

## **2008 Precision Cultivation Studies**

Richard Smith and Miriam Silva, Farm Advisor and Research Assistant  
University of California Cooperative Extension, Monterey County

**Summary:** These trials evaluated the efficacy of finger and torsion weeders for removing weeds from the seedline of transplanted or large seeded crops. These cultivation implements take advantage of the size difference of transplant and young weed seedlings. These studies indicated that finger and torsion weeders can reduce the number of weeds in the seedline and the amount of time for subsequent hand weeding operations. This was most dramatically seen in two trials where the weeds were at the cotyledon to first true leaf stage. Once weeds get larger (eg 2-3 true leaf stage), they become more difficult for these cultivation implements to remove without damaging the crop. These studies indicate that these cultivators can be effective if timing and soil conditions are ideal for their operation.

### **Introduction**

Lettuces, cole crops and other crops are frequently grown on 40 or 80 inch wide beds on the Central Coast. The number of seedlines on these beds varies but generally is 2 on a 40-inch bed and 5-6 on an 80-inch bed. Standard cultivation typically leaves a 3 to 5 inch uncultivated band around the seedline of the crop, thereby cultivating 80-85% of the bed. The uncultivated portion of the bed in conventional production is treated with herbicides which further reduced weed pressure. However, the majority of labor expended in removing weeds from vegetables occurs in the seedline. There has been few new developments in cultivation technology for many years until recently when precision guided cultivation (eg EcoDan and Robocrop) provided a tool for growers to cultivate more closely to the seedline. In addition, there are cultivation tools such as finger weeders and torsion weeders that are widely used in Europe that are little used in vegetable production in the US. These tools have the ability to take weeds from the seedline. Three companies produce these implements in Europe. Finger weeders from the Kress Company® are made of plastic and come in different levels of hardness (Figure 1). Orange is the softest and yellow is more firm. They also come in different sizes (eg 9.5 and 14.5 inches in diameter). Though the choice of hardness and size it is possible to adjust the level of aggressiveness of the implement and the level of safety to the crop. The implements can also be adjust as to how closely they are separated around the seedline (Figures 1&2). The fingers are ground driven and spin thereby uprooting young roots (Figure 3). Torsion weeders come in different diameters. 7 mm are less aggressive and 9 mm are more aggressive (Figure 4). They also can be adjusted to be more or less aggressive to the weeds and crop by setting the distance between them.

These tools however, are most appropriate for transplanted crops; they work best if the crop is firmly rooted in the soil and the weeds are small (eg cotyledon to first true leaf stage). If these tools prove to be practical for vegetable production on the Central Coast of California, they could help increase the efficiency of mechanical weeding operations. These trials were designed to evaluate finger and torsion weeders on key crops on the Central Coast.

### **Methods**

All trials were conducted in cooperation with growers. The cultivation implements were mounted on the grower's cultivator. The implements were mounted behind the standard

knives, sweeps and coulters implements that the growers use for their standard cultivation. The experimental cultivators were adjusted to remove weeds from the uncultivated band left by standard cultivation. See the following for details of each trial.

***Trial No. 1:*** The trial was conducted with John Sargenti of Violini Ranches in Gonzales on snap beans planted on 6 seedlines on 80 inch beds. Two cultivators per bed were placed on the last bar of the standard cultivation rig. The beans were at the 2-3 true leaf stage at the time of cultivation. The beans had been cultivated once prior to the start of the experiment. Hairy nightshade was at the 3-4 true leaf stage and was the dominant weed at the site. Precultivation weed counts were made on June 18 by counting all the weeds in an 8-inch wide strip around the seedline by 30 foot; the plots were cultivated on June 19 and post cultivation weed counts were made of the same area as the precultivation counts on the same day. Time of weeding evaluations were conducted on June 19 by timing how long it took to weed a 75 foot long strip in each plot. There were 12 replications of each plot. No harvest evaluation was conducted.

