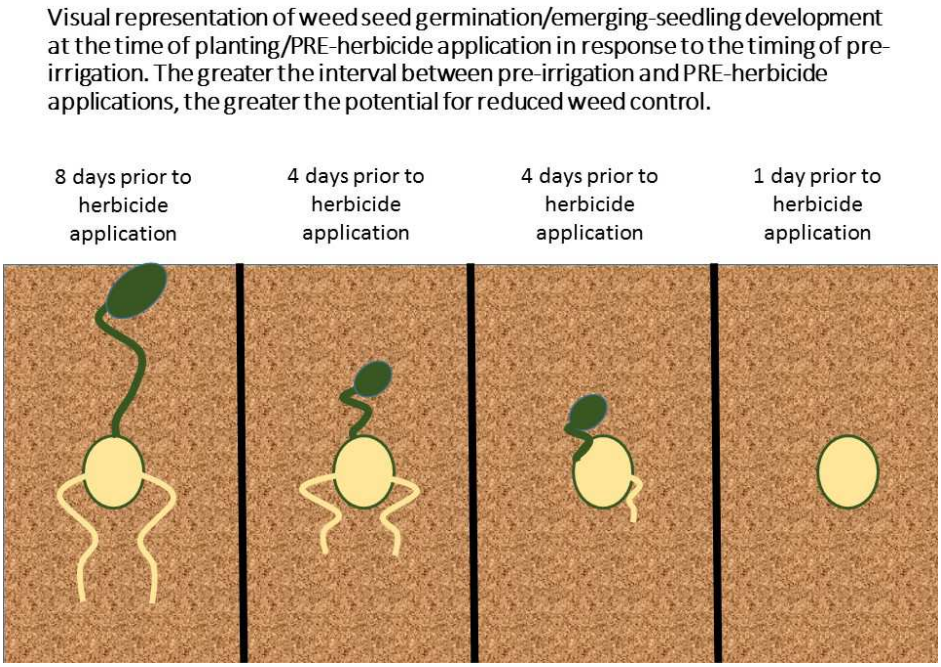

Figure 3. Representation of weed seedling emergence at planting/PRE herbicide application in response to the timing of pre-irrigation events. Increasing the interval between pre-irrigation and residual herbicide application may result in less weed control as the emerging seedlings may become less sensitive to soil-applied products.

Due to a planter malfunction, melons were not planted evenly in the 2014 research trials, resulting in extremely uneven stands. As a consequence, the plots could not be rated, successfully, for herbicide injury nor could yield be harvested. However, results from a similar, company-sponsored trial, showed that the Dual Magnum and Zeus plots (27-45 fruit/plot) yielded as well as the control treatment (29 fruit/plot), despite evidence of early season crop injury.

In 2014, an additional study was undertaken to evaluate the effects of three proprietary soil adjuvants (hereafter referred to as 'safeners') designed to improve herbicide retention within the treatment zone, thereby preventing leaching and minimizing the potential for crop injury. Herbicides (Curbit at 4 pt/A; Dual Magnum at 1.3 pt/A) were applied to the soil surface prior to seeding; the safeners (labeled as 1, 2 or 3) were applied in mixture with Dual Magnum. The trial was sprinkler irrigated, weekly, with 0.5-1" of water for up to eight weeks; overhead irrigation was utilized to facilitate movement of the herbicides into the seedline/seedling root zone and maximize crop injury. Dual Magnum significantly injured melons for several weeks following herbicide applications (Figure 4). Observed melon injury was lower, over all evaluation dates, when Safeners 1 and 3 were included in a tank mix, relative to Dual Magnum applied singly. Over time, injury in the Dual Magnum + Safener 1 and Safener 3 treatments were reduced to levels observed for the Curbit standard.

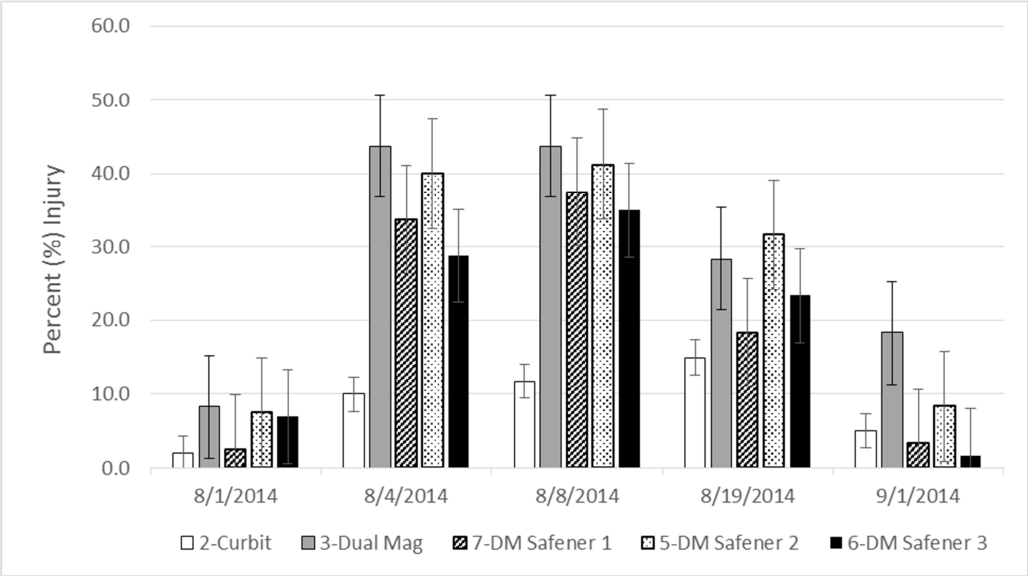

Figure 4. Effects of three potential herbicide safeners on Dual Magnum injury in melons. Curbit and Dual Magnum were applied at 4 and 1.3 pt/A, respectively. Plots were established in mid-July and were sprinkler irrigated once per week for eight weeks to maximize the potential for melon injury.

