USE OF ORGANIC AND GREEN MULCHES IN AN APPLE ORCHARD

M.J. HARTLEY[1*] and A. RAHMAN[2]

[1]*AgResearch, Hawkes Bay Research Centre, Hastings*
[*]*Current address: Lawn Road, R D 2, Hastings*
[2]*Ruakura Agricultural Research Centre, Private Bag 3123, Hamilton*

ABSTRACT

Four organic mulches, sawdust, straw, compost and wooldust and two green mulches, grass and clover were compared with herbicide for weed control in an established apple orchard. The green mulches Serra hard fescue (*Festuca longifolia*) and Tahora white clover (*Trifolium repens*) were established on plots previously treated with compost or wooldust. Hard fescue, established for only 3 years under these conditions, reduced apple yield but also reduced the proportion of small reject apples. Straw gave the most consistent weed control throughout the 6 year trial period. Although the mulches affected the chemical characteristics of the soil, they had little effect on the nutrient status of apple leaves or the fruit.

Keywords: apple, orchard, weed control, organic mulches, green mulches.

INTRODUCTION

The fruit industry is moving rapidly to adopt more sustainable integrated and biological production with little or no chemical input. One form of chemical input in apple production is the use of herbicides for weed control. In most New Zealand orchards weeds are controlled within the tree rows by various herbicides (Harrington *et al*. 1992). To investigate ways of reducing herbicide use, a trial was established in 1992 in an apple orchard in Hawkes Bay to compare organic mulches with herbicides for weed control under the trees. The initial effects of the organic mulches on weed control, tree growth and earthworms (Hartley and Rahman 1994) and on soil respiration and microbial activity (Hartley *et al*. 1996) have been reported previously. This paper reports on the long term effects of organic mulches on fruit yields and the trial of "green mulches" for weed control in the orchards.

METHOD

The trial commenced in 1992 in a young apple (cv. Fiesta) orchard in Hawkes Bay as detailed by Hartley and Rahman (1994). Treatments consisted of a residual herbicide, terbuthylazine (Gardoprim) applied each September at 4 kg/ha and four organic mulches, sawdust, straw, compost topped with sawdust and wooldust. An additional no-mulch treatment was included to serve as a 'control' in which weed growth was controlled with a non-residual herbicide, viz. paraquat/diquat (Preglone) or glyphosate (Glyphosate 360) as required. Each plot was 7.5 m long containing two sample trees and a guard tree at either end of the plot. For practical reasons, mulch plots were 1.5 m wide while herbicide treatments were applied over a 3 m wide band. Treatments were replicated six times in a randomised block design.

The straw was applied each September, using one or one and a half bales of barley straw per plot (15m^2); the sawdust was applied every alternate year while the compost and wooldust were applied once only at the beginning of the trial in 1992. Each mulch was approximately 10 cm deep. Further treatment details are provided by Hartley and Rahman (1994). Each winter all plots were sprayed with glyphosate to control any surviving weeds. The orchard was grazed by sheep each winter.

Proc. 51st N.Z. Plant Protection Conf. 1998: 195-198

In 1995 the trial was modified to include green mulches. Due to their poor performance, the compost and wooldust treatments were replaced by a grass treatment, Serra hard fescue (*Festuca longifolia*), and a clover treatment, Tahora white clover (*Trifolium repens*). Three of the six compost plots were converted to grass and three to clover. The wooldust plots were converted in the same manner. The fescue was initially sown at 30 kg/ha and the white clover at 5 kg/ha on 11.4.95. Establishment was poor and sheep camped on the plots during the winter grazing. Both grass and clover were resown on 2.6.95 at considerably higher rates (65 kg/ha for fescue and 17 kg/ha for white clover) a few days before the sheep were removed. This resulted in an acceptable stand of both species. Both grass and clover plots were mown (by hand held rotary slasher) twice during spring 1995 to control broadleaf weed growth. Some damage occurred to the green mulches from an unscheduled herbicide application in November 1995. Damage was repaired, as far as possible, by resowing bare areas with the appropriate seed on 17.5.96, while sheep were present, but they were excluded from the trial area shortly afterwards.