***Trial No. 2:*** The trial was conducted with Bill Sullivan of Crown Packing in Salinas on transplanted romaine lettuce. Lettuce variety 'Nirvana' was transplanted on June 2. Burning nettle was the dominant weed at the site and was at the cotyledon to first true leaf stage at the time of cultivation. Precultivation weed counts were made on June 17 by counting all the weeds in an 8-inch wide strip around the seedline by 10 foot long; the plots were cultivated on June 20 and post cultivation weed counts were made of the same area as the precultivation counts on June 23. Time of weeding evaluations were conducted on June 24 by timing how long it took to weed a 75 foot long strip in each plot. Harvest evaluations were conducted by harvesting 15 heads from each plot to measure mean head weight on July 22. There were 8 replications of each plot.

***Trial No. 3:*** This trial was conducted with Bill Sullivan of Crown Packing in Salinas on transplanted celery. The celery was transplanted on May 22. Chickweed and henbit were the dominant weeds at the site and were at the 2-3 true leaf stage at the time of cultivation. Precultivation weed counts were made on June 23 by counting all the weeds in an 8-inch wide strip around the seedline by 20 foot long. The plots were cultivated on June 24 and post cultivation weed counts were made of the same area as the precultivation counts on the same day. Time of weeding evaluations were conducted on July 7 by timing how long it took to weed a 75 foot long strip in each treatment. Each plot was replicated eight times.

***Trial No. 4:*** This trial was conducted with Israel Morales of American Farms in Chualar on transplanted lettuce. The lettuce variety Nirvana was transplanted on June 30. Malva was the main weed at this site and was at the 1-2<sup>nd</sup> true leaf stage. Precultivation weed counts were made of an 8-inch wide strip around the seedling by 50 feet long on July 16; the plots were cultivated on July 18 and post cultivation weed counts were made of the same area on July 18. Time of weeding evaluations were conducted on July 22 by timing how long it took to weed a 75 foot long strip in each plot. Harvest data was collected on August 18 by randomly harvesting 8 heads per plot to establish mean head weights and combining this data with stand counts to estimate yield. Each plot was replicated eight times.

**Trial No. 5:** This trial was conducted with Israel Morales of American Farms in Chualar on transplanted lettuce. The broccoli variety Marathon was transplanted on June 30. Malva was the main weed at this site and was at the cotyledon-1<sup>st</sup> true leaf stage. Precultivation weed counts were made of an 8-inch wide strip around the seedline by 30 feet long on July 16; the plots were cultivated on July 18 and post cultivation weed counts were made of the same area as the precultivation on July 18. Time of weeding evaluations were conducted on July 22 by timing how long it took to weed a 75 foot long strip in each treatment. Harvest data was collected on September 10 by randomly harvesting 8 heads per plot to establish mean head weights; the field was then harvested by a commercial harvest crew and cut heads were counted and yield estimated. Each plot was replicated ten times.

**Trial No. 6:** The trial was conducted with Phil Foster of Foster Ranches in San Juan Bautista on leeks. Leeks were transplanted on September 9. Malva, pigweed, nettle and hairy nightshade were the principle weeds at this site. The malva was at the 1-2<sup>nd</sup> true leaf stage, but nettle was at the cotyledon to 1<sup>st</sup> true leaf stage. Precultivation weed counts were made of an 8-inch wide strip around the seedline by 10 feet long on September 30; the plots were cultivated on October 1 and post cultivation weed counts were made of the same area as the precultivation on October 2. Time of weeding evaluations were conducted on October 7 by timing how long it took to weed a 75 foot long strip in each treatment. Each plot was replicated 8 times. Harvest evaluations will be conducted in March 2009.

## **Results**

**Trial No. 1:** Hairy nightshade was the dominant weed at this site (Table 1). All cultivation methods effectively reduced weeds at this site. Standard cultivation removed a high percent of weeds and the torsion and finger weeders did not remove an additional percentage of weeds (Table 2). Weeding time was not further reduced by these cultivators, but the 14.5 inch in diameter finger weeders appear to have damaged more bean plants per acre than the other treatments.

