

## Productivity, Economics, and Fruit and Soil Quality of Weed Management Systems in Commercial Organic Orchards in Washington State, USA

David Granatstein, Preston Andrews, Alan Groff

Research published in *Organic Agriculture*, 2014, Vol. 4(3), pp. 197-207.

### On-line Resources

On-line Resource 1. Costs of in-row weed management (metric and US units).

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On-line Resource 1. Costs of in-row weed management.

Costs of tillage for weed control (metric units).

Item	Value
Tillage capital expenditure <sup>1</sup> (Wonder Weeder, lift)	\$11,700
Equipment cost/yr	\$2,187
Equipment cost/ha	\$98.22
Tractor <sup>2</sup> operating cost/hr	\$29.21
Tillage speed (km/hr)	4.02
Hectares/hr	0.89
Tractor operating cost per hectare	\$32.80
Passes/yr	5
Total tillage cost/ha/yr	\$262.22
<sup>1</sup> Assumes 7-yr equipment life; 5% cost of capital, used on 20.2 ha per year. <sup>2</sup> Includes \$9/hr tractor rent, \$13/hr tractor driver, \$7.21/hr tractor fuel.	

Costs of tillage for weed control (U.S. units).

Item	Value
Tillage capital expenditure <sup>1</sup> (Wonder Weeder, lift)	\$11,700
Equipment cost/yr	\$2,187
Equipment cost/acre	\$39.76
Tractor <sup>2</sup> operating cost/hr	\$29.21
Tillage speed (mph)	2.5
Acres/hr	2.2
Tractor operating cost per acre	\$13.28
Passes/yr	5
Total tillage cost/acre/yr	\$114.46
<sup>1</sup> Assumes 7-yr equipment life; 5% cost of capital, used on 50 ac per year. <sup>2</sup> Includes \$9/hr tractor rent, \$13/hr tractor driver, \$7.21/hr tractor fuel.	

Costs of wood chip mulch for weed control (one-time application) (metric units).

Item	Value
Mulch needed (coverage of 0.9 m of tree row with 10 cm of mulch) m <sup>3</sup> /ha	85.6
Mulch cost /m <sup>3</sup> (delivery only, material was free)	\$10.46
Mulch material cost/ha	\$2,213.12
Mulch application cost /ha (13.8 m <sup>3</sup> /hr)	\$756.31
Total mulch cost/ha	\$2,969.43
Total mulch cost/ha/yr (3 yr)	\$989.81

Costs of wood chip mulch for weed control (one-time application) (U.S. units).

Item	Value
Mulch needed (coverage of 3.0 ft of tree row with 4 inches of mulch) cu. yd./acre	112
Mulch cost /cu. yd. (delivery only, material was free)	\$8.00
Mulch material cost/acre	\$896
Mulch application cost /acre (18 cu. yd./hr)	\$306.20
Total mulch cost/acre	\$1202.20
Total mulch cost/ac/yr (3 yr)	\$400.73

Costs of organic herbicide for weed control. (metric units)

Item	Value
Est. sprayer cost/ha	\$25.37
Treatment rate (ha/hr) at 3.22 kph	0.71
Water (L/ha)	60.6
WeedPharm herbicide cost (\$/ha) at 112.2 L/ha and \$1.585/L	\$177.84
Horticultural oil cost (\$/ha) at 18.7 l/ha and \$1.585/L	\$29.64
Citric acid cost (\$/ha) at 6.7 kg/ha and \$3.30/kg	\$59.28
Material cost per pass (\$/ha)	\$266.76
Tractor operating cost per pass (\$/ha)	\$41.00
Total cost per pass (\$/ha)	\$307.76
Number of passes per year	4
Total herbicide spray cost (\$/ha/yr)	\$1256.41

Costs of organic herbicide for weed control. (U.S. units)

Item	Value
Est. sprayer cost/ha	\$10.27
Treatment rate (acres/hr) at 1.14 mph	1.76
Water (gal/acre)	16
WeedPharm herbicide cost (\$/acre) at 12 gal/acre and \$6.00/gal	\$72.00
Horticultural oil cost (\$/acre) at 2 gal/acre and \$6.00/gal	\$12.00
Citric acid cost (\$/acre) at 16 lb/acre and \$1.50/lb	\$24.00
Material cost per pass (\$/acre)	\$108.00
Tractor operating cost per pass (\$/acre)	\$16.60
Total cost per pass (\$/acre)	\$124.60
Number of passes per year	4
Total herbicide spray cost (\$/ac/yr)	\$508.67