Weeds were assessed visually 3-5 times each year for % ground cover, height and plant biomass. In March 1997, a 2 m x 0.5 m strip was mown across each plot, by rotary mower, and fresh weight of clippings recorded. Mowing height was 5 cm to avoid fallen apples. Apple yield and trunk diameter 30 cm above the ground were recorded annually. In June 1996 ten 2.5 cm diameter soil cores (to 5 cm depth) were collected from each plot for chemical analyses which were performed by the Soil Fertility Service, Ruakura Research Centre, Hamilton. Leaf samples (50 fully expanded leaves/plot) were collected for nutrient analyses in February 1997 and fruit samples (10 fruits/plot) were taken for nutrient analyses in February 1998. Analyses were carried out by the Analytical Research Laboratories, Napier.

All plots except sawdust and straw were mown by hand pushed rotary lawn mower twice during spring 1997. The herbicide treatment was discontinued in winter 1997 when the owner commenced an “organic” programme and vegetation was controlled by mowing. Mowing also controlled excessive growth on the grass and clover plots and simulated the effect that could be obtained by a swing-arm orchard mower.

RESULTS

This paper concentrates on the apparent trends resulting from the introduction of the green mulches. Table 1 shows the level of weed control achieved during the last 2 years of the trial. The data for 1997 were similar to the first four years of the trial, with straw consistently giving the best weed control. The residual herbicide, terbuthylazime, gave good weed control for the first part of each season but plots became covered by summer growing grasses later in the season. Sawdust provided good weed control in the first season after re-application in September 1997 but became weedy in 1998 without repeat application. A similar trend occurred in earlier years (Hartley and Rahman 1994). The residual herbicide treatment showed a rapid increase in weeds after annual treatment ceased in 1997. The hard fescue mulch provided good control of broadleaf weeds but allowed ingress of other grasses. Although the grass plots were uniform with little rank growth, the fresh weight of vegetation cut from these plots showed a significantly higher vegetation mass than on the control and residual herbicide plots. No fresh weight samples were cut from the sawdust or straw plots as the mower would have collected the sawdust and straw.

The biomass estimates and visual weed height estimates made in 1998 showed grass plots had high vegetation density but low height, well below tree branch level, whereas the straw kept the weed density low but the few weeds present were tall and entangled with the tree canopy.

The first significant effect of treatments on fruit yield appeared in 1998 (Table 2). Both the total and saleable apple yields were significantly depressed by the green mulches (compared to the control), but more so by the grass treatment. The yield data were also examined according to the initial compost and wooldust treatment applied in 1992. This showed that compost also depressed apple yield, with the result that the yield on the grass/compost plots was only 64% of that on the other treatments.

Comparing the yield off the grass treatment with treatments 1-4 (control, herbicide, sawdust and straw), the harvested yield was down 23% but the reject fruit yield (mainly sunburnt and small apples and those affected by black spot) was down 36% i.e. less rejects than from the other treatments. Mean size of reject apples off the grass treatment was significantly higher than those on the other treatments (Table 2). Unfortunately, the small rejects were not recorded separately from the large rejects so their mean weight is not known. However if it were assumed that the small apples weighed 75 g, then the small rejects from control treatment comprised 65% of total rejects, from herbicide 68%, sawdust 71% and straw 68%, whereas for the grass treatment were only 53%, approximately 20% less small apples. By winter 1997, mulch treatments had shown no significant effect on trunk diameter.

TABLE 1: Weed cover, biomass and height as affected by herbicide and mulch treatments in the apple orchard.

Treatment	1996-97			1997 - 1998		
	% weed cover December	% weed cover April	FW vegetation April	% weed cover December	Biomass of vegetation[1] January	Weed height[2] January
Control	24	94	0.71	75	3.9	4.2
Residual herbicide	2	48[3]	0.85	29	1.4	3.8
Sawdust	3	17	not cut	54	2.9	4.9
Straw	1	9	not cut	4	1.4	6.5
Clover	21	56	1.09	78	9.2	4.2
Grass	16[3]	23[3]	2.27	37[3]	10.0	1.1
LSD 5%	6.8	14.2	0.33	14.6	1.4	1.5

[1]On a 0 - 10 scale where 0 = bareground, 10 = dense vegetation.
[2]Estimated relative height of most taller weeds on a 0 - 10 scale; 0 - 3 indicates weeds below tree canopy, 10 = approx. 2 m high.
[3]Predominantly grass weeds.

