

2010 Precision Cultivation Studies

Richard Smith, Aaron Heinrich and Karen Adler, Farm Advisor and Research Assistants
University of California Cooperative Extension, Monterey County

Summary

Trials 1&2 were evaluations of the Tillet robotic cultivator which uses a camera coupled with a data processor to detect crop plants; this guides notched rotating discs that travel in the seedline and indicates when they need to swing out of the way of crop plants (Figure 1). In these trials the Tillet thinned direct seeded lettuce. The lettuce still needed hand thinning to achieve a satisfactory stand, the time to thin was reduced. The Tillet also weeded celery and removed 57% of the weeds, but did not reduce subsequent hand weeding time over the standard hand weeding treatment. Trials 3&4 were evaluations of finger weeders in transplanted radicchio. In one of the trials there was heavy weed pressure and the finger weeders removed 81% of the bedtop weeds, while standard cultivation removed 48%. However, this did not result in lower weeding time. The finger weeders were safe to the radicchio crop.

Methods

Trial No. 1: The trial was conducted with Ed Mora of D'Arrigo Brother in Castroville. The trial was conducted on head lettuce (variety 'Steamboat') planted on 2 seedlines on 40 inch beds. Lettuce was direct seeded at three inch spacing on May 20. Plot were two 40-inch beds wide by 100 feet long and replicated four times in a randomized complete block design. The Tillet cultivator was set to thin plants to 9 inches apart. The Tillet unit used in this trial was equipped with 4 rotating knife units that each cultivated one seedline. Pre thinning weed and lettuce stand counts were made on June 16. Two treatments were applied on June 16: 1) thinning by the Tillet machine and 2) standard thinning by hand. Following thinning by the Tillet, weed and stand counts were made to estimate thinning efficacy by the Tillet machine. Tillet plots were rethinned by hand and time to rethin was timed to judge the efficiency of thinning by the Tillet machine. Plots were cultivated on June 19 with the grower's standard cultivator which removed weeds from the entire bed top except for two five-inch wide bands around the seedlines. Plots were weeded on June 25 and the number of weeds and doubles were recorded, as well as the time to remove weeds and doubles. Harvest evaluations were conducted on July 22 by harvesting and weighing 12 untrimmed heads per plot. **Trial No. 2:** The trial was conducted with John Romans in King City on transplanted organic celery (variety 'Conquistador) which was transplanted on May 28. Tillet cultivation was conducted on June 16; pre and post celery stand, pre and post weed counts and weeding time were also conducted on June 16. Weed pressure was light at this site and the dominant weed was volunteer tomatoes. Crop biomass was evaluated on August 11 and no harvest was conducted because the field was disced due to poor market conditions. **Trial No. 3:** The trial was conducted with Earthbound Farms in Gilroy. The trial was conducted on transplanted radicchio (variety 'Leonardo') which was transplanted to the field on August 22 in 2 seedlines on 40 inch beds. Plot were four 40-inch beds wide (the width of the cultivators) by the length of the field and replicated three times in a randomized complete block design. Finger weeders (14.5 inch in diameter, yellow model from Kress Company, Germany) were installed on a standard four bed cultivator. The finger weeders were located on either side of the seedline and adjusted to work the 4-inch wide seedline which is left uncultivated by the standard knives and sweeps. The cultivation tractor was a New Holland 7840 which traveled at 1.5 mph through the field. Finger weeder cultivation was compared with a standard 4-bed cultivator with standard knives and sweeps. Precultivation weed counts were made on September 7. The field was cultivated on September 8 and post cultivation weed counts were made on September 9. The

cultivation treatments were hand weeded on September 16 and the time to weed 200 feet of row and the number of weeds removed was recorded. Radicchio stand counts were made at this time. Harvest evaluations were made on November 15, but were after the crew harvested the field so counts of unharvested heads were made to provide a measure culled heads. **Trial No. 4:** The trial was conducted as described above in the same block, but in the next radicchio planting. Radicchio was planted on August 29 and precultivation counts were made on September 16. The cultivation was conducted on the same day and post cultivation weed counts were made on 17. Weeding time and counts of weeds removed by hand weeding were made on October 1. Harvest evaluations were conducted the same as described above.