Costs of flaming for weed control. (metric units)

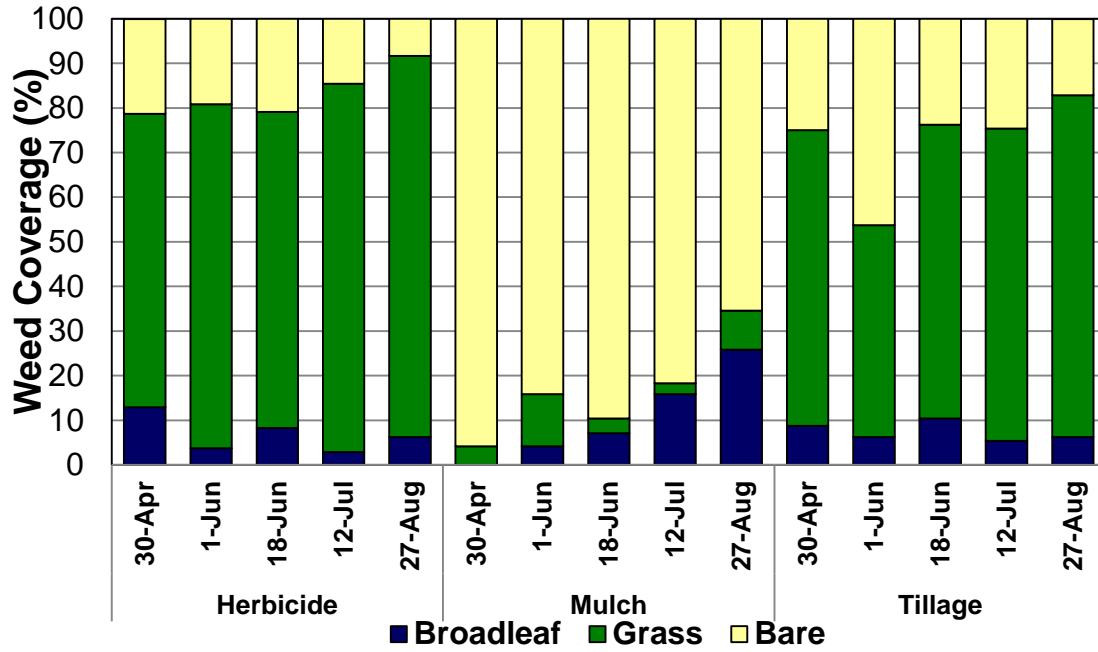
<b>Item</b>	<b>Value</b>
Flamer capital expenditure <sup>1</sup>	\$2,500
Equipment cost/yr	\$424
Equipment cost/ha	\$20.99
Flaming speed (km/hr)	8.04
Ha/hr	1.78
Propane cost (\$/ha)	\$34.58
Tractor operating cost per hectare	\$16.40
Cost per hectare per pass	\$50.98
Passes / yr	5
Total flaming cost/ha/yr	\$275.89
<sup>1</sup> Assumes 7-yr equipment life; 5% cost of capital, used on 20.2 ha per year. <sup>2</sup> Includes \$9/hr tractor rent, \$13/hr tractor driver, \$7.21/hr tractor fuel.	

Costs of flaming for weed control. (U.S. units)