**Trial No. 2:** There was good weed pressure in this trial and the weeds were small and at the ideal stage for removal by the finger and torsion weeders (Table 3). The finger and torsion weeders removed a higher percentage of all weeds except for malva (Table 4). Standard cultivation removed 51% of total weeds while the finger and torsion weeders removed from 74 to 87% of total weeds. It took 11.5 hours per acre to weed the standard cultivation plots, but weeding time was reduced with the finger and torsion weeders and was the lowest in both the yellow and orange 9.5" finger weeders. Mean head weight was lowest in the 9 mm torsion weeder indicating that there may have been some damage to the lettuce by this implement.

**Trial No. 3:** There was relatively low weed pressure at this site (Table 5) and the weeds were older (eg 2-3 true leaf stage). Standard cultivation removed about 41% of the weeds. None of the experimental implements significantly reduced weeding time (Table 6).

**Trial No. 4:** There was relatively low weed pressure at this site (Table 7); malva was the dominant weed and was at the 2-3 true leaf stage at the time of cultivation. None of the implements increased the percent removal of the weeds. There was slight reduction in weeding time and some indication of reduced yield in the torsion weeder treatments (Table 8).

**Trial No. 5:** There was low weed pressure at this site and the weeds were a mixture of malva, nettle and nettle leaf goosefoot (Table 9) and they were generally at the 1-2 true leaf stage. Standard cultivation removed 53% of nettle and the finger and torsion weeders removed from 54-100% of this weed (Table 10). None of the implements removed a significantly higher percent of malva. Overall standard cultivation removed 50% of total weeds and the finger and torsion weeders removed from 63-85% of total weeds. There were slight reductions in weeding time with the highest reductions with the 14.5" finger weeders and the 9 mm torsion weeder. The 9 mm torsion weeder significantly reduced the yield in comparison with the standard cultivation.

**Trial No. 6:** There was a high weed population at this site (Table 11); malva was generally more developed (1-2 true leaf stage) and the nettle was smaller (cotyledon to 1<sup>st</sup> true leaf stage). The soil was harder at this site and the 7 mm torsion weeder did not dig into the soil surface as well as the other implements. All implements significantly increased the percent of weed removal for all weed species except malva (Table 12). Standard cultivation removed 28% of total weeds while the finger weeders removed from 73-88% of the weeds. The torsion weeders removed less probably due to hard soil conditions. Standard cultivation took 18.8 hours per acre to weed while the finger weeders ranged from 9.3 to 12.0 hours per acre.



Figure 1. 14.5 inch in diameter finger weeders. The orange are softer and the yellow are harder which allows you to select their aggressiveness. The fingers are ground driven and spin faster than the ground speed, thereby flipping young weeds out of the ground.

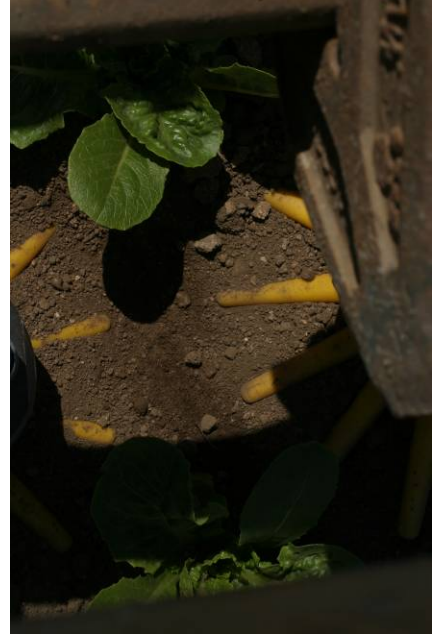


Figure 2. 9.5 inch finger weeders rotate and up root small weeds. They can be more or less aggressive to the weeds and crop by adjusting the distance between them.

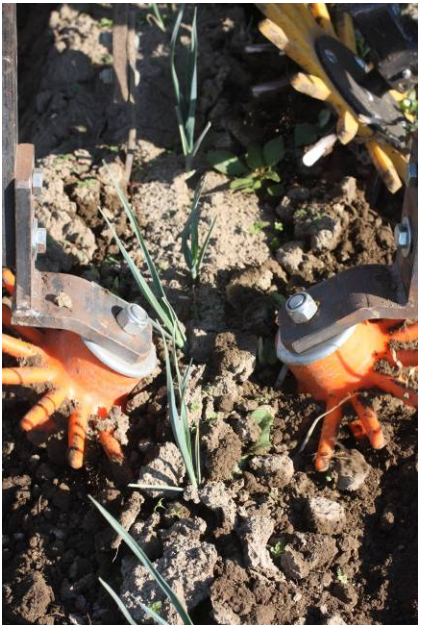


Figure 3. Finger weeders cultivating the uncultivated strip in leeks leaving young weeds uprooted.