Mean plant biomass, as determined at eight weeks after planting, was highest in the Curbit (585 g/plant), Dual Magnum + Safener 3 (528 g/plant) and Dual Magnum + Safener 1 (479 g/plant) treatments; plants receiving these plots were larger than plants in the untreated check (379 g/plant), Dual Magnum (359 g/plant) and Dual Magnum + Safener 2 (362 g/plant) treatments (Figure 1). Similar trends were observed with respect to the number of fruit per plant. Mean fruit per plant, as determined at eight weeks after planting, was highest in the Curbit (10 fruit/plant), Dual Magnum + Safener 3 (11 fruit/plant) and Dual Magnum + Safener 1 (10 fruit/plant) treatments; plants receiving these treatments were larger than plants in the untreated check (379 g/plant), Dual Magnum (359 g/plant) and Dual Magnum + Safener 2 (362 g/plant) plots. Preliminary results suggest that some commercial safeners (particularly 1 and 3) may be effective at limiting Dual Magnum injury under the field conditions observed during the trial.

Table 1. Effects of three potential herbicide safeners on mean plant mass (g) and fruit production. Curbit and Dual Magnum were applied at 4 and 1.3 pt/A, respectively, post-seeding. Plots were established in mid-July and were sprinkler irrigated once per week for six weeks to maximize the potential for injury. Numbers in parentheses indicate the treatment's ranking where a '1' = largest plants or most fruit and a '6' = smallest plants or least fruit.

Treatment	Mean plant biomass (g)	Mean number of fruit/plant
Untreated	378.7 (4)	6.0 (5)
Curbit	585.4 (1)	10.3 (2)
Dual Magnum	358.8 (6)	6.0 (5)
Dual Magnum + Safener 1	478.9 (3)	9.7 (3)
Dual Magnum + Safener 2	362.1 (5)	8.7 (4)
Dual Magnum + Safener 3	528.3 (2)	11.3 (1)

Conclusions and future research:

According to some of the most recently available statistics, the United States (US) was the world's sixth largest producer of melons, the majority of which were grown in California, who leads the nation in both volume and value. In 2010, California produced 10.9 million cwt of cantaloupe; in comparison, Arizona and Georgia, the second- and third-ranked states for melon production, respectively, each produced less than half of California's total yield. The 2011 crop of cantaloupes and melons in California was worth an estimated $227 million, and accounted for >50% of the US's total production value.

Early-season weed control is crucial in order to prevent competitive interference between melons and weeds, which can reduce crop yields; late-season weed management is also important as weeds can harbor pests and pathogens which can adversely affect fruit quality. Weeds can also reduce harvest efficiency, which can result in increased labor costs. The objective of this current study was to evaluate the effects of prospective and existing pre-emergence (PRE) herbicides on cantaloupe and honeydew safety and season-long weed control.

Ethalfluralin (Curbit) was selected for use in the study because it is a commonly applied PRE herbicide in California melons. Although halosulfuron (Sandea) is an excellent product for the suppression of nutsedge in melons, rotation restrictions may limit its use in California. Both served as performance standards in this trial. Command is labeled for use in melons in every state, except California; it served as an industry (country-wide) standard in this trial. *S*-metolachlor and sulfentrazone have been explored for PRE use in melons because of their superior weed control (broadleaved species, nutsedges). Results from our 2013-2014 research trials show that Dual Magnum and Zeus can be very effective at suppressing troublesome weeds in melon production systems, although soil-irrigation interactions can significantly affect crop injury potential.

Future research objectives include:

a. Evaluate the safety and efficacy of both registered and non-labeled PRE-applied herbicides (singly and in combination) in melon production. **Deliverables:** Results from this project will determine if lower rates of Dual Magnum and Zeus, in combination with Curbit, can provide effective and durable early season weed control in seeded melons without causing significant injury to the melon crop.

b. Determine the efficacy of safeners for reducing melon crop injury from PRE-applied herbicides. **Deliverables:** Results from this project will help to determine if safeners can be used in conjunction with Dual Magnum and Zeus, to reduce melon injury, without reducing herbicide efficacy.

c. Evaluate the use of a commercial ethylene inhibitor to reduce transplant shock in melons and improve early-season crop establishment. Evaluate the differences in early-season crop competitiveness between seeded and transplanted melons both with and without herbicides. **Deliverables:** Results from this project will determine if mitigating transplant shock with 1-MCP can improve the rate of melon canopy development relative to traditionally-seeded melons. Results will also provide us with a direct comparison of seeded and transplanted melon sensitivity to soil-applied herbicides.

d. Develop a set of melon symptomology photos that can be contributed to an online visual tool being developed to help diagnose herbicide injury in a variety of crops. **Deliverables:** Results from this project will help growers diagnose instances of herbicide injury. Increased knowledge about injury development will support grower decision-making processes regarding crop replant and/or additional management options.