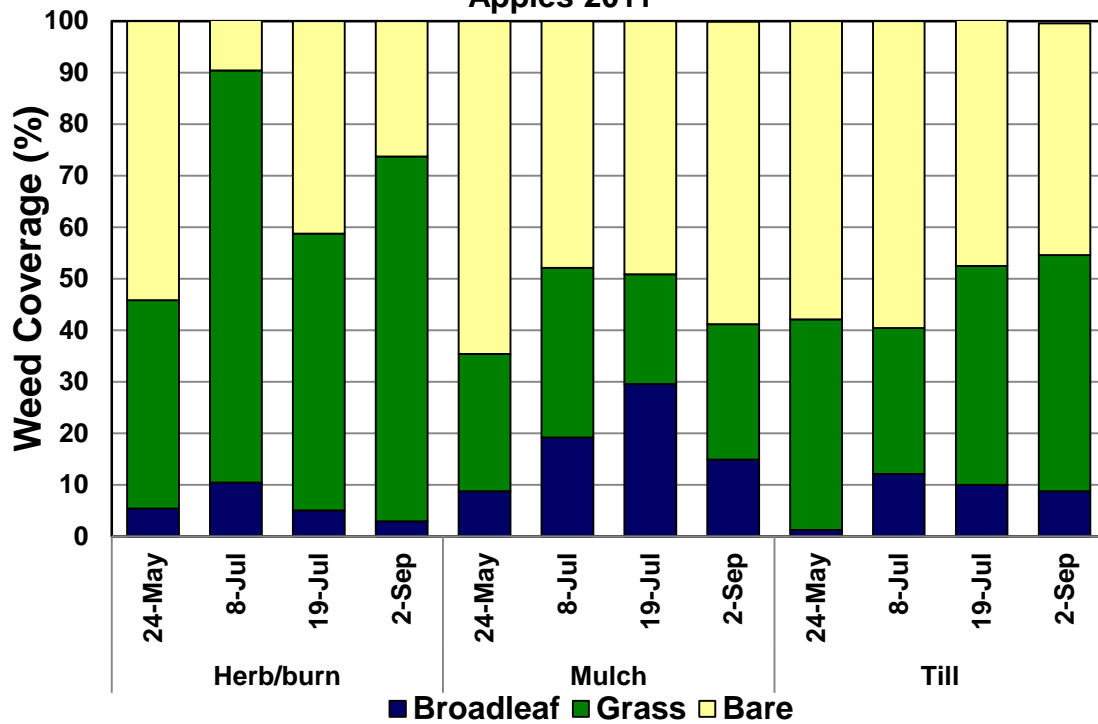
<b>Item</b>	<b>Value</b>
Flamer capital expenditure <sup>1</sup>	\$2,500
Equipment cost/yr	\$424
Equipment cost/acre	\$8.50
Flaming speed (mph)	5.0
Acres/hr	4.4
Propane cost (\$/acre)	\$14.00
Tractor operating cost per acre	\$6.64
Cost per acre per pass	\$20.64
Passes / yr	5
Total flaming cost/acre/yr	\$111.70
<sup>1</sup> Assumes 7-yr equipment life; 5% cost of capital, used on 50 acres per year. <sup>2</sup> Includes \$9/hr tractor rent, \$13/hr tractor driver, \$7.21/hr tractor fuel.	

On –line Resource 2. Weed percent cover in the tree row, separating broadleaf weeds, grass weeds, and bare ground, for organic apple and pear orchards in both 2010 and 2011.