Figure 4. Torsion weeders undercut small weeds. They can be adjusted to not hit the crop or to hit the crop at various levels of aggressiveness by setting the distance between the tines. They hit the crop at an oblique angle and glance off of it well rooted transplants.

### **Acknowledgements**

We greatly appreciate the following cooperators for their assistance:

Phil Foster of Foster Ranches in San Juan Bautista; Israel Morales of American Farms in Chualar; Jim Muscio at AgriFrame in Gonzales; John Sargenti of Violini Ranches in Gonzales and Bill Sullivan of Crown Packing in Salinas.

Table 1. Trial No. 1: Pre and post cultivation weed counts (20 ft<sup>2</sup>) of direct seeded snap beans

	Pre cultivation on June 18				Post cultivation on June 19			
	Night shade	Malva	Pigweed	Total	Night shade	Malva	Pigweed	Total
Standard	10.7	0.3	0.4	11.4	0.1	0.0	0.0	0.0
9.5 " yellow	5.5	1.7	0.3	6.0	0.1	0.0	0.0	0.1
9.5" orange	13.2	0.1	2.0	15.2	0.4	0.0	0.0	0.4
14.5" yellow	9.6	0.1	1.0	10.6	1.7	0.0	0.0	1.7
14.5" Orange	11.5	0.0	1.3	12.8	0.5	0.0	0.0	0.5
9mm	21.6	0.2	0.3	22.2	1.1	0.0	0.0	1.1
7mm	15.1	0.1	0.3	15.5	0.5	0.0	0.0	0.5
Pr>F Treat	0.0001	0.6691	0.0189	<0.0001	<0.0001	---	---	<0.0001
LSD 0.05	5.9	NS	1.1	5.974	0.7			0.7

Table 2. Trial No. 1: Percent removal of weeds, time of weeding and number of bean plants injured by cultivation of direct seeded beans

	Percent removal				Weeding time hrs/A	Bean Plants killed/Acre
	Night shade	Malva	Pickweed	Total		
Standard	99.4	100	100	99.4	14.9	363.0
9.5 " yellow	98.1	100	100	98.1	11.3	272.3
9.5" orange	97.5	100	100	97.5	13.5	0.0
14.5" yellow	83.7	100	100	83.7	12.7	2,541.0
14.5" Orange	95.7	ND	100	95.7	13.3	1,089.0
9mm	93.1	100	100	93.1	14.5	272.3
7mm	88.7	100	100	88.7	16.1	453.8
Pr>F Treat	0.0006	-----	-----	0.0006	0.0791	<0.0001
LSD 0.05	8.1	-----	-----	8.1	NS	879.0

Table 3. Trial No. 2: Pre and post cultivation weed counts (6.7 ft<sup>2</sup>) of transplanted lettuce

Treatments	Pre cultivation counts June 16, 2008					Pre cultivation counts June 20, 2008				
	Nettle	NLGF	Malva	Shepherd's purse	Total	Nettle	NLGF	Malva	Shepherd's purse	Total
Standard	16.9	2.7	1.0	1.7	19.5	8.4	1.3	0.6	1.0	9.8
14.5" orange	16.6	2.9	1.5	1.6	20.5	2.4	0.1	1.0	0.2	2.9
14.5" yellow	20.0	3.5	1.5	1.5	24.5	4.6	0.8	0.8	0.2	5.8
9.5" orange	9.8	3.2	1.0	1.6	12.9	1.3	0.0	0.0	0.2	1.4
9.5" yellow	11.8	2.3	1.3	1.6	15.0	1.4	0.0	0.7	0.0	1.6
Torsion 9mm	10.5	2.9	1.0	1.3	13.6	2.3	0.3	1.0	0.3	2.8
Pr>F Treat	0.007	0.9046	0.2843	0.6823	0.0174	<.0001	0.0031	0.4353	0.0096	<.0001
LSD 0.05	6.2	NS	NS	NS	7.1	3.9	0.9	NS	0.7	4.1

