Efficacy and Economics of Weed Control in Lemon Production----Newman Ranch, Ventura County

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Introduction

Several studies have recently detected pesticide residues in wells from 35 California counties. The resulting public concern has created an urgent need for farmers to find pest control alternatives that do not pollute the groundwater. Simazine and other residual herbicides used in citrus have frequently been identified as well-water contaminants. However, growers are reluctant to give up the season-long control of Simazine without knowing the efficacy and alternatives of other weed control measures.

Glyphosate is a broad-spectrum systemic herbicide that readily degrades. Growers frequently apply it as a spot treatment. We are now testing a new surfactant that increases the efficacy of glyphosate. By mixing in a surfactant we can reduce the amount of glyphosate used and thus decrease costs.

An obvious nonchemical weed control alternative for tree fruit production is a cover crop. However, cover crops may also increase costs by additional water usage and other effects on the production system. Further, there are many different species and mixes of species used by growers, but little is known of how effectively they control weeds or whether the additional expense and maintenance of covers can be justified economically.

State law mandates that by 1995 all communities were to have reduced the amount of waste sent to landfills by 25%. An obvious alternative use for yard waste is as mulch in tree crops. The wide row spacing allows mulch to be readily spread in citrus groves. Weed control and improved soil structure have been suggested as potential benefits to growers. Our preliminary data suggests that mulches can control at least some weed species, but the depth of mulch applied is an important factor. The costs of transporting and spreading mulch were considerations in calculating the economic benefits of yard waste as an alternative weed control practice.

This study compares three alternatives to residual herbicides: spot treatments with glyphosate, an oat/vetch cover crop that shades out weeds and is mowed, and yard waste mulch at two depths (3 and 6 inches). Efficacy of control was evaluated by measurements of weed density, biomass, and diversity. Fruit yield and yield loss due to weed interference were measured and used to calculate the economic return of all treatments.

Objectives

Determine the economic return and relative efficacy of weed control with following treatments:

A) No herbicides:
   1) Cover Crop (80 lb oat/vetch seed per acre)
   2) 3 inch mulch (50 tons per acre)
   3) 6 inch mulch (100 tons per acre)

B) Herbicide treatments:
   1) Glyphosate (41%) 4 lb ai per acre
   2) Simazine (DF 90%), 4 lb ai per acre

Procedure

The field experiment was conducted at the Newman Ranch Lemon Orchard in Ventura County. The lemon trees incorporated in this study were eight years old. The plot size was 16'x20', four trees per plot with five treatments replicated nine times. Postemergent herbicides were applied after plots were laid out. Simazine was applied one time. A subsequent glyphosate application was made later in the season. All herbicides were applied with a backpack CO_2 sprayer with 8002 nozzles delivering 20 gallons of spray solution per acre. Mulch treatments were added with hand shovels at three and six inch depth along the tree row, in a 6-foot swath. The vetch/oat cover crop was planted in October 1995. Tree rows in the cover crop plots were maintained weed free with glyphosate.

The trees were drip irrigated. All plots had tensiometers at 12 and 24 inches depth within the wetted zone of the drip irrigation. Although all trees were irrigated in a similar fashion, a moisture release curve was developed to approximate water use by the different treatments.

Plots were monitored for snail activity by counting the snails on tree trunks on a monthly basis.

All plots were visually rated twice for weed control. Visual rating also observed weed control on winter and summer weeds. Weed biomass was measured after visual rating as average of two 0.1 m2 samples taken from each representative plot. (See Newman Ranch Lemon Weed & Mulch Experiment Table 1).

Lemon fruit were harvested twice, August 7, 1996 and February 19 1997. Yield data was fresh weight of lemon fruit in pounds per plot. Yield was sorted for fresh and damaged fruits. Fresh fruit were converted to tons per acre and used to calculate the economic return of all treatments (Table 2). Yields in all plots were lower than the industry standard because they were heavily pruned and two of the customary 4 harvests per year were not obtained.

Cost studies are based largely on Guidelines to Production Costs and Practices, 1997 Lemons Establishment and Production Costs, Ventura County. This reference was selected because our experimental site, production practices, and climate during the season are similar.

Our cost studies differ from this guideline because of differences in yield and treatment practices used in our study. Our analysis is based only on one year of data. The cost and application of the mulch are annualized over 3 years, since it is persistent. The cover crop was mowed at the time of pruning so there is no added charge to this practice.

All weed control data, including herbicide rates as pounds of active ingredient per acre, has been summarized in Table 2.

Results

The following results are based on annual usage of the Orchard. The weed species mostly found at the trial site are listed in Table 1. Table 2 has all weed control data, as well as other cultural costs and yield data. Simazine, 3 inch and 6 inch mulch effectively control all weed species native to the site. Overtime, glyphosate and the oat/vetch cover crop performed least well in controlling the weeds.

A notable effect of the mulches was their reduction in evaporative loss, equivalent to approximately 20% less water use compared to the other treatments. There was also negligible snail activity in the mulched plots. There was higher vole activity in the mulched plots which lead to several tree deaths. Even though only two of the harvests were collected, the mulch plots had a lower fruit yield than the other treatments.

