J.HAW.PAC.AGRI. 5:9-15 (1994)

EVALUATION OF SEVEN WEED CONTROL METHODS IN A NEWLY PLANTED 'TAHITIAN' LIME ORCHARD[1]

Robert M. McLean, Michigan State University, Department of Horticulture, East Lansing, MI 48824-1325 USA

Kent D. Kobayashi and Joseph DeFrank, University of Hawaii at Manoa, Department of Horticulture, Honolulu, HI 96822 USA

ABSTRACT

Due to the phytotoxic hazards of herbicides applied in 'Tahitian' lime (Citrus aurantifolia Swingle) orchards less than one year old, non-chemical methods of controlling weeds and enhancing tree growth were compared. An unweeded control, hand weeding, mechanical mowing, polyester geotextile fabric, eucalyptus (Eucalyptus robusta Sm.) mulch, lychee (Litchi chinensis Sonn.) mulch, and oxyfluorfen herbicide were selected to determine their effectiveness in a newly planted lime orchard. All treatments significantly reduced weed dry weight compared to the hand weeded control. There were no significant differences in weed control among the oxyfluorfen, polyester fabric mulch, lychee mulch, and eucalyptus mulch treatments.

KEYWORDS: *Citrus aurantifolia, Eucalyptus robusta, Litchi chinensis, oxyfluorfen*

INTRODUCTION

Prior to the early 1960s, orchard floor management consisted of continuous cultivation during the growing season (Lord and Vlach, 1973; White and Holloway, 1967). Today, annual and perennial weeds are still adequately suppressed by cultivation practices (Klingman and Ashton, 1982) though the disadvantages of cultivation are well documented (Cary 1978; Haynes, 1980). With increasing labor and equipment costs, cultivation has also become more expensive (Tucker and Muraro, 1980).

Sod culture gradually replaced cultivation in many orchards by the 1960s (Haynes and Goh, 1980). Although sod culture was successful in reducing the destructive effects of cultivation, it had some serious problems (Jordon and Day, 1973).

Mulches have been successfully used to increase the growth and vigor of fruit trees (Haynes, 1980; Lord and Vlach, 1973). Additional benefits from mulching can potentially be obtained by using mulches with allelopathic properties. Allelopathy has been reported to be

[1]*Hawaii Institute of Tropical Agriculture and Human Resources Journal Series No. 3882.*

significant in controlling the understory vegetation under *Eucalyptus camaldulensis* (Del Moral and Muller, 1969a), *E. baxteri* (Del Moral et al., 1978), and *E. globulus* (Del Moral and Muller, 1969b).

Oxyfluorfen is not currently registered for use in bearing lime orchards, and herbicides can be phytotoxic in less than one-year-old lime orchards. The objective of this study was to evaluate the potential of a known allelopathic mulch (*Eucalyptus robusta* Sm.) and a non-allelopathic mulch (*Litchi chinensis* Sonn.) in suppressing weeds and enhancing tree growth in a newly planted, non-irrigated 'Tahitian' lime (*Citrus aurantifolia* Swingle) orchard. The performance of the mulches was compared with more established weed control methods.

MATERIALS AND METHODS

This experiment was initiated on July 25, 1986 in Mililani, Oahu at an elevation of 340 m with an annual precipitation of 150-200 cm. The field was subsoiled to a depth of 46 cm and disked prior to tree planting. Two-year-old 'Tahitian' lime trees grafted on *Citrus volkameriana* rootstock were planted in non-irrigated raised beds approximately 20 cm high with treatment plots 2 m wide by 10 m long. There were two trees centered in each treatment plot spaced at 5 m within rows and 5 m between rows. All but 3 main limbs were removed from the trees at planting.

The experimental design was a randomized complete block with eight replications. Experimental trees were planted in blocks oriented in an east-west direction. Experimental blocks were in the middle of the orchard with several guard rows bordering the experimental field. Treatments consisted of the following:

a) Control--weeds were allowed to remain in the plots until the completion of the experiment.
b) Warren's "Terrabond" polyester geotextile fabric (85 mm thickness) (Warren's Turf Nursery, Inc., Crystal Lake, IL).
c) Lychee organic mulch--applied at 200 tonnes/ha. Lychee limbs (maximum diameter 16 cm) and leaves were mechanically shredded into chips approximately 0.25 cm thick by 2 cm wide by 6 cm long.
d) Mechanically mowed--with a weed whip at 169, 232, 302, and 372 days after planting.
e) Chemical herbicide--oxyfluorfen at 0.9 kg active ingredient per ha applied at 169, 232, 302, and 372 days after planting.
f) Hand weeding--with hoes and sickles.
g) Eucalyptus organic mulch--applied at 200 tonnes/ha. Eucalyptus limbs (maximum diameter 16 cm) and leaves were mechanically shredded into chips.