Table 4. Trial No. 2: Percent removal of weeds, time of weeding and mean head weight of transplanted lettuce

Treatments	Percent Weed Removal					Weeding Time Hr/A	Mean Head wt. lbs
	Nettle	NLGF	Malva	Shepherds purse	Total		
Standard	51.6	57.8	40.0	37.5	51.5	11.5	1.32
14.5" orange	87.8	92.9	25.0	90.0	87.4	6.8	1.40
14.5" yellow	73.9	76.7	50.0	83.3	74.5	9.7	1.57
9.5" orange	86.3	100.0	100.0	90.0	87.9	6.0	1.21
9.5" yellow	85.1	100.0	50.0	100.0	87.7	5.9	1.27
Torsion 9mm	77.7	83.3	0.0	66.7	78.5	8.8	1.15
Pr>F Treat	<.0001	0.0122	0.568	0.0321	<.0001	<0.0001	0.0318
LSD 0.05	18.5	31.8	NS	49.2	14.7	2.4	0.44

Table 5. Trial No. 3: Pre and post cultivation weed counts (13.3 ft<sup>2</sup>) of transplanted celery

Treatments	Percultivation precounts done in June 23, 2008						Postcultivation counts on June 24, 2008					
	Henbit	Chick	Pigweed	Nettle	Others	Total	Henbit	Chick	Pigweed	Nettle	Others	Total
Standard	4.0	3.3	1.5	1.0	0.1	10.9	2.8	2.3	0.5	0.8	0.1	7.0
14.5" orange	5.1	3.1	0.8	2.0	0.0	11.8	3.0	2.0	0.2	0.7	0.0	6.7
14.5" yellow	4.3	2.1	1.8	0.8	0.1	10.2	3.3	1.7	0.3	1.1	0.0	6.7
9.5" orange	4.1	2.1	1.8	0.8	0.0	10.0	2.0	0.8	0.0	0.8	0.0	4.1
9.5" yellow	2.8	3.1	0.3	1.7	0.0	8.5	1.7	2.1	0.1	0.7	0.0	5.0
Torsion 7mm	3.1	3.1	0.6	0.6	0.2	8.1	1.1	2.2	0.2	0.2	0.1	4.0
Torsion 9mm	3.8	4.2	1.1	0.8	0.1	11.0	1.5	2.0	0.1	1.0	0.0	4.8
Pr>F	0.7941	0.7354	0.5343	0.1901	0.5107	0.6383	0.3556	0.7763	0.2310	0.736	0.5302	0.1964
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 6. Trial No. 3: Percent removal of weeds and time of weeding of transplanted celery

Treatments	Percent Weed Removal						Weeding Time Hr/A
	Henbit	Chickweed	Pigweed	Nettle	Others	Total	
Standard	42.57	31.45	56.06	14.81	50.00	41.84	18.13
14.5" orange	37.11	31.48	66.67	71.43	.----*	42.73	18.67
14.5" yellow	31.09	47.62	33.33	22.92	100.00	42.30	18.53
9.5" orange	71.07	58.33	100.00	0.00	.----*	65.20	18.85
9.5" yellow	41.84	31.45	50.00	52.78	.----*	39.13	16.37
Torsion 7mm	73.61	34.64	50.00	62.50	50.00	55.58	19.24
Torsion 9mm	55.16	49.55	91.67	11.11	100.00	57.46	17.32
Pr>F	0.2619	0.9577	0.1134	0.9793	.----*	0.8045	0.7687
LSD 0.05	NS	NS	NS	NS	.----*	NS	NS

Table 7. Trial No. 4: Pre and post cultivation weed counts (33.3 ft<sup>2</sup>) of transplanted lettuce

