Project title	Apples: Long term effects of applied composted green waste mulch on the cropping of Braeburn and Cox
Project number	TF 177
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Report	Annual Report 2011
Previous report	Annual report 2010
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Location of project	North Court Farm Old Wives Lees Lower Lees Road Canterbury Kent CT4 8AU
Project coordinator	Simon Foad
Date project commenced	2008
Date completion due	2014
Key words	Braeburn, Cox, green waste, mulch, compost

The results and conclusions in this report are based on an investigation conducted over one year. The conditions under which the experiment was carried out and the results obtained have been reported with detail and accuracy. However, because of the biological nature of the work, it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results especially if they are used as the basis for commercial product recommendations.

Contents

Grower summary

Headline

- The use of compost as a mulch can increase fruit number and fruit size.

Background and expected deliverables

Previous work has been carried out to determine the effect of the application of composted green waste as a mulch in apple production. Positive effects on fruiting as well as growth have been observed but work tended to be relatively short term and concentrate on testing the effect in the years following planting. This project is a continuation of previous work funded by WRAP which tested the effect of green waste compost mulch on the growth and fruiting of two varieties of apple (Cox and Braeburn). This project is extending the evaluation of the effect on growth and fruiting of the trees. The final report will also include an economic analysis of the use of composted green waste as a mulch for apple production.

Summary of the project and main conclusions

The trial was conducted on two apple varieties: Cox and Braeburn to which mulch was applied to half the field on two occasions. In 2004 when the trees were planted, a 10cm layer of compost was applied equating to a rate of 30 tonnes per hectare. This was then repeated in 2007. The mulched trees are being compared to those where the herbicide strip was left bare.

Fruit size was measured weekly from June to August and then again at harvest. Fruit number was also recorded at harvest. Fruit maturity tests were conducted on both varieties in September just prior to harvest as an additional measurement. Length of shoot growth was recorded in October. Soil, leaf and fruit nutrient analyses were conducted to determine the effect of mulch on soil nutrient content and uptake by the tree. Enviroscan soil moisture probes were used to determine the effect of compost on soil moisture content.

Fruit size increased by 6.7% in Cox but only by 2.1% in Braeburn. This was important because in addition to fruit size being increased with compost, so fruit number also increased in both varieties. In Braeburn the increase was 30% and in Cox, 23%. There was however significant tree to tree variation, sothese differences were not statistically significant. Like last year, there was a difference in the amount of shoot growth between the two treatments with the compost increasing growth by 11% and 18% in Braeburn and Cox respectively. The combined effect of increased growth over the last 6 years has resulted inthe compost treated trees filling their spaces whereas trees in the control plots have not. This was the reason the compost treated trees were able to produce so much more fruit without a detrimental effect on fruit size.

The application of composted green waste increased the fruit nitrogen and decreased fruit phosphate levels. This has implications for fruit storability and may mean that fruit treated with compost will not store for as long as fruit from trees not treated with compost. It will certainly mean that fertilizer and foliar feed applications need to be based on analyses.

In 2009 there was a significant effect of treatment on soil moisture content with compost giving rise to a greater soil moisture content than the control. However, in 2010 there were no differences observed. This difference can be attributed to the overall amount of rainfall, which in 2010 was around 60% higher than in 2009. It is important though that significant differences between treatments were still seen even though the soil moisture content was the same in the two treatments.

Financial benefits

The yield of Braeburn increased by 7.5kg per tree with the addition of compost. Yield of Cox increased by 5.5kg per tree with the addition of compost. Using a farm gate price of £80 for a 330kg bin, these represent increases in return of £1.81 per tree for Braeburn and £1.33 per tree for Cox. At the density of 2300 trees per hectare, these equate to increases of around £4200 and £3100 per hectare respectively.

Action points for growers

- Use mulch to aid establishment and growth of trees.
- Mulch can be used in situations where increased growth is required. This has been shown to result in improved yield as tree volume increases.

- However, where vigour is already adequate or strong, the use of a mulch could lead to problems of excessive vigour.
- Conduct leaf and fruit analyses to determine whether fertilizer and foliar applications are necessary.
- Assess maturity and obtain fruit analysis separately to non-treated blocks of trees as maturity and storability can be affected by compost mulch applications.

Science Section

Introduction

A series of trials on the use of compost as a mulch in fruit orchards in Kent have been conducted as part of a WRAP project over the 4 years prior to the start of this project. The current project, funded by the HDC, aims to determine the effect of long-term compost use beyond the WRAP funded part of the project.

All of the sites tested as part of the original WRAP funded work showed similar soil alterations with addition of compost mulch which included increases in soil organic matter, pH, and general increase in the pool of available nutrients (N, P, K, S).

Generally the fruit crops tested all responded well with yield increases (fruit weight per tree) of blackcurrant (23%), Bramley (30%) and Conference pear (54%) compared to unmulched controls. Such increases are of economic significance to the growers and once again highlight the potential of compost mulch for improving top and soft fruit yields.