Using yield and price records for Ventura County, the price of fresh lemon fruit was sold for $7.60 per 55 Ibs box. This value was used to calculate each gross field benefit for different practices of weed control. Table 2. presents the summary of lemon yield, benefits, costs and net return (profit) above all costs from weeds control measure for lemons at Newman Ranch in Ventura County. The economic summary table is presented in tons per acre basis.

Economic interpretation is based on profit (net return) above all costs. Profit is the result of subtracting the total costs from the value of net yield on per acre basis. The net returns for all treatment were low when we consider cash and non cash overheads. Each treatment returned a net loss over $400 per acre.

However, when we look at the net benefit (return) of all practices over their respective total operating costs, each practice returned over $1000 per acre. Simazine returned the greatest amount ($1674.09), followed by the cover crop ($1484.04), glyphosate ($1365.37) followed closely by the 3-inch Mulch ($1328.29) and the 6-inch mulch ($1211.53).

The reduced water and molluscicide use in the mulch treatments and their slightly reduced use of glyphosate did not offset the loss in yield. Why there was reduced yield in the mulch treatments is not entirely clear. It may partially be due to the higher soil moisture in the mulched trees leading to a weakened root system. Most certainly the tree deaths due to voles helped skew the results.

Result - Table 1

1995, Visual Count of Weed Species After Treatment

*Date of Rating: Weed species from **Newman Ranch Lemons Weed & Mulch Experiment** March 29*

Treatment	Large Crabgrass	Spurge	Hairy fleabane	Pigweed	Stinging Nettle	Black Nightshade	Composite
Cover Crop @ 80 LB/A	0.00	12.60	1.00	13.40	0.60	1.00	1.60
Glyphosate 2 % solution	0.00	14.80	1.00	6.80	2.80	0.00	0.60
3 inch mulch	0.60	0.00	0.00	0.00	0.00	0.00	0.00
6 inch mulch	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Simazine @ 4 LB/A	0.00	10.40	0.00	6.40	0.40	1.40	1.80

Date of Rating: May 10

Treatment	Spurge	Hairy fleabane	Pigweed	Stinging Nettle	Black Nightshade	Composite
Cover Crop @ 80 LB/A	12.33	0.33	2.33	0.00	0.22	0.44
Glyphosate 2 % solution	9.44	0.22	2.00	0.33	0.11	0.11
6 inch mulch	0.00	0.00	0.00	0.00	0.00	0.00
3 inch mulch	0.11	0.11	0.00	0.00	0.00	0.00
Simazine @ 4 LB/A	5.33	0.00	1.11	0.11	0.22	0.22

1996, Visual Count of Weed Species After Treatment

Date of Rating: April 2

Treatment	Malva	Stinging nettle	Groundsel	Sow thistle	Lambs-quarter	Spurge	Pigweed	Black-nightshade	Com-posite
Cover Crop @ 80 LB/A	41.22	156.2	32.56	6.33	0.11	0.22	0.33	0.00	0.00
Glyphosate 2 % solution	20.33	277.9	27.56	6.67	0.11	1.22	0.00	0.22	0.00
6 inch mulch	1.56	0.11	1.11	3.00	0.00	0.00	0.00	0.00	0.00
3 inch mulch	2.44	0.44	1.00	6.89	0.00	0.00	0.00	0.00	0.20
Simazine @ 4 LB/A	4.89	6.56	34.78	0.11	0.00	4.22	0.44	0.78	0.20

Date of Rating: September 13

Treatment	Malva	Grass	Purslane	Sow thistle	Pigweed	Black-nightshade	Spurge	Composite
Cover Crop @ 80 LB/A	3.11	0.33	0.22	0.11	0.67	0.78	2.67	0.44
Glyphosate 2 % solution	2.22	0.33	0.11	0.00	0.67	0.11	4.22	0.33
6 inch mulch	0.11	0.00	0.00	0.00	0.11	0	0.00	0.00
3 inch mulch	0.11	0.00	0.00	0.00	0.00	0	0.00	0.00
Simazine @ 4 LB/A	0.22	0.11	0.22	0.11	0.11	0.22	0.22	0.11

Dry weight of weeds sampled on April 2, 1996

Treatment	Grams/ 1m sq.
Cover Crop @ 80 LB/A	41.92
Glyphosate 2 % solution	83.56
6 inch mulch	2.24
3 inch mulch	12.56
Simazine @ 4 LB/A	1.38

Table 2.

