APRC Project Report

Project SP77	Orchard soil management (including requirements for Integrated Fruit Production [IFP])
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Background

The project contains two field trials comparing soil management treatments after tree planting that offer alternatives to pre-planting soil sterilisation. A further two trials consider suitable alternatives to residual herbicides for controlling competition by weeds. A fifth trial, investigating the effects of previous soil management commenced in February 1996. This report includes results obtained or analyzed during the period April - September 1996. Trial numbers are consistent with those given in previous reports for projects SP77 and SP10(b).

Trial 2 (Soil sterilisation, nitrogen and phosphorus fertigation)

This trial planted with Queen Cox/M.9 in 1990 investigates the potential of nitrogen and phosphorus fertigation, irrigation, and broadcast fertiliser as alternatives to pre-planting soil sterilisation for improving tree establishment. The former treatments have been applied annually since the trial commenced.

None of the soil management treatments has influenced the concentration of nitrogen in the leaves sampled in August 1995. Fertigation of phosphorus (irrigation + phosphorus fertiliser) increased phosphorus concentration in the leaves by 32% compared to the untreated control. Irrigation alone increased phosphorus concentration by 10% (Table 1). Irrespective of application method, nitrogen fertiliser reduced the concentration of phosphorus found in leaves (Table 1). The concentration of manganese in leaves was increased by nitrogen fertiliser, but irrigation had the opposite effect.

Irrigation increased the concentrations of nitrogen, phosphorus and potassium in fruit, but had the opposite effect on calcium (Table 2). This reduction in calcium concentration was due to dilution in the larger fruit caused by irrigation. Nitrogen fertiliser increased the nitrogen concentration in the fruit and fruit size irrespective of application method. Phosphorus concentration in the fruit was not affected by phosphorus fertiliser irrespective of the application method.

The quantity of sugar in the fruit did not differ between treatments. Maturity was determined by measuring the concentration of starch in the fruit at harvest. No differences occurred between treatments. Malic acid concentration was increased by irrigation.

The main increases in tree growth and crop yield were due to irrigation alone. In this experiment, calcium concentrations in the fruit were above the critical concentration associated with the cause of bitter pit (4 mg/100 g fresh weight). However, the reduction in calcium caused by irrigation could cause problems in other orchards (or in other varieties) and may need to be rectified by additional calcium sprays. Increases in the concentration of P in leaves caused by fertigation were not related consistently to improved yield for these young trees (see previous reports). This was due to a sufficient

background concentration of phosphorus in the soil (>35 ìg/g dry soil). Phosphorus fertigation could be particularly useful to rectify problems of low phosphorus concentration in established orchards. In these situations, broadcast phosphorus fertiliser cannot be incorporated into the soil to enrich the zone around the roots, and the greater mobility of the phosphorus in fertigation enables the nutrient to reach tree roots more effectively. Fertigation of nitrogen fertiliser offers little advantage over broadcast application. Fruit maturity was unaffected by soil management treatment, therefore picking dates would not need to be adjusted accordingly.

This trial is now complete.

Trial 3 (Novel alternatives to soil sterilisation)

This trial has been completed.

Trial 4 (Alternatives to residual herbicides for Bramley)

Concern exists over the long-term viability of residual herbicide use in orchards and their use is not encouraged in Integrated Fruit Production systems. This trial investigates the use of plastic mulch, organic (straw) mulch and non-residual herbicides (glufosinate ammonium) as alternatives to residual herbicide (simazine) in a Bramley/M.9 orchard planted in 1992. All treatments are applied with or without irrigation.

Analysis of leaf samples taken in August 1995 revealed that the different soil management treatments did not affect the concentrations of nitrogen, phosphorus, calcium and magnesium (Table 3). Leaf concentrations of potassium and manganese were raised by the organic mulch.

Nitrogen, phosphorus, potassium and calcium concentrations in the fruit were unaffected by any of the soil management treatments (Table 4). The low concentration of calcium in the fruit may account for the large amount of damage due to bitter pit found after storage of the fruit harvested in 1995 (see previous report).

Simazine was applied at 4.5 l/ha on 25 April 1996. Glufosinate ammonium was applied on 25 April at 5l/ha; 17 June 1996 at 5l/ha. Complete weed control was achieved on the plots treated with simazine. Plots treated with glufosinate ammonium had a wide area infested by weeds prior to application of the herbicide, but good suppression subsequently. The plastic and straw mulch treatments required spot spraying for small areas of grass weeds. Weed infestation tended to be worse near the drippers on the irrigated plots. In September, groundsel was present in the non-residual herbicide treated plots. The soil management treatments did not affect the number of fruit buds, fruit set and final yield (Table 5). Leaf samples were taken for mineral analysis in August.

The nitrate nitrogen concentration was measured at 30 cm depth between May and September 1996. Soils under either the plastic mulch or residual herbicide treatments generally had higher concentrations of nitrate nitrogen in solution than those under either organic mulch or non-residual herbicide (Fig 1). This was probably due to the less efficient weed control achieved on the non-residual herbicide treated plots and microbial breakdown of the straw under the organic mulch.