Weeds were hand harvested with hoes and sickles from a 0.5 m^2 sample area in the middle of the treatment plot. Sample time for weed harvests were 169, 232, 302, and 372 days after the trees were planted. All aboveground weed biomass was oven dried at 72°C for 4 days and weighed.

Lime tree growth for the eucalyptus mulch treatment was measured at 10, 113, and 354 days after planting. The trunk diameter of the scion 25 mm above the graft union was measured. Two measurements were recorded at the same height, rotated 90° about the trunk axis and averaged to compensate for irregularities in trunk diameter. Limb diameter of the 3 limbs 5 mm above the trunk/limb union to the terminal end of the limbs was taken. Lengths of the 3 limbs were measured (and combined) from the trunk/limb union to the terminal end of limbs. Total leaf count for the 3 limbs was recorded for each tree.

RESULTS AND DISCUSSION

Visual observations of the treatments suggested that oxyfluorfen provided better weed control than the mulch treated plots. Many oxyfluorfen treated plots were totally without weeds, whereas the mulch treated plots contained weeds that gave the appearance of being a less effective control. However, statistically there were no differences in weed dry weights (Table 1). Hand weeded plots had significantly greater weed dry weight than all the other treatments (Table 1). Mean weed weights for all treatments decreased from January to March (Figure 1). The polyester fabric mulch, lychee mulch, oxyfluorfen, and eucalyptus mulch treatments were equally effective in reducing weed dry weight (Table 1).

The control trees had a significantly smaller trunk and limb diameter (combined) than trees of the other treatments 113 and 354 days after planting (Table 2). Limb length of the control trees was significantly less than those of the other treatments at 354 days after planting but not at 113 days. Leaf number of the control trees was significantly less than that of the other treatments 113 and 354 days after planting.

Trees in the oxyfluorfen treated plots had greater trunk and limb diameters (combined) compared to the mulch treated trees at 113 and 354 days after planting (Table 2). Limb length of the trees in oxyfluorfen treated plots was not significantly different from that of the mulch treated trees at 113 and 354 days after planting. Leaf number of the trees in the oxyfluorfen treated plots was significantly greater than that of the mulch treated trees at 354 days after planting, but not at 113 days.

Trees in the polyester fabric mulch plots were not significantly different in trunk and limb diameter (combined) and limb length from the lychee mulch and eucalyptus mulch treated trees at 113 and 354 days after planting (Table 2). Leaf number of the trees in the polyester fabric mulch treated trees was significantly less than that of the lychee mulch and eucalyptus mulch treated trees at 113 days after planting. There were significant differences in leaf number at 354 days after planting among the mulches.

Lychee mulch treated trees had significantly greater trunk and limb diameter (combined) than eucalyptus mulch treated trees at 113 days after planting, but not at 354 days (Table 2). There was no significant difference in limb length and leaf number between the eucalyptus and lychee mulched trees at 113 and 354 days after planting.

Trees in the oxyfluorfen treated plots had significantly greater trunk and limb diameter (combined) and leaf number than the other treatments at 113 and 354 days after planting (Table 2). There was no significant difference in limb length of the trees in the oxyfluorfen treated plots and the other treatments at 113 days after planting.

Due to the allelopathic properties of eucalyptus (Del Moral and Muller, 1969; Patrick et al., 1963), eucalyptus mulch was expected to control weeds better than the lychee mulch, which is not known to have allelopathic properties. However, results from this experiment showed that the eucalyptus mulch and lychee mulch were equivalent in their weed control ability. Either both mulches were allelopathic or the physical presence of the mulches provided the observed level of control.

