USE OF MULCHES AND HERBICIDES IN AN APPLE ORCHARD

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SUMMARY

Four organic mulches, viz. sawdust, straw, compost and wooldust, with and without the residual herbicide terbutylazine, were compared to no mulch or residual herbicide in an apple orchard for two growing seasons. Initially the herbicide and all mulches except compost gave good weed control but only straw maintained control throughout the season and into the second year. Mulches reduced diurnal fluctuations in soil temperature at 50 mm, but also reduced mean temperature. Compared with the no mulch treatment earthworm populations were increased by compost, but reduced by sawdust, wooldust and terbutylazine. The mulches had negligible effect on tree growth, fruit yield or leaf and fruit nutrient analysis.

Keywords: organic mulches, herbicide, apples, weed control, fruit yield.

INTRODUCTION

Satisfactory weed control in horticultural crops is a requirement for efficient and economic crop production. The traditional strategy in New Zealand orchards is to control all vegetation within the rows using herbicides and mow or cultivate between the rows (Harrington *et al.* 1992). However, there are concerns about intensive use of persistent herbicides, herbicide costs, problems of herbicide resistance and the effects on non-target organisms. This study examined the effect of different mulches and herbicides in an apple orchard on weed control, earthworm population and tree growth.

METHOD

The trial was conducted in a young apple orchard near Havelock North, Hawkes Bay. Six replicate blocks were used, three containing 2 year-old Braeburn apple trees on M 793 rootstock planted winter 1991 (3 m apart in rows 5 m apart), and three containing 3 year-old Fiesta on MM 106 rootstock planted winter 1990 (2.5 m apart in rows 5 m apart). The Braeburn were on a silt loam and the Fiesta on a clay loam.

Mulch plots were 1.5 m wide by 9 m for Braeburn and 1.5 x 7.5 m for Fiesta. Herbicide treatments, both alone and under the mulches, were applied over a 3 m wide band. Plot division occurred at a tree giving two sample trees per plot 3.0 m or 2.5 m into the plot. Any sub-standard trees were ignored and the plots extended to encompass two sound trees. Each replicate occupied one row of trees.

Treatments consisted of a residual herbicide terbutylazine (4 kg/ha) (Gardoprim) applied 19.8.92, and four mulches each with and without terbutylazine at 2 kg/ha under the mulch. Mulches, laid between 11 and 14.9.92, were untreated pine sawdust 10 cm thick alone or 5 cm with herbicide, barley straw 10 cm alone or 5 cm with herbicide, commercial compost topped with sawdust, total depth 5 cm, with and without herbicide, and wooldust (short fibre combings contaminated by sheep dung) approximately 10 cm deep with and without herbicide. Straw on replicates 1-3 was ex-stable lightly contaminated with horse manure and on replicates 4-6 ex-bales laid in slabs. Terbutylazine was reapplied as before in August 1993 over the old mulches. Straw mulch was replenished on replicates 1-3 in September 1993, while other mulches were not reapplied. A non-residual herbicide, paraquat/diquat (Preeglone) or glyphosate (Roundup), was applied as needed to control excess weed growth.

Proc. 47th N.Z. Plant Protection Conf. 1994: 320-324

Visual assessments were made of percent weed cover and percent major species on each plot before the mulches were applied in September 1992 and again on 2.12.92, 3.2.93, 22.4.93 and 15.12.93. A non-residual herbicide (paraquat/diquat (Preeglone)) was applied after each December weed assessment to clean up surviving weeds and glyphosate (Roundup) was applied during the winter.

Trunk circumference of each tree was measured at a marked location about 30 cm above ground level on 24.8.92, 16.6.93 and 11.4.94. On 17.2.93 when branch extension growth had ceased, the extension growth on the lower five branches of each Braeburn tree and 10 branches spread around each Fiesta tree were measured for new seasons extension growth. Fruit yield was recorded in the second year over three picks for Fiesta between 14.2.94 and 7.3.94 and two picks for Braeburn on 21.3.94 (following hail damage) and 11.4.94.

On 9.2.93 and 8.3.94 five young fully expanded leaves were collected from around each tree and bulked by treatment. These leaves were analysed by Analytical Research Laboratories Ltd, Hastings, for the major elements N, P, K, S, Ca, Mg and Na and trace elements Fe, Mn, Cu, Zn and B. On 11.4.94 three fruit per tree (Braeburn only) were collected, bulked by treatment and analysed for major nutrients.