However the effects in 2008 on Braeburn were very different. The use of compost mulch actually resulted in a decrease in fruit yield per tree of approximately 15% which was completely out of line with other, previous findings. The conclusion made was that increasing levels of nutrients (nitrogen, potassium and phosphate) appeared to have triggered a shift towards vegetative growth (stem/shoot/leaf) rather than the real target of increased fruit production. However, in years prior to 2008, there were generally positive effects of mulch on fruiting with yield increasing by around 50%. It was possible that the different results observed in 2008 were down to the extended duration of compost application (Lock *et al*., 2008). The results described here investigate the effect of compost further both its effects on growth and fruiting but also on nutrient availability and uptake and on soil moisture content.

The use of compost in orchards has been tested in a number of studies around the world and has been shown to affect not only growth and fruiting of trees but also management of weed, fungal, and insect pests. For example, Brown and Tworkoski (2004) found populations of leaf miner and wooly aphid to be reduced through the use of compost in apple orchards in the USA. In a Golden Delicious orchard, the use of compost was found to increase natural insect predator levels (Matthews *et al*., 2004) which may explain the reduction in leaf miner and aphid levels as described above.

In previous work, composted sewage sludge increased growth of apple seedlings, possibly through an increased level of tissue Ca. Other effects included an increased pH which alleviated the effect of naturally high manganese levels (Korkak, 1980). In contrast Rumberger *et al*. (2005) found that pre-planting compost or fumigation soil treatments had no effect on tree growth when applied in an apple replant situation. Yaoa *et al*. (2006) also found little effect of compost in a replant site with the only significant effect being an increase in lateral extension growth. These data however, contrast with work on 'Macoun' which found compost to increase tree growth 7 years after compost application. Yield was increased only in alternate years suggesting that the effect of compost needs to be managed carefully to obtain consistent effects. Interestingly, in this trial there was no effect of applied monoammonium phosphate (Moran and Schupp, 2005). This is important because one of the effects of compost observed in the trial described here was to increase the level of phosphate. However, in complete contrast, Wilson *et al*. (2004) found exactly the opposite. Compost had no effect whilst monoammonium phosphate increased tree growth significantly. Effects of compost addition include altered soil nutrient and physical characteristics. Compost treatments have been shown to result in higher microbial activity over standard fertilizer treatments in apple replant sites and also cause higher levels of nitrogen, phosphorus, potassium, and organic matter (Travis *et al*., 2006). It has also been shown that pH increases with the addition of compost.

It is clear that the effects of compost on apple tree growth are complex and varied. Effects on soil nutrient content and microbial activity vary and the effect of compost from year to year varies. The aim of the project described here is to determine the long term effect of compost mulch on two varieties of apple: Braeburn and Cox. The cumulative effect of the compost will be tested over the duration of this project.

Materials and methods

The experiment is being conducted at North Court Farm, Old Wives Lees, Kent in a Braeburn/Cox orchard planted in 2004. The farm is on the Downs and the soil is generally clay over flint. The farm does not have irrigation. This was the first site to become involved in the previous WRAP project (RMD 0002-008) when compost was first applied in June 2004. The compost was applied in a strip one metre wide and 7 to 10 cm deep which was equivalent to approximately 4 tonnes of mulch per 100m of row. Application along the rows of Braeburn and Cox trees was accomplished using a side spreader adapted from straw/manure application systems.

In 2007, the compost was re-applied to the same trees which had received compost in 2004. The compost was applied to 13 rows of trees at a width of 1m and depth of 0.1m at a rate of 11.5 tonnes per row. Delivery and application took place in late spring to allow the soil to absorb as much moisture as possible during the winter, and for the soil to warm in the spring before applying the compost. The rest of the orchard was not treated.

During 2010, assessments of crop growth and development were conducted to determine the effect of the compost mulch. Fruit diameter of 50 fruit was measured weekly from June to September. Final fruit size and number was recorded at harvest as was shoot growth, both new shoot growth in 2010 and tree radius. The length of new shoot growth in 2010 was recorded for shoots arising from the terminal bud of 2nd year shoots. Tree radius was measured from the trunk to the furthermost point on the tree circumference. In addition, soil, leaf and fruit samples were analysed to determine the impact of compost on soil fertility.

Enviroscan soil moisture loggers were used to determine the effect of compost on soil moisture content. The probes are placed at depths of 10, 20, 30, 40, 50, 60, 70 and 80cm and record the soil moisture content (mm) every 5 minutes.

The compost had been applied to one half of the field, the other half remaining without compost as the control treatment (Figure 1) rather than applying the compost in a completely randomized block design. Therefore whilst statistical analysis was carried out to determine the effect of compost, it was not possible to dissociate this from position effects. ANOVA was used to determine the statistical significance of treatments.