The polyester fabric mulch proved to be durable and effective in inhibiting weeds from growing through it. However, it did not prevent weed seeds from germinating on its surface and penetrating into the soil below. The polyester fabric mulch accumulated wind-blown soil and provided a suitable environment for weed seed germination. The polyester fabric mulch was so strong that the lime trees were girdled as the trunks grew into the fabric. Increasing the diameter of the opening around the tree corrected this problem, but allowed weeds to emerge from the enlarged hole. This fabric was considered unsuitable for weed control in a commercial lime orchard.

Many trees in the mechanically mowed plots were chlorotic as has been reported in apple trees (Stott, 1976). Weller et al. (1985) reported that young peach trees grown with common bermudagrass ground covers were stunted and chlorotic. Many trees grown under grass in this experiment were also stunted and had chlorotic leaves. The leaf chlorosis and growth reduction may be due to competition with the trees for moisture (White and Holloway, 1967), nitrogen (Stott, 1976), and other nutrients (Jordon and Russel, 1981).

Trees in the hand weeded plots were smaller than those in all other treatments except the controls. Hand weeding was more time consuming than the other treatments and would not be recommended for weed control in orchards when other methods are available.

Based on the results of this experiment, the use of oxyfluorfen in newly planted, non-bearing lime orchards appears to be suitable to commercial operation for weed control in Hawaii (Rohm and Haas Co., 1988). Oxyfluorfen is not currently registered for use in bearing lime orchards. A combination of organic mulches and a postemergence herbicide such as glyphosate could be employed. The mulch would suppress many weeds, and the glyphosate could then be used as a spot treatment for weed control.

Mulches derived from leaves and limbs from fruit orchards other than lychee should be investigated. If heavy annual pruning is a part of management practices, chipping of limbs for mulch may prove to be cost-effective by eliminating the need to remove branches and providing a degree of weed control.

LITERATURE CITED

Cary, P. 1978. Soil management and herbicide use. Proc. Intl. Soc. Citriculture 209-214.

Del Moral, R. and C.H. Muller. 1969a. The allelopathic effects of *Eucalyptus camaldulensis*. Amer. Midland Naturalist 83(1):254-281.

Del Moral, R. and C.H. Muller. 1969b. Fog drip: a mechanism of toxin transport from *Eucalyptus globulus*. Bul. Torrey Bot. Club 96(4):467-475.

Del Moral, R., R.J. Willis, and D.H. Ashton. 1978. Suppression of costal heath vegetation by *Eucalyptus baxteri*. Austral. J. Bot. 26:203-19.

Haynes, R.J. 1980. Influence of soil management practice on the orchard agro-ecosystem. Agro-Ecosystems 6:3-32.

Haynes, R.J. and K.M. Goh. 1980. Some effects of orchard soil management on sward composition, levels of available nutrients in the soil, and leaf nutrient content of mature 'Golden Delicious' apple trees. Scientia Horticulturae 13:15-25.

Jordan, L.S. and B.E. Day. 1973. Weed control in citrus, p. 82-97. In: W. Reuther (ed.). The citrus industry. Vol. III. Univ. of Calif. Press, Berkeley.

Jordan, L.S. and R.C. Russel. 1981. Weed management improves yield and quality of 'Valencia' oranges. HortScience 16:785.

Klingman, G.C. and F.M. Ashton. 1982. Weed Science: Principles and practices. 2nd ed. Wiley, N.Y.

Lord, W.J. and E. Vlach. 1973. Responses of peach trees to herbicides, mulch, mowing, and cultivation. Weed Sci. 21(3):227-299.

Patrick, Z.A., T.A. Toussoun, and W.C. Snyder. 1963. Phytotoxic substances in arable soils associated with decomposition of plant residues. Phytopathology 53:152-161.

Rohm and Haas, Co. 1988. Agricultural Chemicals Label Manual 1988. p. 52-54. Fre sno, Calif.

Stott, K.G. 1976. The effects of competition from ground covers on apple vigour and yield. Ann. Applied Biol. 83:327-330.

Tucker, D.P.H. and R. Muraro. 1980. Two weed control systems for Florida citrus. Proc. Fla. State Hort. Soc. 93:30-33.

Weller, S.C., W.A. Skroch, and T.J. Monaco. 1985. Common bermudagrass (*Cynodon dactylon*) interference in newly planted peach (*Prunus persica*) trees. Weed Sci. 33:50-56.

White, G.C. and R.J.C. Holloway. 1967. The influence of simazine or a straw mulch on establishment of apple trees in grassed down or cultivated soil. J. Hort. Sci. 42:377-389.