Treatments	Pre cultivation counts July 16, 2008					Post cultivation counts July 21, 2008				
	Malva	Shepherd's Purse	NLGF	Others	Total	Malva	Shepherd's Purse	NLGF	Others	Total
Standard	7.4	2.0	1.7	1.4	8.4	3.7	1.0	0.5	0.3	4.1
14.5" orange	11.3	ND	1.0	1.3	12.1	4.1	ND	0.5	0.0	4.2
14.5" yellow	7.5	ND	ND	1.0	7.7	3.2	ND	ND	0.0	3.2
9.5" orange	9.6	2.6	1.7	1.0	11.7	5.8	0.3	0.7	0.0	6.3
9.5" yellow	11.3	1.5	1.3	2.0	12.7	6.6	0.0	0.6	1.0	7.1
Torsion 7mm	9.5	1.0	1.0	1.0	10.8	3.2	0.0	1.0	0.0	3.3
Torsion 9mm	6.8	1.0	1.0	1.7	8.2	3.3	0.00	0.0	0.5	3.6
Pr>F	0.0234	0.9141	0.4886	0.6371	0.037	0.0099	0.1064	0.5477	0.2939	0.0037
LSD 0.05	3.6	NS	NS	NS	4.1	2.1	NS	NS	NS	2.2

NLGF – nettle leaf goose foot; ND - No data.

Table 8. Trial No. 4: Percent removal of weeds, time of weeding and yield of transplanted lettuce

Treatments	Percent Weed Removal					Weeding Time Hr/A	Yield Plant/A	Yield Lbs/A	Mean head wt lbs
	Malva	Shepherd's Purse	NLGF	Others	Total				
Standard	47.1	35.0	63.1	74.0	46.8	5.3	33,542	56,075.9	1.67
14.5" orange	64.6	ND	50.0	100.0	65.4	4.7	32,235	53,117.1	1.64
14.5" yellow	54.8	ND	ND	100.0	55.8	4.3	32,888	54,226.6	1.65
9.5" orange	42.1	91.6	54.1	100.0	47.1	5.5	30,928	49,267.4	1.58
9.5" yellow	44.5	100.0	33.3	66.6	47.1	4.4	32,670	55,203.2	1.68
Torsion 7mm	62.7	100.0	0.00	100.0	67.1	4.1	30,710	48,153.7	1.56
Torsion 9mm	51.2	100.0	100.0	50.0	57.1	6.0	32,452	47,031.6	1.43
Pr>F	0.2233	0.0759	0.8325	0.397	0.0816	<.0001	0.0028	0.0011	0.0483
LSD 0.05	NS	NS	NS	NS	NS				

NLGF – nettle leaf goose foot; ND - No data.

Table 9. Trial No. 5: Pre and post cultivation weed counts (20.0 ft<sup>2</sup>) of transplanted broccoli

Treatments	Pre cultivation counts July 16 2008					Post cultivation counts July 18 2008				
	Malva	Nettle	NLGF	Others	Total	Malva	Nettle	NLGF	Others	Total
Standard	3.6	2.0	1.9	1.7	6.2	1.9	1.0	0.6	0.8	3.1
9.5" orange	3.2	2.2	1.3	1.5	5.8	1.2	0.0	0.3	0.0	1.3
9.5" yellow	3.5	2.7	1.0	2.4	6.0	1.6	0.7	0.0	0.4	2.1
14.5" yellow	3.8	1.8	2.5	1.2	6.0	1.0	0.2	0.0	0.2	1.2
14.5" orange	5.7	1.7	1.3	1.4	6.4	1.5	0.0	0.0	0.2	1.3
Torsion 7mm	4.7	2.2	1.6	1.8	9.2	1.7	0.3	0.3	0.0	2.20
Torsion 9mm	4.2	2.8	1.1	2.3	7.5	1.5	0.2	0.0	0.1	1.5
Pr>F	0.3702	0.3458	0.5318	0.7494	0.1601	0.1726	0.3136	0.1977	0.001	<0.0001
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	0.6	1.5

Table 10. Trial No. 5: Percent removal of weeds time of weeding and yield of transplanted broccoli