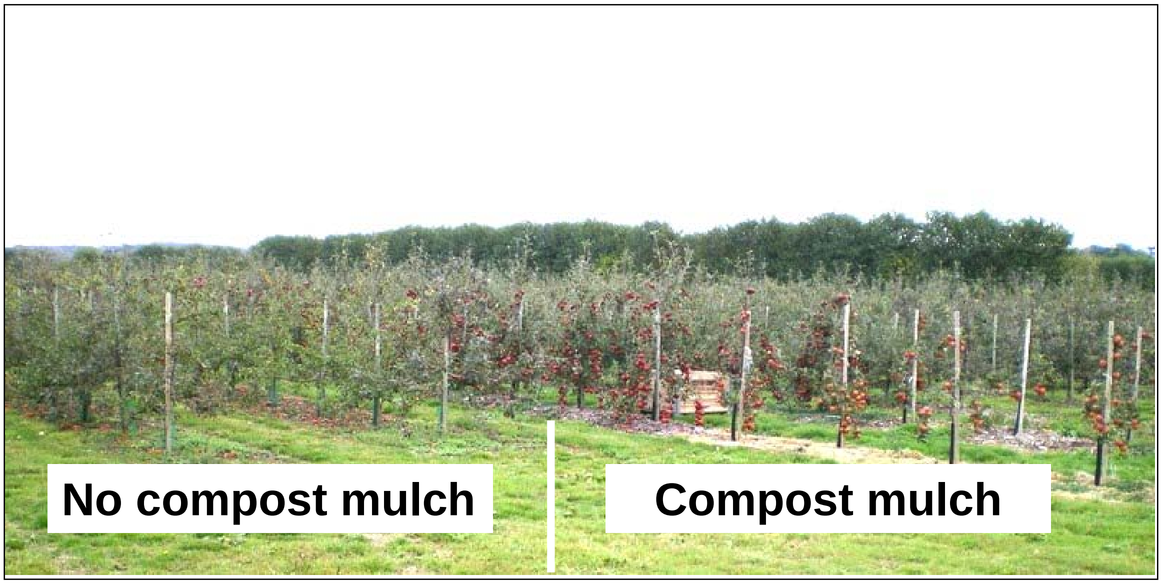

Figure 1. Photograph showing the arrangement of the compost treatments.

Results

Effect of compost on Braeburn fruit growth

The effect of compost treatment on fruit growth for Braeburn is shown in Figure 2. At the start of measurements in June, there was no difference in fruit size. However, as growth rate was greater in the compost treatment than the no compost control, the compost treated fruit increased in size more than the untreated control fruit. At the final weekly measurement date there was a difference in fruit size of 3.4mm between treatments.

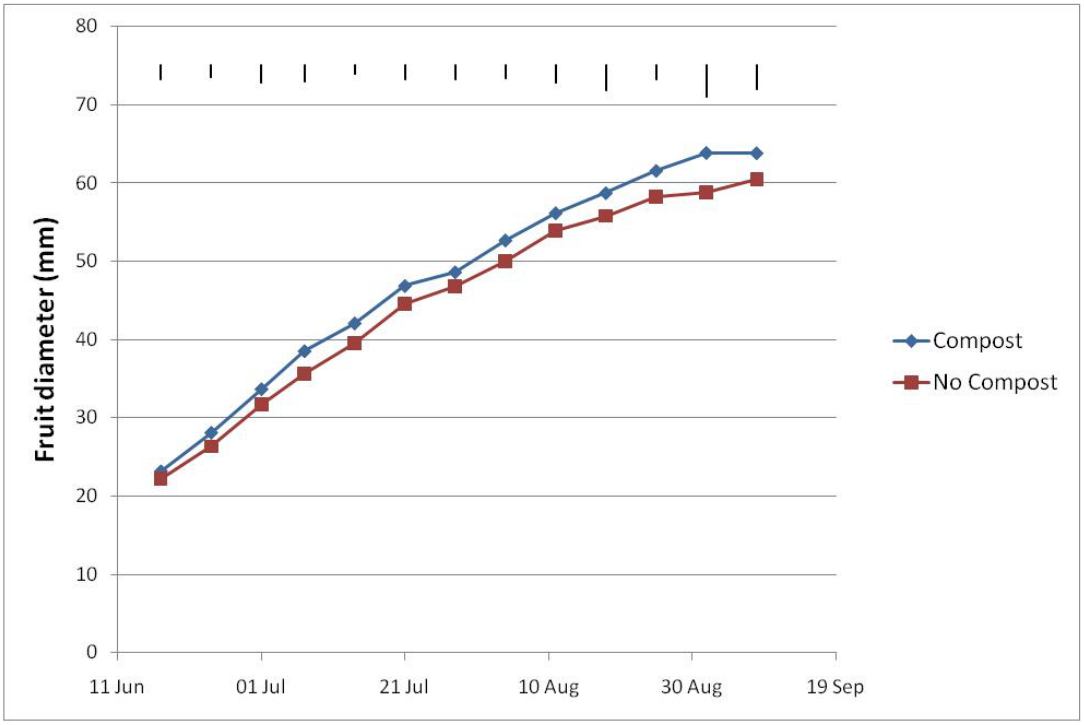

Figure 2. Effect of compost on increase in fruit size of Braeburn in 2010. Bars shown uppermost are least significant differences.