In May 1993, an earthworm survey was conducted by taking four 150 mm diameter soil cores to a depth of 150 mm in each plot, except half rate herbicide plots, and extracting all earthworms by hand. Earthworms were identified for species, sorted by age, counted and weighed by Dr Jo Springett, AgResearch Grasslands, Palmerston North.

Soil temperatures at 50 mm were recorded on all plots every 2-3 weeks at about 8 am and 4 pm.

RESULTS

Weed control

The pre-trial weed assessment showed approximately 25% weed cover with the major weeds being creeping mallow (*Modiola caroliniana*), white clover (*Trifolium repens*), scrambling speedwell (*Veronica persica*) and docks (*Rumex* sp.). Weed infestation was fairly uniform over the trial area.

The weed assessment in December 1992 showed all treatments except compost without herbicide significantly reduced weed cover compared to no mulch alone. The residual herbicide, terbutylazine, applied at 4 kg/ha, continued to have an effect throughout the season (cf. no mulch treatments (Table 1)), as did the half rate (2 kg/ha) under compost, but not to a satisfactory level. The half rate under wooldust did not improve weed control while the half rate under sawdust or straw was no more effective than doubling the thickness of the mulch. Straw maintained good weed control throughout the season even on replicates 1-3 (ex-stable straw) where it broke down rapidly from January 1993 onwards. Wooldust gave similar weed control to sawdust until March 1993 after which the layer cracked and weeds invaded.

In December 1993 the best weed control resulted from re-application of the full rate of herbicide in August, in the absence of mulches, and from straw (Table 1). Straw was equally effective on replicates 4-6 and where it was reapplied on replicates 1-3 with and without herbicide. Herbicide applied over sawdust and compost had no additional effect on weed control but over wooldust gave some improvement.

Tree growth

Tree branch extension was unaffected by any treatment. Measurements of trunk cross section areas showed that trees on compost plots were initially smaller than those on the other treatments, but that their growth in year 1 was significantly greater than that of the no mulch treatment (Table 2). The mean increase on all herbicide treatments was significantly greater than that without herbicide (Table 2). There was no significant difference between treatments in trunk area increase in year 2 nor in the total increase over the 2 years. Fruit yield in 1994 was lowest on the compost treatment (Table 2), but these trees had a smaller initial trunk cross section area.

TABLE 1: Effect of treatments on percent weed cover throughout 1992-93

Treatment	Assessment Date				
	2.12.92 ¹	3.2.93	11.3.93	22.4.93	15.12.93 ¹
No mulch	19	52	43	65	38
No mulch + terbuthylazine (4 kg ai/ha)	3	10	19	28	7
Thick sawdust	3	14	10	18	14
Thin sawdust + terbuthylazine (2 kg ai/ha)	<1	18	11	28	17
Thick straw	1	0	<1	7	5
Thin straw + terbuthylazine (2 kg ai/ha)	<1	0	2	6	2
Compost	27	55	50	78	16
Compost + terbuthylazine (2 kg ai/ha)	2	27	28	50	31
Wooldust	2	12	15	42	47
Wooldust + terbuthylazine (2 kg ai/ha)	<1	11	14	33	26
LSD 5%	8.4	16	12	12	16
Herbicide ²	0.7	1.4	1.4	29	19
No herbicide	8.1	2.0	1.8	36	20
LSD 5%	5.4	NS	NS	NS	NS

¹ All plots sprayed with paraquat/diquat after these assessments.

² Main effect of herbicide over all mulch and no mulch treatments.

TABLE 2: Increase in trunk cross section area and fruit yield in response to mulches and herbicide treatment.

Treatment main effects	Area 24.8.92 (cm ²)	% Increase year 1	% Increase year 2	% Increase over 2 years	Fruit yield/tree (kg) 1994
No mulch	9.1	128	50	245	45
Sawdust	9.0	133	50	252	44
Straw	9.3	131	51	250	44
Compost	7.3	137	52	264	39
Wooldust	9.2	133	47	246	45
LSD 5%	0.77	9.3	5.5	20.4	5.6
No herbicide	9.1	129	50	246	44
Herbicide	8.8	136	50	257	43
LSD 5%	0.51	5.7	3.4	12.8	3.6

Leaf analysis in February 1993 showed mulches had no effect on the concentration of any major nutrient or Fe, Ca and Zn. Tree growing on wooldust plots had leaf manganese concentration 32% higher than the mean of the other treatments, while trees on compost plots had leaf boron 50% higher than the mean of the other treatments. Manganese was in the acceptable level range for all treatments but boron was low for

all except compost. Leaf analysis in March 1994 showed similar results with leaf manganese 32% higher than other treatments on wooldust plots and boron, 16% higher on compost plots. Fruit nitrogen levels were above optimum, especially on the no mulch and sawdust treatments, while boron was high on straw and compost treatments. All other elements were similar between treatments.