NEWMAN RANCH---1997 PIAP MULCH STUDY AND WEED CONTROL ON LEMON PRODUCTION---COST/BENEFIT					
Treatments: Glyphosate 2% solution, Cover Crop, 3 inch mulch, 6 inch mulch & Simazine @ 4 lbs per acre Yield---900 50-lb. Box @ 7.60 source: 1997 Ventura County Agricultural Report					
OPERATION	**Average gross returns, costs and benefit of Lemon picked in 1997 (per acre basis)**				
Benefit	**Glyphosate**	**Cover crop**	**3 inch mulch**	**6 inch mulch**	**Simazine**
Average yield (ton/acre)	6.13	6.36	5.72	5.58	6.67
Adjustment for harvest loss (10%)	5.52	5.72	5.15	5.02	6.00
Gross field benefit ($/acre at 684.00/ton)	3773.63	3915.22	3521.23	3435.05	4106.05
Operating Costs					
CROP MAINTENANCE					
Water:					
Amount	30 Acln	30 Acln	22.5 Acln	22.5 Acln	30 Acln
Unit cost	15.83	15.83	15.83	15.83	15.83
Value of water applied	*475.00*	*475.00*	*356.10*	*356.10*	*475.00*
Customs:					
Prune & Sucker	475.00	475.00	475.00	475.00	475.00
Vertebrate Pest	10.00	10.00	10.00	10.00	10.00
Budmite Treatment	200.00	200.00	200.00	200.00	200.00
Thrips Treatment	100.00	100.00	100.00	100.00	100.00
Gibberellic Acid	55.00	55.00	55.00	55.00	55.00
Snail Control	50.00	50.00	0.00	0.00	50.00
Frost Protection	125.00	125.00	125.00	125.00	125.00
Value of customs	*1015.00*	*1015.00*	*965.00*	*965.00*	*1015.00*
Herbicide:					
Roundup-Row Spray (1Qt) @ 13.25/Qt	13.25	13.25	8.83	8.83	13.25
Roundup-Spot Spray (25.60 Oz) @ 13.25/Qt	12.00	12.00	4.00	4.00	12.00
Value of herbicide	*25.25*	*25.25*	*12.83*	*12.83*	*25.25*
Fertilizer:					
Zinc Sulfate (8Lb) @ 0.35	3.00	3.00	3.00	3.00	3.00
Manganese Sulfate (8 Lb) @ 0.38	3.00	3.00	3.00	3.00	3.00
Soluble N (150 Lb) @ 0.17	25.00	25.00	25.00	25.00	25.00
Value of fertilizer	*31.00*	*31.00*	*31.00*	*31.00*	*31.00*
Fungicide:					
Copper Sulfate Foliar Spray (3 Lb) @ 1.11	3.33	3.33	3.33	3.33	3.33
Lime Foliar Spray (4.50 Lb @ 0.153	1.00	1.00	1.00	1.00	1.00
Value of fungicide	*4.33*	*4.33*	*4.33*	*4.33*	*4.33*
TOTAL VALUE OF CROP MAINTENANCE	*1550.58*	*1550.58*	*1369.26*	*1369.26*	*1550.58*
APPLICATION (PRACTICES)					
Amount Applied	0.74 gal	80 Lb	50 Ton	100 Ton	3.35 Lb
Unit Cost	43.00/gal	0.46/ Lb	0.33/Ton	0.33/Ton	4.00/Lb
Value (money field cost of practices)	31.82	36.80	16.50	33.00	13.40
Cost of Application	11.70	11.70	25.00	50.00	11.70
TOTAL VALUE OF PRACTICES	*43.52*	*48.50*	*41.50*	*83.00*	*25.10*
HARVEST:					
Cost of Harvest (39.00/bin), 1 bin = 900 Lb	478.16	496.10	446.18	435.26	520.28
Labor (machine) 18.41 hrs @ 11.70	215	215	215	215	215
Labor (non-machine) 2.10 hrs @ 11.70	25	25	25	25	25
Fuel-Gas (18.53 gal) @ 1.20	22	22	22	22	22
Fuel-Diesel (12.55 gal) @ 1.15	14	14	14	14	14
Machinery repairs	60	60	60	60	60
TOTAL VALUE OF HARVEST	*814.16*	*832.10*	*782.18*	*771.26*	*856.28*
Total Operating Costs ($/Acre)	***2408.26***	***2431.18***	***2192.94***	***2223.52***	***2431.96***
Net Benefit Above Operating Costs ($/Acre)	***1365.37***	***1484.04***	***1328.29***	***1211.53***	***1674.09***

CASH OVERHEAD COSTS					
Office Expense	100.00	100.00	100.00	100.00	100.00
Liability Insurance	14.00	14.00	14.00	14.00	14.00
Property Taxes	287	287	287	287	287
Invertment Repairs	138	138	138	138	138
TOTAL CASH OVERHEAD COST/ACRE	539.00	539.00	539.00	539.00	539.00
Total Cash Costs/Acre	***2947.26***	***2970.18***	***2731.94***	***2762.52***	***2970.96***
NON-CASH OVERHEAD COSTS (DEPRECIATION & INTEREST)					
Shop Building	65	65	65	65	65
Shop Tools	21	21	21	21	21
Fuel Tanks & Purmps	21	21	21	21	21
Irrigation VCL	91	91	91	91	91
Wind Machines	97	97	97	97	97
Land	936	936	936	936	936
Establishment	160	160	160	160	160
Equipment	160	160	160	160	160
TOTAL NON-CASH OVERHEAD COSTS/ACRE	1551	1551	1551	1551	1551
Total Costs/Acre	***4498.26***	***4521.18***	***4282.94***	***4313.52***	***4521.96***
Net Return Above All Costs $/Acre	**-724.63**	**-605.96**	**-761.71**	**-878.47**	**-415.91**