Effect of compost on Cox fruit growth

The effect of compost treatment on fruit size of Cox is shown in Figure 3. The fruit size at the beginning of June was slightly greater in the compost treatment than the control, no compost treatment. Again the fruit from the compost treated trees grew at a faster rate than the untreated trees and so by the end of August the fruit size was greater in the compost treated trees. The difference at this stage was 4.1mm.

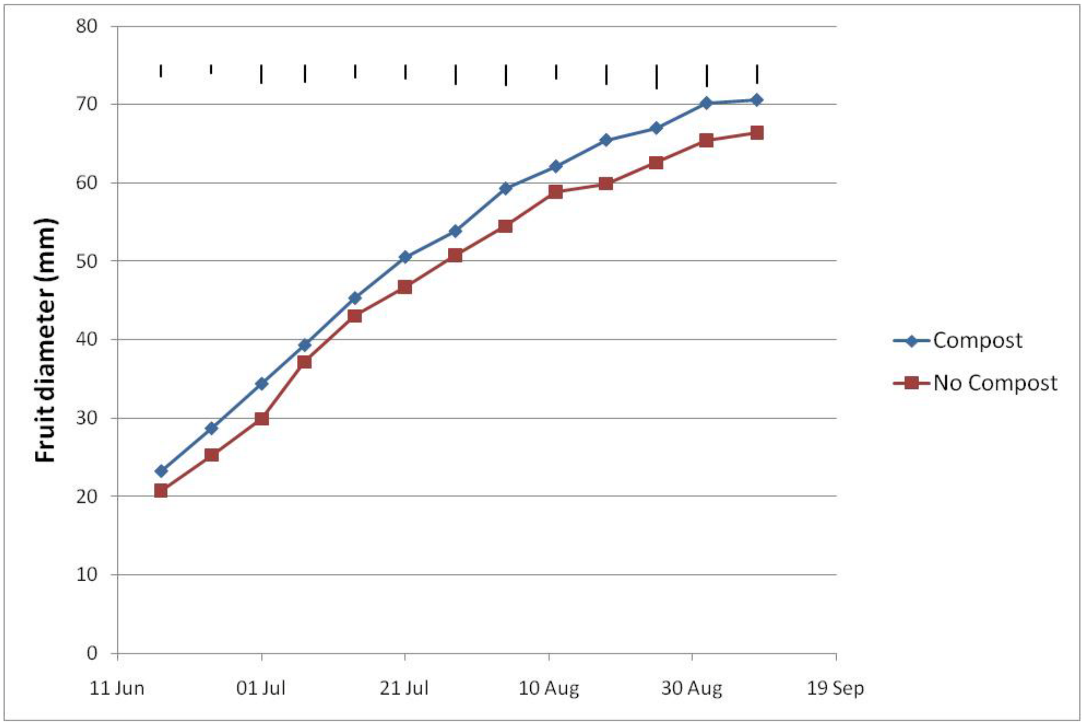

Figure 3. Effect of compost mulch on increase in fruit size of Cox in 2010. Bars shown uppermost are least significant differences.

Effect of treatment on fruit number

For both varieties, the compost treated trees produced more fruit than the no compost, control trees (Figures 4 and 5). For Braeburn this increase in fruit number per tree was about 38 fruit per tree and for Cox, the difference was less at 19 fruit per tree. However, these differences were not significant for either variety because of significant variation in fruit number between trees. For example, fruit number per tree in Braeburn from the no compost treatment, varied by as much as 175 fruit per tree. Having said that, both varieties did produce more fruit in the compost treatment than the no compost, control treatment.

