CALIFORNIA MELON RESEARCH BOARD
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Project: Weed control and cost benefit analysis of automated cultivators and herbicides to control within-row weeds in melons.

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Summary: A weed management trial was conducted in a late-season commercial cantaloupe field in the Dos Palos area to evaluate weed management, crop safety, and an economic analysis of using finger weeder and robotic cultivators compared to standard herbicides registered for melon production in California. Cultivar "Caribbean King" was direct seeded on July 7, 2021, on 80" centers. Herbicide treatments included Curbit (ethalfluralin), Prefar (bensulide), and Sandea (halosulfuron) applied 2 and 4 weeks after planting and were mechanically incorporated. Mechanical cultivation treatments were performed at 4 weeks after planting and only cultivated the narrow band in the plant row. A standard cultivation treatment was included for comparison. No crop injury was observed from any of the treatments. Sandea, Curbit, and both cultivators significantly reduced in-row weeds as compared to the standard cultivation, however, the weed pressure in this field was very low – less than 10% in any location. As a result, no hand crew was needed to remove weeds and a cost analysis could not be performed. Plots were commercially harvested before treatment yields could be measured. Overall yield for this field was good, at 929 cartons per acre and 11.8% Brix.

Objectives

1. Evaluate weed control, time, and costs associated with using mechanical cultivators as part of a conventional weed management program in commercial melons in central CA.
2. Evaluate pre and post herbicide programs in comparison to mechanical cultivators for in-row weed management and crop safety.

Methods.

This trial began on July 16, 2021, in a commercial late-season field near Dos Palos, in Merced County. Melon variety Caribbean King was direct seeded on July 7 on 80" centers and 16" seed row spacing. No pre-emergent herbicides were applied prior to the initiation of this project, and plants were about 1 true leaf at the time of first application. Herbicide treatments consisted of 1) standard cultivation; 2) Prefar (bensulide) at 6 qts/A; 3) Sandea (halosulfuron) at 1 oz/A; 4) Curbit (ethafluralin) at 4 pts/A; 5) in-row mechanical cultivation using a Steketee finger weeder; and 6) in-row mechanical cultivation using a robotic cultivator (Robovator). The grower's standard program consisted of 2 post-plant cultivations. As this was a very clean field, no grass herbicides or hand crews were used. Treatment listing and trial details are shown in Table 1.

All herbicide treatments were applied after crop emergence but before weed emergence. The initial herbicide application was made on July 16 with an over-the-top application of Prefar when melons were 1 true leaf; a second application of al herbicides were made on July 29 then incorporated into the soil by hand. For the second application, Curbit was directed as a band application on either side of the plant row to minimize contact with foliage. Herbicides were applied with a CO_2 backpack sprayer at 38 psi with a

4-ft boom using two Tee Jet 8002 flat fan nozzles and two 8002 OC nozzles on the ends, calibrated to 26.8 gpa equivalent. Spray swath was 60" when measured ~24" above the soil surface. Cultivation treatments were also performed on July 29 (Figure 1). The finger weeder was run at 3.5 mph, while the Robovator worked at 1.8 mph. The Robovator used standard 5" blades set to leave a 2" buffer zone around each plant at a depth of about 1" below the soil surface. Using a camera guidance system and a wheel to provide information on forward speed, the blades open around the plants to prevent injury (Figure 2). The finger weeder used Steketee "medium" 14-inch fingers with a slight overlap (Figure 3).

Plot size for the herbicide treatments was 1 row by 40 ft; the cultivation treatments were 1 bed by the length of the field, about 800 feet. The experimental design was an RCB with 4 replications. At the first weed evaluation 2 weeks after mechanical cultivation treatments, the number of emerged weeds per 40 foot plot area were counted. Subsequent weed and crop phytotoxicity ratings were done using a subjective scale, where 0 = no weeds/no phyto, 1 = 1 – 2.5%, 2 = 2.5 - 10%, 3 = 10 - 21%, 4 = 21 - 35%, 5 = 35 - 50%, 6 = 50 – 65%, 7 = 65 – 79%, 8 = 79 – 90%, 9 = 90 – 97.5%, and 10 = 97.5 - 100% weeds or crop injury. A once-over harvest was planned for early October, however, this field was harvested early on Sept 28 and so no yield data were obtained. Brix readings were done on 3 sample fruit from each treatment using a hand held refractometer at room temperature. All data were analyzed using analysis of variance for a replicated block design; means comparisons were performed using Fishers Protected LSD at 95% confidence level.