Treatments	Percent Weed Removal					Weeding Time Hr/A	Yield Plant/A	Yield Tons/A	Mean head wt. Lbs
	Malva	Nettle	NLGF	Others	Total				
Standard	43.28	53.74	58.97	43.12	50.73	7.64	63,751.8	10.29	0.51
9.5" orange	57.41	100.00	83.33	100.00	69.44	7.24	61,392.3	9.56	0.50
9.5" yellow	60.93	54.17	100.00	76.00	63.79	7.18	62,526.8	9.27	0.49
14.5" yellow	76.67	95.00	100.00	75.00	81.08	6.63	61,664.7	9.88	0.51
14.5" orange	69.05	100.00	100.00	90.00	85.23	6.86	56,628.0	9.68	0.52
Torsion 7mm	55.17	85.00	77.78	100.00	75.62	8.02	57,580.8	9.72	0.54
Torsion 9mm	68.21	94.39	100.00	83.33	82.00	6.96	57,354.0	8.00	0.47
Pr>F	0.1285	0.0037	0.373	0.0023	0.0003	<.0001	<0.0001	0.0141	0.5416
LSD 0.05	NS	39.657	NS	47.421	20.372	0.7171	1822.1	2.10	NS

Table 11. Trial No. 6: Pre and post cultivation weed counts (6.67 ft<sup>2</sup>) of transplanted leeks

Treatments	Pre cultivation counts September 30, 2008							Post cultivation counts Oct 2, 2008						
	Nettle	Pig weed	Night shade	Malva	Sow Thistle	Others	Total	Nettle	Pig weed	Night shade	Malva	Sow Thistle	Others	Total
Standard	69.6	47.2	24.7	5.3	3.4	4.9	161.1	50.0	34.6	18.9	4.4	1.8	2.3	115.7
14.5" yellow	60.4	31.6	13.4	2.2	4.4	5.2	124.6	17.4	7.2	3.0	1.8	0.0	1.4	32.0
14.5" orange	74.4	49.2	39.6	6.2	2.6	4.2	180.8	7.8	3.4	3.0	4.8	0.0	0.0	19.4
9.5" orange	139.0	28.6	17.2	4.8	2.6	3.2	199.8	35.0	9.8	4.0	2.4	0.2	1.4	53.4
9.5" yellow	66.4	36.8	14.4	2.0	3.0	7.0	133.8	12.0	6.2	1.0	1.4	0.4	1.6	23.4
Torsion 7mm	73.8	71.6	26.0	8.6	3.2	5.4	193.8	43.2	53.2	14.8	7.0	3.0	4.2	127.4
Torsion 9mm	141.0	32.8	15.6	7.0	2.6	3.2	207.6	55.8	17.0	6.4	6.0	1.6	2.2	89.6
Pr>F	<0.0001	0.0160	0.0001	0.0657	0.7888	0.3356	0.0001	<0.0001	<0.0001	<0.0001	0.0780	<0.0001	0.0309	<0.0001
LSD 0.05	19.8	19.1	6.2	NS	NS	NS	36.9	19.8	19.1	6.2	NS	1.1	2.1	36.9

Table 12. Trial No. 6: Percent removal of weeds and time of weeding in transplanted leeks

Treatments	Percent Weed Removal							Weeding Time Hr/A
	Nettle	Pig weed	Night shade	Malva	Sow	Others	Total	
Standard	30.1	24.1	25.6	33.6	49.9	47.9	28.9	18.88
14.5" yellow	69.9	70.4	77.8	18.0	100.0	77.0	73.4	9.85
14.5" orange	88.5	92.6	92.8	15.7	100.0	100.0	88.7	10.43
9.5" orange	74.9	68.2	76.0	30.4	93.3	57.7	73.8	12.00
9.5" yellow	80.6	82.1	94.0	25.0	70.0	81.3	82.7	9.29
Torsion 7mm	41.7	31.0	37.8	17.0	23.3	31.1	35.8	14.50
Torsion 9mm	60.4	43.5	61.7	28.3	25.0	27.6	56.8	22.82
Pr>F	<0.0001	<0.0001	<0.0001	0.9781	<0.0001	0.0035	<0.0001	0.0002
LSD 0.05	16.2	21.0	23.6	NS	35.7	36.6	13.9	5.71