Table 1. Effect of weed control methods on weed dry weight in a newly planted 'Tahitian' lime orchard in Mililani, Oahu. Values represent the sum of 8 replications.

Treatment no.	Treatment	Weed dry weight (g) Harvest date (days after planting) 169	354
1	Polyester fabric mulch	32	7.8
2	Lychee mulch	18	15.0
3	Oxyfluorfen	11	0.1
4	Hand weeding	108	93.0
5	Eucalyptus mulch	34	15.9
	Contrasts		
4 vs. 1, 2, 3, 5		***	***
3 vs. 1, 2, 5		NS	NS
1 vs. 2, 5		NS	NS
2 vs. 5		NS	NS

NS, *** Nonsignificant (NS) or significant at P = 0.001.

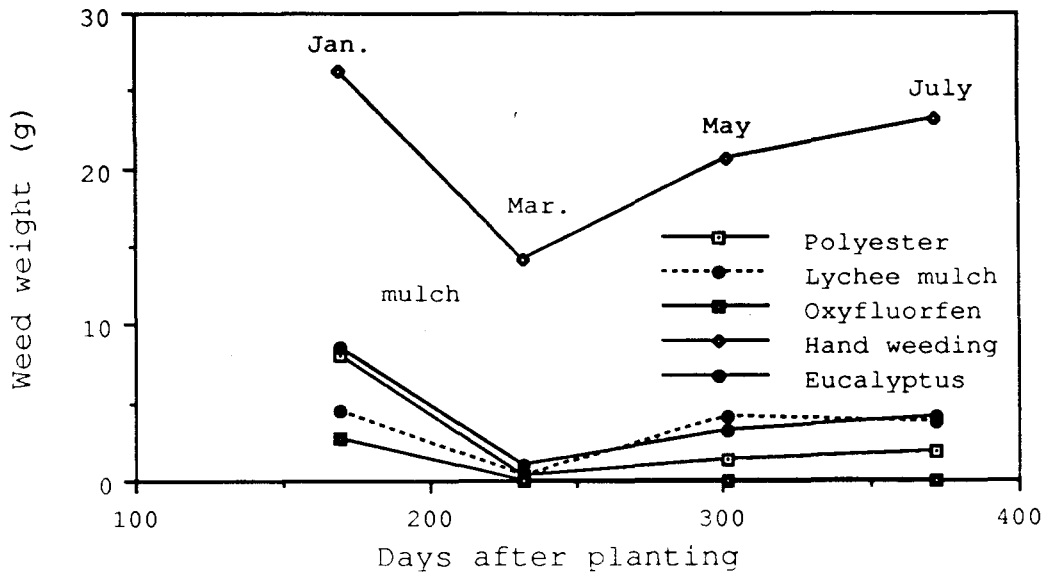

Figure 1. Weed weight per plot for 5 weed control treatments in a newly planted 'Tahitian' lime orchard in Mililani, Oahu. Values represent the sum of 8 replications.

Table 2. Effects of weed control methods on tree growth in a newly planted lime orchard. Values represent the sum of 8 replications.

Treatment no.	Treatment	113 Days[z]			354 Days		
		Diameter (mm)	Limb length (mm)	Leaf number	Diameter (mm)	Limb Length (mm)	Leaf number
1	Polyester fabric mulch	102	2648	318	204	5911	2438
2	Control	96	2571	318	149	4410	851
3	Lychee mulch	119	3219	554	229	5947	3942
4	Mechanical mowing	105	2923	414	177	4668	1168
5	Oxyfluorfen	123	3186	606	246	6614	4845
6	Hand weeding	103	2708	434	201	5679	3256
7	Eucalyptus mulch	106	2912	573	218	5829	3320
	Contrasts						
2 vs. 1, 3, 4, 5, 6, 7		*	NS	*	***	**	***
5 vs. 1, 3, 4, 6, 7		**	NS	*	*	*	***
5 vs. 1, 3, 7		*	NS	NS	*	NS	**
7 vs. 1, 3		NS	NS	NS	NS	NS	NS
1 vs. 3, 7		NS	NS	**	NS	NS	NS
7 vs. 3		*	NS	NS	NS	NS	NS

[z]Days after planting.

NS, *, **, *** Nonsignificant (NS) or significant at P = 0.05, 0.01, or 0.001, respectively.