Table 1. Herbicide and cultivator trial information and treatments, Merced County 2021.

Location	Dos Palos	Lexington and Eucalyptus Rds
Cooperator	Jim Vincent	
Soil	Dos Palos clay, partially drained, slightly sodic	
Variety and plant date	Caribbean King, July 7	1 row, 16" (4900 plants/A)
Plot size	Herbicide plots:	1 bed (80") x 40 ft
	Cultivation plots:	1 bed (80") x 800 ft (field length)
Irrigation	furrow	1st post plant irrigation on 8/19
Herbicide incorporation	hand hoe	
Weed evaluation	8/13, 8/19, harvest	
Harvest	Sept 28-30, 2021	
days	84	

Treatments		***timing***
1	Standard cultivation	---
2	Prefar 6 qts/A	7/16 and 7/29 over the top
3	Prefar 6 qts fb Sandea 1 oz/A	7/16 and 7/29 over the top
4	Prefar 6 qts fb Curbit 4 pts/A	7/16 over the top, 7/29 directed
5	finger weeder	29-Jul
6	Robovator	29-Jul
	Herbicide treatments applied at 40 gpa and incorporated by hand	

Figure 1. Finger weeder (left) and Robovator cultivation at 3 weeks after seeding.

Figure 2. Robovator blades are closed (left) between plants, then open at a present "buffer zone" when a plant is detected by the onboard cameras.

Figure 3. Finger weeders were set to overlap about 1" to cultivate between plants.

Results

Due to the hard and cloddy nature of a Dos Palos soil, the finger weeder was used with the stiffer, medium length fingers (14"). While weed emergence was minimal, this set up worked well and caused no visible crop injury. The Robovator also worked well at this location, even though plants were larger than ideal. However, the blades were running shallower than expected, and the machine was overheating halfway through the plots.

Weed and crop injury evaluations were made on Aug 13 and Aug 19, approximately 2 and 4 weeks after the plots were cultivated. No crop injury from any of the treatments was observed, and weed pressure was minimal. In some of the plots, there were no emerged weeds, and in general the entire field was mainly weed-free after 4 weeks. Nonetheless, there was a significant reduction in grassy weeds by the last evaluation at harvest for all treatments except the Prefar-only treatment (Table 2). The least amount of weed pressure was observed in the Curbit and finger weeder plots. Both had nearly 100% control of weeds.

Because weed pressure was so low in this field, there was no need to remove missed weeds with a hand crew, and an economic analysis comparing the cost of hand weeding with and without in-row cultivation could not be performed. Additionally, yields for each treatment were not measured due to harvest occurring earlier than expected. Overall market yield was 929 cartons/A. Because a cost analysis was not done, these treatments will be repeated in 2022.

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Table 2. Treatment weed and crop injury ratings, canteloupe weed trial 2021.

Treatment	13-Aug weed count	19-Aug weeds (1)	0 - 10 scale crop injury	6-Oct BL weeds	0 - 10 scale grasses		Ctns/A (field average) 12's	9's	Jumbos	%Brix
1 Standard cultivation	2.00	0.75	0.00	0.25	1.50	a				13.4
2 Prefar 6 qts/A	0.50	0.25	0.00	0.00	1.25	a				11.2
3 Sandea 1 oz/A	0.25	0.25	0.00	0.25	1.00	ab				12.9
4 Curbit 4 pts/A	0.00	0.00	0.00	0.00	0.25	c				11.0
5 finger weeder	0.00	0.00	0.00	0.25	0.25	c				11.1
6 Robovator	1.00	0.00	0.00	0.25	0.50	bc				11.1
Average	0.63	0.21	0.00	0.17	0.79		204	474	251	11.8
LSD 0.05	1.19	ns	---	ns	0.61		---	---	---	---
CV	125	181	---	219	51.1		---	---	---	---

weed count: number of weeds per 40 ft on 13-Aug.

0 - 10 scale. Subjective scale.
0 = no weeds/no crop phytotoxitity
1 = 2.5%
2 = 10%
3 = 21%
4 = 35%
5 = 50%
6 = 65%
7 = 79%
8 = 90%
9 = 97.5%
10 = all weeds/total crop loss

Main grass weed: barnyardgrass
Main broadleaf (BL) weeds: pigweed, lambsquarter, puncturevine, purslane, and nutsedge
Commercial harvest results for field, 30 lb cartons/A
LSD 0.05 = Least significant difference at the 95% confidence level. NS = not significant. --- = not enough data to perform statistical analysis.
CV% = coefficient of variation