TABLE 2: Apple yield per tree in 1998 as affected by original and subsequent mulch treatments.

Treatment	Total yield (kg)	Saleable yield			Reject yield		
		Wt (kg)	No.	Mean wt. (g)	Wt (kg)	No.	Mean wt. (g)
Control	74	47	303	156	27	262	105
Residual herbicide	72	44	306	145	28	282	101
Sawdust	68	42	278	153	26	249	106
Straw	68	39	269	152	29	276	106
Clover	64	37	236	159	27	258	105
Grass	52	34	220	154	18	148	119
Compost[1]	53	33	200	162	20	180	112
Wooldust[1]	62	38	255	152	24	227	112
LSD 5%	9.0	7.2	48.3	14.8	6.2	68.1	8.8

[1] Data regrouped to show the carryover effects of the original treatment which preceded the grass or clover mulch.

Soil analyses showed wooldust increased the sulphur level in soil nearly 5-fold (28.5 mg/kg compared to a mean of 5.9 mg/kg for all other treatments). This resulted in a lowering of the pH by 1.14 (wooldust 5.04 cf. mean 6.18, LSD 0.28). There were other minor but significant shifts in the chemical characteristics of the soil which will be reported in detail later (Hartley and Rahman in preparation). Leaf analyses showed little effect from mulch treatments except for a significant increase in boron on the original compost plots. Boron level in the leaves on compost plots was 21.25 mg/kg against a mean for the other treatments of 18.35 mg/kg (LSD 1.4). This carried through to the fruit where compost increased the boron level to 2.43 mg/kg compared to an all treatment mean of 2.10 mg/kg (LSD 0.30). Sawdust depressed the boron level in fruit to 1.78 mg/kg. Wooldust increased the nitrogen level in the fruit by 18% above the all treatment mean (wooldust 404 mg/kg cf. mean 341 mg/kg, LSD 50.6). It is difficult to predict from these results whether the changes in soil characteristics due to different mulches would have any long term implications for the chemical composition and quality of the fruit.

DISCUSSION

Although hard fescue restricted the growth of other vegetation and reduced broadleaf weeds under the trees, it also appears to have reduced the apple yield. This supports the work of Atkinson and Crisp (1983) who showed the yield of both young and mature apple trees was reduced by grass between the tree rows. Thus while grass or clover species may be desirable green mulches in establishment and management of orchards (Harrington and Rahman 1998), they may also compete strongly with the apple trees. There were also indications that the grass mulch, by reducing apple number also reduced the number of small apples, thus increasing the ratio of export fruit (if the very hot El Nino summer had not caused an excess of sunburnt apples). These are areas of investigation that need further study if non-herbicide weed control in apple orchards is required.

ACKNOWLEDGEMENTS

We would like to thank Nick Pattison for use of his orchard and John Waller for statistical analyses of the data. This research was funded by the Foundation for Research, Science and Technology.

REFERENCES

Atkinson, D. and Crisp, C. M., 1983. The effect of weeds and grass on apple yield and quality. *Proc. 10th Int. Cong. Plant Prot.*: 124.

Harrington, K.C., Berry, S.B. and Sims, R.E.H., 1992. A survey of weed control practices in New Zealand pipfruit orchards. *Proc. 45th N.Z. Plant Prot. Conf.*: 285-288.

Harrington, K.C. and Rahman, A., 1998. Tolerance to herbicides of ground cover species for New Zealand orchards. *Plant Prot. Quarterly 13*: (in press).

Hartley, M.J. and Rahman, A., 1994. Use of mulches and herbicides in an apple orchard. *Proc. 47th N.Z. Plant Prot. Conf.*: 320-334.

Hartley, M.J., Reid, J.B., Rahman, A. and Springett, J.A., 1996. Effect of organic mulches and a residual herbicide on soil bioactivity in an apple orchard. *N.Z. J. Crop and Hort. Sci. 24:* 183-190.