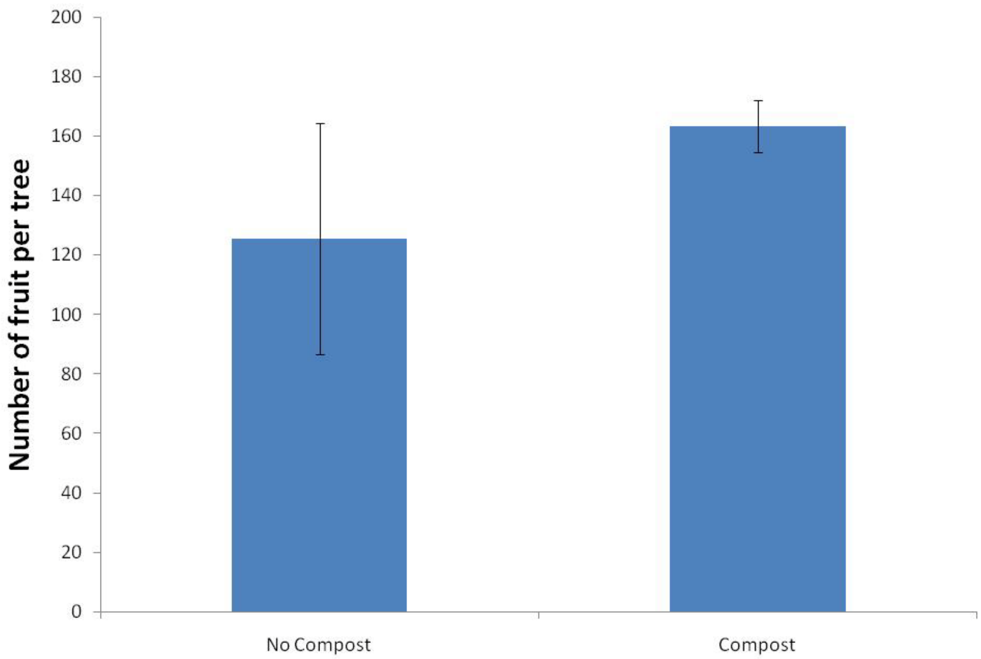

Figure 4. Effect of compost treatment on number of fruit per tree for Braeburn in 2010. Standard error bars are shown.

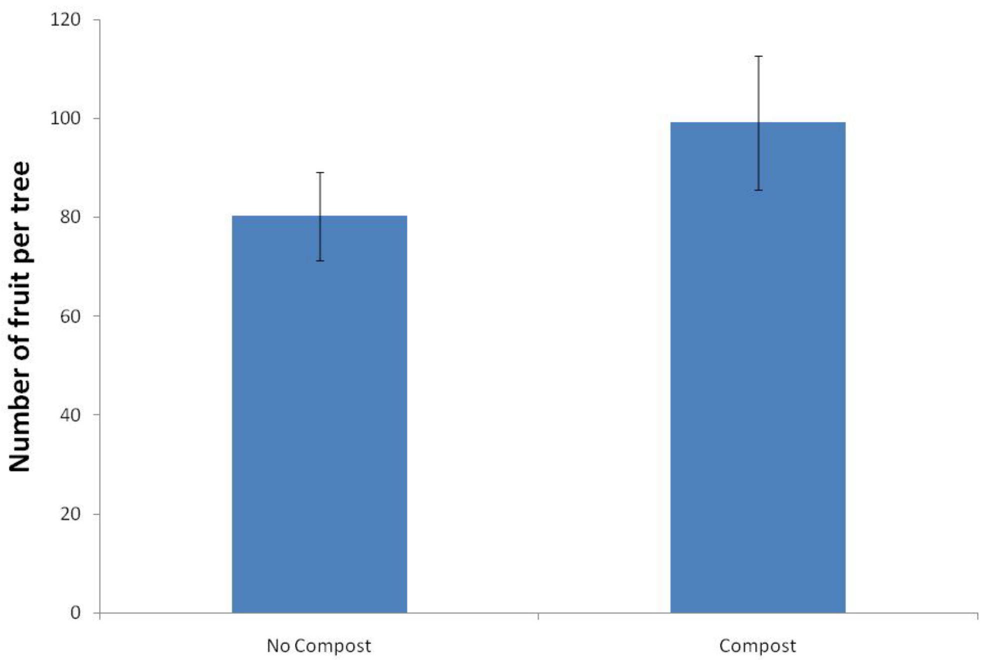

Figure 5. Effect of compost treatment on fruit number per tree of Cox in 2010. Standard error bars are shown.

Effect of treatment on fruit diameter at harvest

150 fruit were sampled just prior to harvest from each variety and treatment to determine final fruit size. Compost increased final fruit size in both varieties. For Braeburn the difference was small, only 1.5mm and this difference was not significant (P=0.06) (Figure 6). For Cox, however, the difference in fruit size was significant (P<0.01) (Figure 7). Fruit were 5mm larger in the compost treatment than the control, no compost trees.

