

## **2009 Precision Cultivation Studies**

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### **Summary**

The Tillet® cultivator is manufactured by Garford Corp (<http://garford.com/>). It utilizes a camera and computer processor to detect crop plants. This computer processor directs and synchronizes rotating hoes to kill weeds and work around crop plants. The machine is capable of thinning direct seeded or weeding transplanted lettuce. To thin, it is most efficient if plants are planted at 3.0 or more inches apart with good singulation. In weeding transplanted crops it needs the crop be significantly larger than the weeds in order for it to be able to effectively differentiate between the weeds and crop. In these trials we evaluated the ability of the machine to thin direct seeded lettuce (trial no. 1) and to weed transplanted radicchio (trial no. 2). In trial no. 1, the Tillet cultivator thinned a stand of lettuce planted at 3.0 inches apart; it reduced the initial stand of lettuce from 102,208 to 39,286 plants/A. However, follow-up hand thinning was required to achieve an acceptable final lettuce stand. However, in the Tillet plot only 4.2 hours/A were required for follow up thinning vs 11.6 hours/A that were required for standard cultivation. In trial no. 2 the Tillet was used to weed transplanted radicchio.

Following passage of the Tillet weeder, it took a total of 11.6 hours/A to do the follow-up hand weeding (two weeding events) vs 15.3 hour/A to weed the standard treatment. In summary, the Tillet cultivator show promise for being able to thin direct seeded lettuce and weed transplanted lettuce. It needs follow-up hand work to achieve acceptable stands and remove all weeds, but the amount of labor needed to do the follow-up work was less than for standard thinning or weeding in these trials.

### **Methods**

**Trial No. 1:** The trial was conducted with Ed Mora of D'Arrigo Brother in Gonzales. The trial was conducted on romaine lettuce 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 (Figure 1). Pre thinning weed and lettuce stand counts were made on June 17. Two treatments were applied on June 17: 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 in collaboration with Rami Colfer of Mission Ranches in Gilroy. The trial was conducted on organic radicchio that was transplanted July 17. Plots were two 40-inch beds wide by 200 feet long and were replicated four times in a randomized complete block design. Pre-weeding counts were made on August 5 in a 25 foot long strip in

the middle of each plot. Two treatments were applied on August 7: 1) weeding with the Tillet and 2) standard hand weeding. Following application of these treatments two hand weedings were carried out in the plots, as well as a harvest evaluation. See tables for evaluations and dates.

## Results

**Trial No. 1:** During thinning, the Tillet removed 62,922 lettuce plants/A (Table 1), but follow-up hand thinning was necessary to achieve an acceptable stand. Hand rethinning of the Tillet plots took 4.2 hour/A vs 11.6 hours/A for standard hand thinning. The final stands of lettuce following hand weeding and hand rethinning of the Tillet plot were 27,786 and 30,693 plants/A, respectively. The higher number of plants in the Tillet plots may have been due to closer plant spacing left by the machine which made it a bit awkward to achieve uniform spacing of the plants to 9 inch spacing. The Tillet machine removed 65% of the weeds in the stand during the thinning operation; hand thinning removed 87% of weeds during thinning (Table 2). There were more doubles in the Tillet thinned plots and it took more time to remove weeds and double lettuce plants in the subsequent hand weeding operation. There were no differences in tonnage/A between Tillet and hand thinned treatments, but individual Tillet thinned plants were lighter than hand thinned plants.

**Trial No. 2:** Standard cultivation leaves a 4-inch wide uncultivated band around the seedline. The pre and post cultivation weed counts measured the number of weeds that were in the seedline before and after Tillet cultivation. The Tillet cultivator removed 64% of the weeds in the seedline while standard cultivation did not remove any (Table 3). Plots were hand weeded on August 7 and the Tillet cultivated plots took 5.9 hours/A to weed and the standard cultivation took 8.4 hours/A. Following a subsequent weeding on August 14, total weeding time of the two weeding operations indicated that the Tillet treatment took 3.7 hours/A less time to weed than the standard cultivation. There were no differences in stand count or yield between the two treatments.



Figure 1. Tillet cultivator heads with rotating knives

Table 1. Trial No. 1: Thinning evaluations

Treatments	June 17			July 14
	Initial lettuce stand Plant/A	Post Tillet Stand Plant/A	Hand thinning time <sup>1</sup> Hrs/A	Final lettuce stand Plant/A
Standard	103,466	NA	11.6	27,786
Tillet	102,208	39,286	4.2	30,693
Pr>F treat	0.107	NA	<0.001	<0.001
Pr>F block	0.108	NA	0.186	0.197
LSD 0.05	NS	NA	1.2	653

1 – The standard treatment was hand thinning only; follow up hand thinning in the Tillet treatment was needed to finalize the stand.

Table 2. Trial No. 1: Weed and harvest evaluations

Treatments	June 17				June 25			July 22	
	Initial Weed count	Weeds remaining after Tillet thinning	Weeds remaining after hand thinning	Percent weeds removed	Weed count post thinning	Doubles <sup>1</sup> post thinning	Weed and double removal	Harvest Untrimmed heads	Plant weight
	Weeds/A	Weeds/A	Weeds/A	%	Weeds/A	Doubles/A	hr/acre	ton/acre	lbs/plant
Standard	4,737	NA	490	87	588	621	1.2	33.4	2.43
Tillet	5,244	1,634	NA	65	751	1,258	1.5	31.8	1.98
Pr>F treat	0.685	NA	NA	0.011	0.414	0.013	0.003	0.348	0.031
Pr>F block	0.045	NA	NA	0.428	0.012	0.154	0.753	0.599	0.437
LSD 0.05	NS	NA	NA	15	NS	492	0.2	NS	0.22

1 – Double lettuce plants

Table 3. Trial No. 2: Weed counts pre and post Tillet cultivation, percent weed removal, weeding time and yield evaluations on October 7.

Treatment	Pre-cultivation weed counts (8.25 sq ft) Aug 5			Post-cultivation weed counts (8.25 sq ft) Aug 7			Weed count reduction <sup>2</sup> %	Hand weeding Aug 7	Hand weeding Aug 14	Total weeding time	Stand count Aug 7	Yield stand count Oct 7	Yield mean head Oct 7	Yield total weight Oct 7
	Night-shade	Common Purslane	Total Weeds <sup>1</sup>	Night-shade	Common Purslane	Total Weeds <sup>1</sup>								
Standard	9.7	7.9	40.3	NA	NA	NA	NA	8.4	6.9	15.3	31,245	29,628	0.84	12.4
Tillet	13.9	4.3	47.6	6.1	2.3	16.9	64	5.9	5.7	11.6	30,721	29,119	0.88	12.7
Pr>F treat	0.142	0.636	0.242	NA	NA	NA	NA	<0.001	0.005	<0.001	0.318	0.278	0.448	0.657
Pr>F block	0.014	0.921	0.06	NA	NA	NA	NA	0.616	0.061	0.156	0.221	0.073	0.251	0.447
LSD 0.05	NS	NS	NS	NA	NA	NA	NA	0.7	0.8	1.3	NS	NS	NS	NS

1 – Other weeds at the site included little mallow, henbit, pigweed, shepherd's purse, sweet alyssum and lambsquarter; 2 – Percent reduction of weeds in the seedline by the Tillet cultivator over standard cultivation (leaving a 4 inch wide uncultivated strip around the seedline).