The plastic and organic mulches and non-residual herbicide provided sufficient weed control to be used as alternatives to residual herbicide. The main draw back of the plastic mulch is the high initial cost (36 p/m^2 in 1992), but it remains intact and has required low maintenance since its initial laying down. The straw mulch needs replenishing every two years. Mulches may also lead to problems of rodent damage at the base of the trees. (A little evidence of this was observed in 1995 on the plots

containing the straw mulch.)

Trial 5 (Alternatives to residual herbicides for Queen Cox)

This trial has been completed.

Trial 6 (Effects of previous soil management)

This new trial investigates the effects of previous herbicide management on the growth, fruit yield and eating quality of Royal Gala/M.9 apple trees. The trees were planted in February 1996 on a site that had previously been either under grass or herbicide for 20 years. Remedial treatments that will be tested include different rates of nitrogen fertiliser, irrigation and use of potting compost.

Soil organic matter concentrations were measured in August to a depth of 40 cm at 10 cm intervals. Soil that had previously been under herbicide had approximately 50% lower concentrations of organic matter at 0-30 cm depth (Fig. 2) than that under grass. This could affect the amount of mineralisable nitrogen available to the trees and thus influence growth.

Initial measurements were made of girths at planting and shoot extension will be measured during the winter. Leaf samples were taken in August for mineral analysis.

Publications

The following publications have been produced during the last year. Copies are enclosed with this report.

HIPPS, NA 1996 Effects of nitrogen, phosphorus, water and pre-planting soil sterilisation on growth and yield of Queen Cox/M.9 apple trees. Acta Horticulturae. In press.

HIPPS, NA 1996 Fertigation of apple trees, Novel methods of establishment for apple trees, Alternatives to herbicides. In Soil and root management in fruit production. Members day report May 1996, East Malling Research Association, East Malling, Kent.3, 4, 12-15.

HIPPS, NA 1996 A report on the Third International Symposium on the nutrition of deciduous fruit trees (and grapevine). Zaragosa, Spain 26-31 May 1996. East Malling Research Association, East Malling Kent. 7 pp.

Table 1. The main effects of irrigation, phosphorus and nitrogen fertilisers on leaf phosphorus concentration (% dry matter) on Queen Cox/M.9 in 1995 (Trial 2).

	Phosphorus (20 g/tree)			
Irrigation (4 l/tree/day)	-	+	Significance level	
-	0.22	0.26	Phosphorus	***
+	0.24	0.29	Irrigation	nearly
	Nitrogen (20 g/tree)			
	-	+		
	0.28	0.23	Nitrogen	***

ns differences in means not statistically significant
* statistically significant
** highly significant
*** very highly significant

Table 2a. The main effects of irrigation, phosphorus and nitrogen fertilisers on the concentrations of nitrogen and phosphorus in fruit of Queen Cox/M.9 in 1995 (Trial 2)

Nitrogen mg/100 g fresh weight

	Nitrogen (20 g/tree)			
Irrigation (4 l/tree/day)	-	+	Significance level	
-	63	65	Nitrogen	**
+	63	73	Irrigation	*

Phosphorus mg/100 g fresh weight

	Phosphorus (20 g/tree)			
Irrigation (4 l/tree/day)	-	+	Significance level	
-	13	13	Phosphorus	ns
+	15	15	Irrigation	***

Table 2b. The main effects of irrigation on potassium and calcium concentrations in fruit of Queen Cox/M.9 in 1995 (Trial 2)

Potassium mg/100 g fresh weight

Irrigation (4 l/tree/day)		Significance level	
-	155	Irrigation	*
+	165		

Calcium mg/100 g fresh weight

Irrigation (4 l/tree/day)		Significance level	
-	5.3	Irrigation	***
+	4.7		

ns differences in means not statistically significant
* statistically significant
** highly significant
*** very highly significant

Table 3. The main effects of soil management treatments on leaf mineral concentration in

Bramley/M.9 in 1995 (Trial 4).

	% dry weight					ppm
	N	P	K	Ca	Mg	Mn
Non-residual herbicide	2.7	0.17	1.5	1.9	0.25	66
Residual herbicide	2.6	0.16	1.5	1.8	0.23	61
Plastic mulch	2.7	0.16	1.6	1.7	0.25	57
Straw mulch	2.6	0.16	1.7	1.7	0.24	77
Significance level	ns	ns	***	ns	ns	**

ns differences in means not statistically significant
* statistically significant
** highly significant
*** very highly significant

Table 4. The main effects of soil management treatments on fruit mineral concentration in Bramley/M.9 in 1995 (Trial 4).

	mg/100 g fresh weight			
	N	P	K	Ca
Non-residual herbicide	54	10	148	3.2
Residual herbicide	55	11	149	3.3
Plastic mulch	57	11	153	3.2
Straw mulch	52	10	145	3.3
Significance level	ns	ns	ns	ns

ns differences in means not statistically significant
* statistically significant
** highly significant
*** very highly significant

Table 5. The main effects of soil management treatments on the number of fruit buds and final set in spur and terminal positions per branch, and harvest yield per tree on Bramley/M.9 in 1995 (Trial 4).

	Fruit buds	Fruit set	Harvest yield	% Class I > 85 mm
Non residual herbicide	44	37	12.0	53
Residual herbicide	45	48	15.5	54
Plastic mulch	49	33	13.4	49
Organic mulch	49	41	16.0	47
Significance level	ns	ns	ns	

ns differences in means not statistically significant
* statistically significant
** highly significant
*** very highly significant