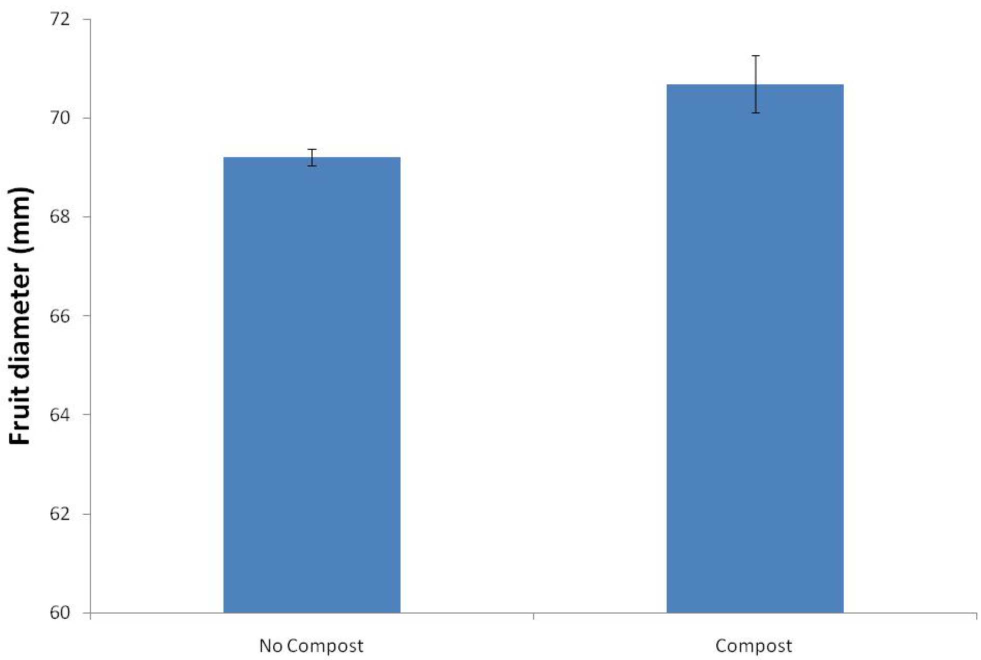

Figure 6. The effect of compost treatment on the fruit diameter for Braeburn in 2010. Standard error bars are shown.

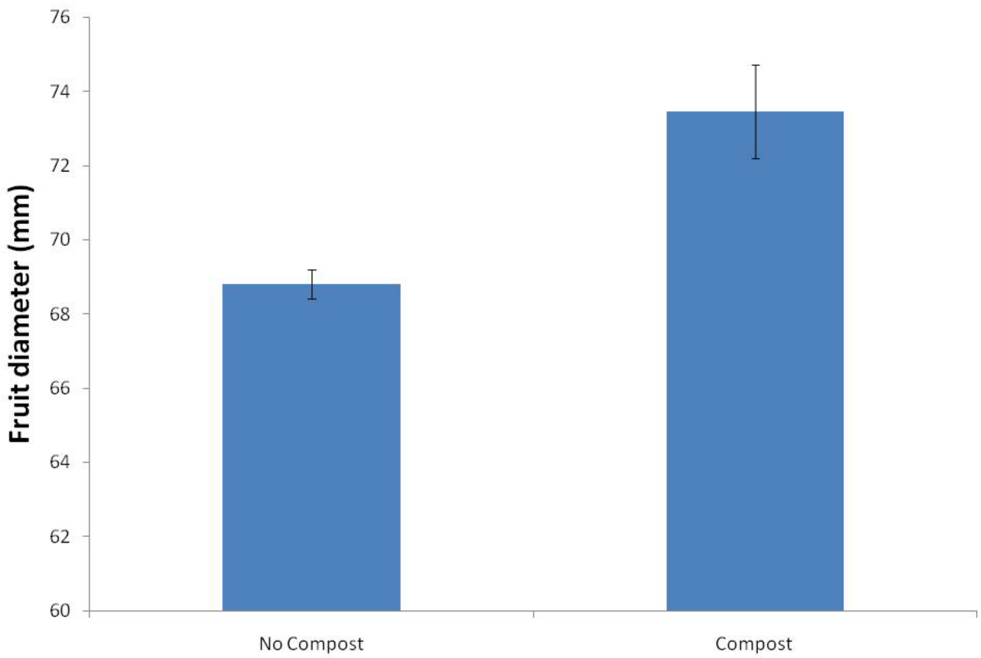

Figure 7. The effect of compost treatment on the fruit diameter for Cox in 2010. Standard error bars are shown.

Effect of treatment on fruit size at harvest

The effect of treatment on fruit size (Figures 8 and 9) was also recorded through measuring individual fruit weight from the same 150 fruit per treatment sampled at harvest which were used to calculate fruit diameter. Individual fruit weight was greater in the compost treatment. The difference in fruit weight was significant ($P<0.05$). For Braeburn the difference was 9g, and for Cox, the increase in fruit weight was greater at 29g per fruit and again this difference was significant ($P<0.01$). The effect of compost on fruit size here is important and for Cox is similar to results from 2009. However, for Braeburn in 2009 fruit size was lower in the compost treatment than the no compost control. It is true though that Cox was more affected by treatment than was Braeburn in 2010.