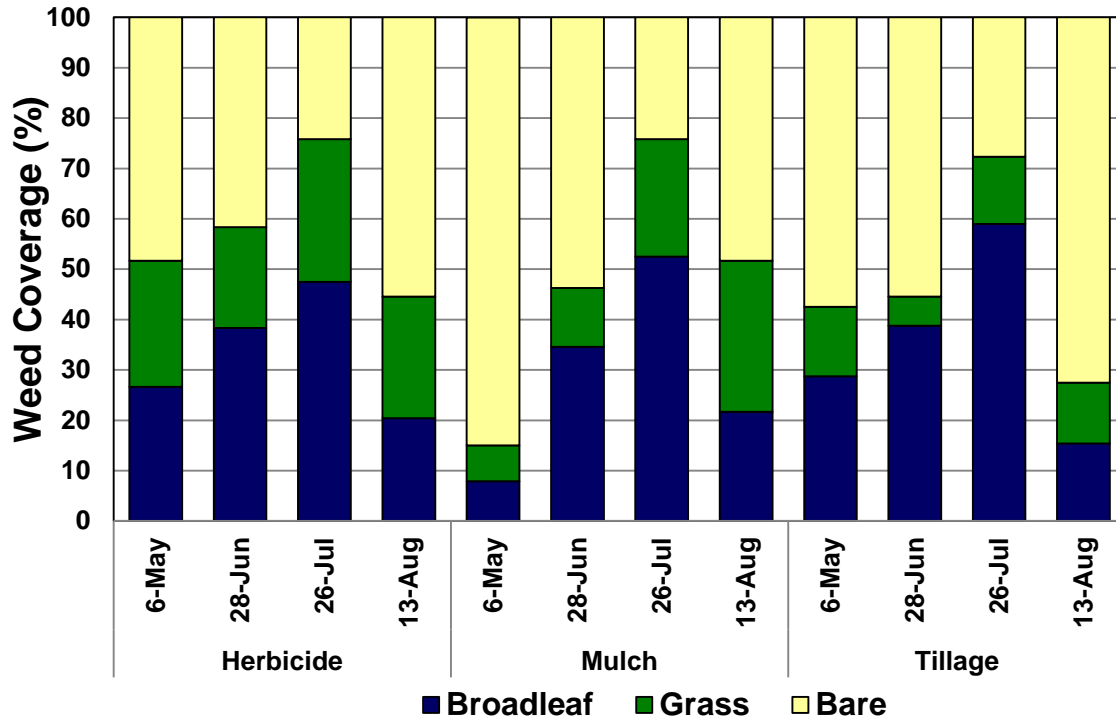
### Apples 2010



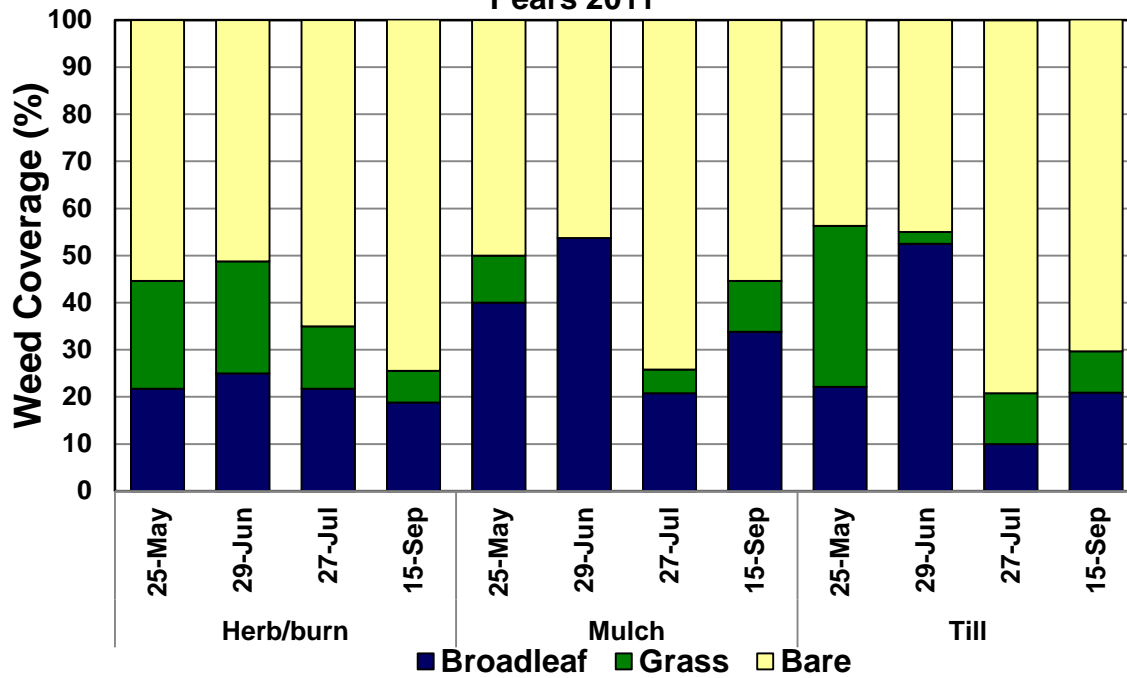
### Apples 2011



### Pears 2010



### Pears 2011



On-line Resource 3.

Apple fruit size by treatment and year. Expressed as percent of total packed yield by box size (80 count to 175 count per 40 lb box [18.2 kg]) or fruit weight (g). Size 80 and 88 are the target for typical maximum price.