Earthworm population

The earthworm survey in May found three species viz. *Aporrectodea caliginosa*, *Lumbricus rubellus* and *Octolasion cyaneum* (Table 3). Total numbers were highest under compost though *L. rubellus* was most numerous in the absence of mulch. Straw and no mulch also had high total numbers but there were more *A. caliginosa* under no mulch and more *Octolasion cyaneum* under straw. Sawdust and wooldust reduced earthworm numbers in all age classes, while no mulch, especially with herbicide had fewer newly hatched earthworms.

TABLE 3: Earthworm populations (No./m²) by species and age under different mulch treatments on 20.5.93.

Treatment	Total	<i>Aporrectodea caliginosa</i>	<i>Lumbricus rubellus</i>	<i>Octolasion cyaneum</i>	Mature	Non-clitella	Newly hatched
No mulch	521	256	190	75	80	291	150
No mulch RH ¹	296	199	46	51	64	168	64
Sawdust	196	106	24	66	27	95	75
Straw	532	177	137	218	66	216	247
Compost	687	384	97	205	128	324	234
Wooldust	152	84	38	31	22	62	68
LSD 5%	137	77	57	81	39	86	102

¹ Residual herbicide terbuthylazine 4 kg ai/ha

Soil temperatures

All mulches tended to have higher soil temperatures in the morning and lower soil temperatures in the afternoon compared to the bare soil. This resulted in a considerably reduced diurnal temperature fluctuation where mulches were applied. The mean temperature also tended to be reduced by all mulch treatments (Fig 1) but the differences declined as the mulches broke down and weed growth increased.

DISCUSSION

There appears to be little advantage in applying low rates of herbicide under a mulch as this gave no improvement in weed control except where compost was used. Sawdust and wooldust gave weed control similar to herbicide alone, while straw was superior to all treatments from February onwards. Straw was very effective during the summer, especially on replicates 1-3, where stable straw was used. This broke down rapidly from January onwards, apparently assisted through disturbance by birds, which probably increased weed control by preventing seedling establishment. Pukekos were often in evidence in the orchard. Straw is known to produce phytotoxins which are inhibitory to seedling growth in wet cool weather (Cochran *et al.* 1977) while the effect here was achieved throughout summer. It is difficult to predict the effect that soil temperature changes caused by mulching may have on trees. The reduced fluctuations on mulched plots may be advantageous by reducing extremes but this was accompanied by a lower mean temperature. Any effect is also likely to be reduced as tree canopy expands to shade the soil.

All species and age groups of earthworms were adversely affected by sawdust and wooldust. Straw and compost were both favoured by worms with particularly high numbers of juveniles present. Earthworm numbers were also depressed on the herbicide plots, but this probably reflects reduced food supply due to reduced weeds, rather than herbicide toxicity (Jo Springett pers.comm). The absence of organic matter

Figure 1: Mean of 8 am and 4 pm soil temperatures at 50 mm depth. For clarity of the figure, points are means of two consecutive measurements. ■ no mulch (solid line); * straw (dotted line); ■ compost (dashed line). Mean temperature for sawdust and wooldust were between compost and straw.

from weeds in the straw plots would have been compensated for by the decomposing straw. A good earthworm population is between 100 and 400/m² for cultivated land and between 400 and 1000/m² for permanent pasture (Jo Springett pers.comm.)

The increase in boron content of the leaves and fruit on the compost treatment suggests some high boron component in the compost. Though treatments had measurable effects on weeds, earthworm numbers, soil temperature and soil bioactivity (Hartley *et al.* in preparation) they have as yet had negligible effect on tree growth. However, trunk cross-section area growth was increased and fruit yield decreased by the compost mulch. This may have occurred because the trees in the compost plots were slightly smaller initially than those in other treatments, or it may be a result of compost increasing vegetative growth at the expense of fruit. When the fruit yield per tree was divided by trunk cross-section area there was no significant difference between treatments.

ACKNOWLEDGEMENTS

Thanks are due to Jo Springett and Jeff Reid for help in planning this trial, and Jo Springett for conducting the earthworm survey, Nick Pattison for use of his orchard and Heather Martin and Rachel Chapman for assistance with the conduct of the trial.

REFERENCES

- Cochran, V.L., Elliott, L.F. and Papendick, R.I., 1977. The production of phytotoxins from surface crop residues. *Soil Sci. Soc. Am. J.* 41: 903-908.
 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 Protection Conf.*: 285-288.