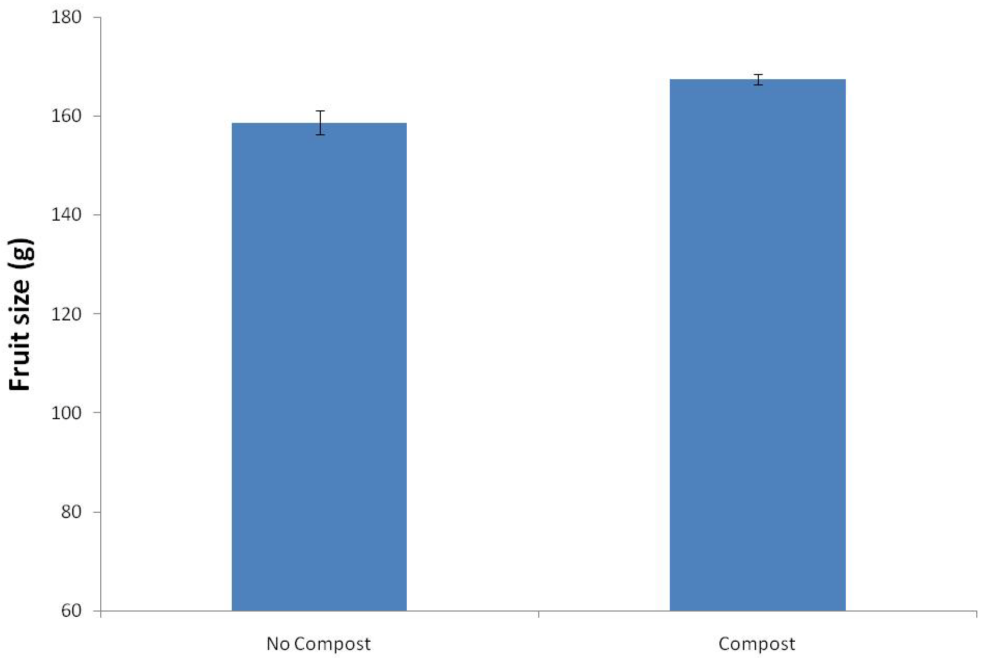

Figure 8. The effect of compost treatment on the fruit size for Braeburn in 2010. Standard error bars are shown.

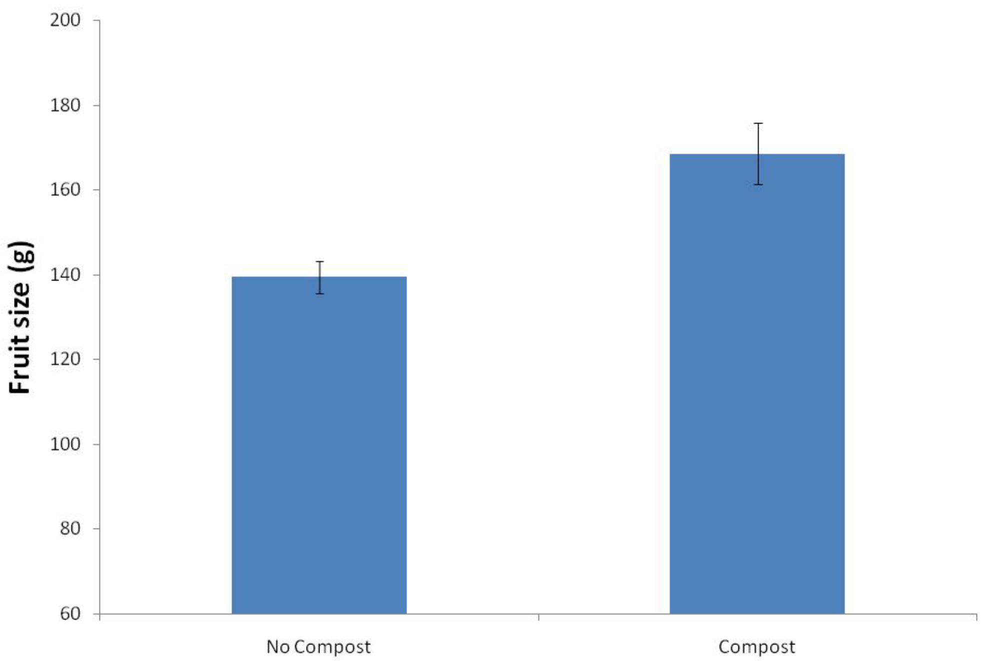

Figure 9. The effect of compost treatment on the fruit size for Cox in 2010. Standard error bars are shown.

Effect of treatment on yield

The effect of compost treatment on the calculated yield per tree is shown in Table 1. This was calculated from the recorded fruit numbers and sizes. In both varieties, the effect of compost mulch was to increase the yield per tree. For Braeburn and Cox, yield increased by 7.5kg and 5.5kg per tree respectively and these increases are similar to the yield increases seen in 2009. Clearly this is an economically important yield increase as it equates to an increase of around 10 tonnes per hectare.

	NO COMPOST	COMPOST
BRAEBURN	19.9	27.4
COX	11.2	16.7

Table 1. Effect of compost tree on yield per tree (kg per tree) for 2010.

Effect of treatment on shoot growth

Shoot growth was assessed in two ways in 2010. Firstly, new shoot growth for 2010 was recorded from 45 branches per treatment. For Braeburn, whilst the shoot growth was greater in the compost treatment, this difference was not significant (P=0.09) (Figure 10). However, new shoot growth was significantly greater in the compost treatment in Cox in 2010 (P=0.03) as it had been in 2009. For Cox average new shoot growth increased from 0.41m in the no compost control to 0.49m in the compost treatment (Figure 11). For Braeburn, average shoot growth was 0.39m in the no compost, control treatment and 0.43m in the compost treated trees.