Results

Trial No. 1: Prior to thinning in the Tillet treatment there were 118,580 lettuce plants per acre and after the Tillet cultivator passed through the field there were 39,374 lettuce plants per acre (Table 1). Tillet treatment still required hand thinning which brought the total number of plants down to 27,143 plants per acre. Prethinning the lettuce stand with the Tillet reduced the time that it took for subsequent hand thinning, 6.4 hours vs 13.2, respectively. However, there was a trend that indicated that following hand weeding there was a lower lettuce stand in the Tillet treatment. Weed pressure in the field was light, and the Tillet treatment removed 79% of the weeds during the thinning operation. There were no differences in the final weight of lettuce or mean head weight. **Trial No. 2:** The Tillet cultivator was reasonably safe on the transplanted celery plants except for one of the four units. As a result, the Tillet decreased the stand of celery by 2% (Table 2). Weed pressure at this site was light and the Tillet removed 57% of the weeds and did not reduce subsequent time to hand weed the field. There was no difference in biomass or mean head weight on August 11. **Trial No. 3:** The finger weeder removed 83% of the weeds and standard cultivation removed 59%, 1,220 vs 4,575 weeds per acre after cultivation, respectively (Table 3). Finger weeders did not reduce the stand of radicchio as measured on September 16. There were no differences in weeding time between the cultivation treatments and no increase in the number of unharvested heads (which would indicate smaller heads in the finger weeder treatment). **Trial No. 4:** Purslane was the dominant weed at this site and there was much greater weed pressure in two of the replications of this trial. The finger weeder removed 81% of the weeds and standard cultivation removed 48%, 4,270 vs 19,172 weeds per acre after cultivation, respectively (Table 4). There was a strong trend indicating lower weeding time in the finger weeder treatment, but it was not statistically significant. There were more unharvested heads in the finger weeder treatment, but the difference between the treatments was not significant.



Figure 1. Tillet cultivator with notched rotating discs



Figure 2. Finger weeders in celery

Table 1. Trial No. 1. Prethinning and post thinning weed counts, thinning times and yield evaluation of direct seeded lettuce

Cultivation Treatment	14-Jun	15-Jun			14-Jun	15-Jun		5-Aug	
	Prethin lettuce stand count plants/A	Post tillet lettuce stand count plants/A	Post thin lettuce stand counts plants/A	Hand thinning time hr/A	Prethin weed count weeds/A	Post tillet weed count weeds/A	% weed removal	Crop Biomass tons/A	Mean head weight lbs
Standard	115,473	NA	30,642	13.2	1243	NA	NA	28	1.81
Tillet	118,580	39,374	27,143	6.4	948	196	79	24	1.78
Pr>F treat	0.063	NA	0.077	0.002	0.464	NA	NA	0.079	0.688
Pr>F block	0.131	NA	0.364	0.171	0.865	NA	NA	0.9	0.900
LSD 0.05	NS	NA	NS	1.9	NS	NA	NA	NS	NS

Table 2. Trial No. 2. Pre and post cultivation weed counts, weeding time and biomass of celery

Cultivation Treatment	16-Jun								11-Aug	
	Initial stand count (plants/A)	Post tillet stand count (plants/A)	% stand decrease	Initial weed count (weeds/A)	Post tillet weed counts (weeds/A)	Post hand weeding weed count (weeds/A)	% weed reduction (pre tillet hand weeding)	Hand weeding time (hr/A/worker)	Crop Biomass T/A	Mean head weight lbs
Standard	46,863	NA	NA	2,616	NA	523	80	3.9	23.2	0.99
Tillet	46,569	45,620	2.0	2,714	1,177	NA	57	3.5	22.0	0.97
Pr>F treat	0.672	NA	NA	0.833	NA	NA	0.059	0.080	0.051	0.239
Pr>F block	0.810	NA	NA	0.422	NA	NA	0.680	0.157	0.048	0.056
LSD 0.05	NS	NA	NA	NS	NA	NA	NS	NS	1.2	NS

Table 3. Trial No. 3. Weed removal by cultivation treatments, weeding time and yield evaluation

Cultivation treatment	Percent weeds removed by cultivation treatments								Post cultivation Stand counts	Weeds removed by hand weeding	Weeding time	Unharvested heads
	Purslane	Night-shade	Shepherd's Purse	Malva	Henbit	Sow Thistle	Other ¹	Total weeds				
Standard	67	84	53	48	65	25	72	59	32,932	3,224	4.0	4,513
Standard + Finger weeder	86	84	88	58	91	100	100	83	32,627	2,832	3.3	4,317
Pr>Treat	0.414	0.978	0.500	0.678	0.080	NA	0.439	0.005	0.696	0.540	0.168	0.879
Pr>Block	0.924	0.759	0.823	0.138	0.393	NA	0.695	0.065	0.131	0.093	0.267	0.439
LSD _{0.05}	NS	NS	NS	NS	NS	NA	NS	7	NS	NS	NS	NS

1 – Alyssum and beet volunteers

Table 4. Trial No. 4. Weed removal by cultivation treatments, weeding time and yield evaluation

Cultivation treatment	Percent weeds removed by cultivation treatments									Weeds removed by hand weeding	Weeding time	Unharvested heads
	Purslane	Night-shade	Shepherd's Purse	Malva	Lambs-quarter	Henbit	Sow Thistle	Other	Total weeds			
Standard	49	50	72	50	50	50	70	33	48	12,810	8.7	6,802
Standard + Finger weeder	59	33	99	87	67	89	80	60	81	3,725	4.5	9,440
Pr>Treat	0.826	NA	0.015	0.368	NA	NA	0.272	0.716	0.024	0.284	0.270	0.097
Pr>Block	0.814	NA	0.630	0.500	NA	NA	0.249	0.989	0.953	0.408	0.390	0.177
LSD _{0.05}	NS	NA	14	NS	NA	NA	NS	NS	26	NS	NS	NS