Box size	<u>80+88</u>	<u>80</u>	<u>88</u>	<u>100</u>	<u>113</u>	<u>125</u>	<u>138</u>	<u>150</u>	<u>163</u>	<u>175</u>
Fruit wt. (g)		228-249	202-227	180-201	160-179	146-159	131-145	120-130	114-119	100-113
<u>2009</u>										
M	21.0	6.1	14.9	21.8	23.6	15.6	8.2 b	4.1	1.8	1.0
HF	20.7	6.7	14.1	21.6	22.4	15.5	8.6 ab	4.3	2.3	1.3
T	17.5	5.2	12.3	20.0	23.9	17.1	9.8 a*	5.0	2.5	1.4
* $p=0.10$ ; for all other sizes, $p<0.05$										
<u>2010</u>										
M	13.3 a	1.8	11.5 a	26.2 a	27.6	12.4	10.3 b	4.1 b	2.8 b	2.2 b
HF	9.3 b	1.3	8.0 b	23.8ab	27.3	14.4	11.9 a	5.2 a	3.7 a	2.9 a
T	9.4 b	1.0	8.4 b	22.8 b	28.5	14.3	11.8 a	5.3 a	3.8 a	2.6 ab
$p<0.05$										
<u>2011</u>										
M	8.3	1.7	6.6	28.7	23.9	17.8	8.4	5.8	4.3	2.5 b
HF	7.4	1.6	5.8	25.8	22.6	18.6	9.8	6.7	5.2	3.0 ab
T	6.4	1.3	5.1	25.1	21.9	17.9	9.9	8.0	6.5	3.4 a
$p<0.05$										
M=Mulch/flaming; HF=Herbicide/flaming; T=Tillage										

Pear fruit size by treatment and year. Expressed as percent of total packed yield by box size (60 count to 165 count per 44 lb box [20.0 kg]) or average fruit weight (g). Larger fruit generally receive a higher price.

Box size	<u>60</u>	<u>70</u>	<u>80</u>	<u>90</u>	<u>100</u>	<u>110</u>	<u>120</u>	<u>135</u>	<u>150</u>	<u>165</u>
Ave. fruit wt. (g)	333	285	250	222	200	182	166	148	133	121
<u>2009</u>										
M	12.2	20.2	26.1	18.0	11.8	6.8	3.3	0.8	0.3	0.2
HF	14.6	25.2	23.7	16.9	10.3	4.9	2.6	1.3	0.2	0.4
T	13.1	27.6	23.5	18.3	10.4	2.2	2.6	2.1	0.1	0.1
<i>p</i> <0.05										
<u>2010</u>										
M	3.5	18.8	21.1	24.1	14.1	10.3	4.1	2.3	1.1	0.6
HF	3.2	19.2	20.6	25.2	11.7	10.6	4.7	2.6	1.3	0.8
T	3.0	20.0	22.3	23.6	12.5	10.2	4.5	2.1	1.4	0.5
<i>p</i> <0.05										
<u>2011</u>										
M	1.2	6.1	11.1	22.0	18.5	14.4	11.1	10.6	2.8	2.0
HF	1.1	6.0	11.5	22.0	19.7	14.9	10.6	10.1	2.5	1.7
T	2.0	7.3	12.8	23.5	18.3	13.6	10.0	8.9	2.6	1.4
<i>p</i> <0.05										
M=Mulch; HF=Herbicide/flaming; T=Tillage										

On-line Resource 4. Fruit quality analyses of apple and pear grown under three weed management systems in 2010 and 2011.

<b>'Gala' apples</b>	Year	Herbicide / flame	Mulch/ flame	Tillage	StdError	P-value
Fruit weight (grams)	2010	156.5	153.6	157.3	8.02	0.90
	2011	181.0	183.0	175.8	2.59	0.18
Firmness (Newtons)	2010	79.9	79.0	77.9	1.01	0.22
	2011	59.8	56.8	58.9	1.13	0.06
Soluble solids (oBrix)	2010	11.9	11.9	11.6	0.24	0.70
	2011	12.4	13.0	12.9	0.32	0.49
Starch index (1-8 scale)	2010	4.6	4.7	4.4	0.36	0.57
	2011	7.5	7.7	7.6	0.17	0.48
Total phenolics, peel	2010	5.30	4.98	5.47	0.88	0.84
	2011	2.21	2.22	2.22	0.05	0.94
Total phenolics, flesh	2010	0.59	0.51	0.47	0.08	0.12
	2011	0.48	0.38	0.37	0.06	0.31
<b>'d'Anjou' pears</b>						
Fruit weight (grams)	2011	240.8	233.8	232.8	2.96	0.17
Firmness (Newtons)	2011	43.2	42.2	38.0	7.18	0.40
Soluble solids (oBrix)	2011	12.3	12.7	12.3	0.15	0.21
Total phenolics, peel	2011	1.04 b	1.13 ab	1.26 a	0.06	0.017
Total phenolics, flesh	2011	0.07	0.06	0.07	0.02	0.86