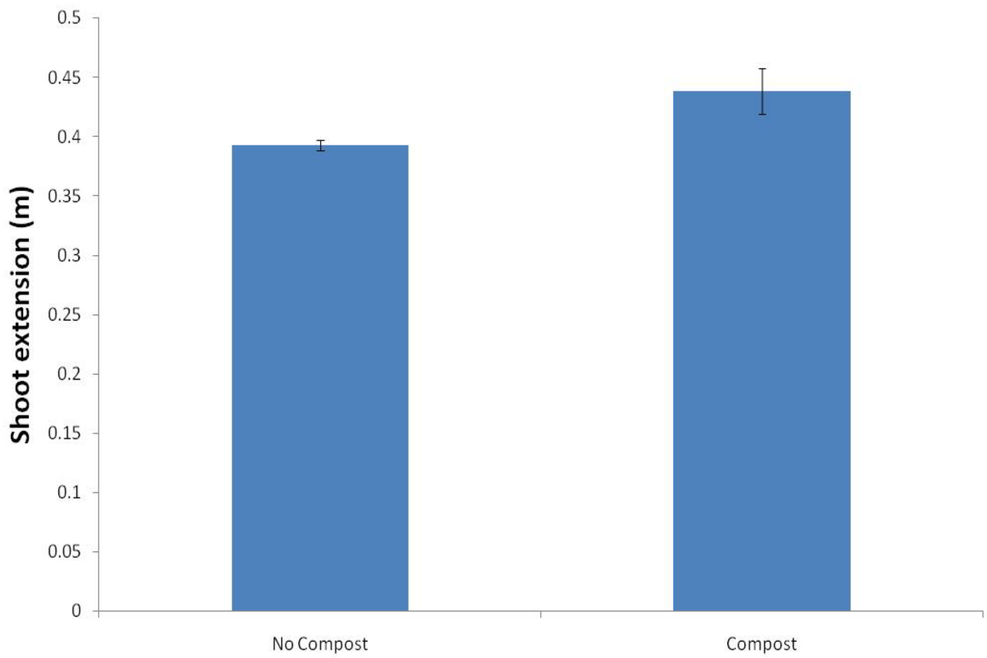

Figure 10. The effect of compost on new shoot growth of Braeburn in 2010. Standard error bars are shown.

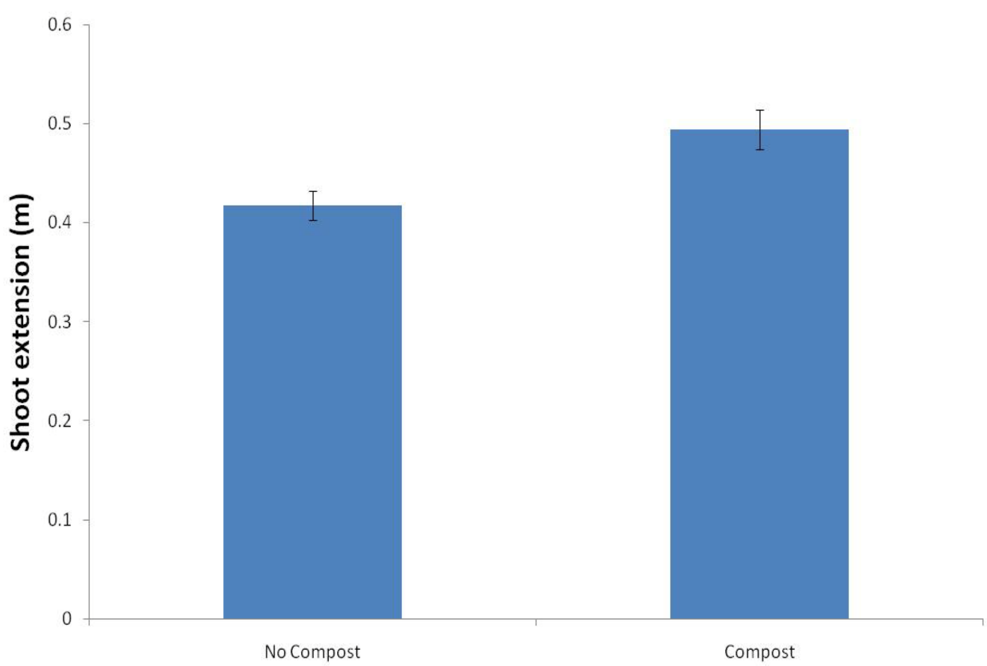

Figure 11. The effect of compost on new shoot growth of Cox. Standard error bars are shown.

Tree radius

As a measure of overall tree size, the average tree radius was recorded for each treatment by measuring from the tree centre to the furthermost point on the tree circumference. This is generally used on the continent as a measure to predict tree productivity. For Braeburn (Figure 12) there was a significant increase in tree radius with the use of compost (P=0.006). Tree radius increased from 1.07m to 1.25m. However for Cox (Figure 13) the difference was less increasing from 1.22m to 1.33m with the addition of compost mulch. This is similar to the effects seen in 2009 with the trees in the compost treatment being significantly larger than the no compost control trees. In most cases the compost treated trees have now filled their spaces whereas there are still gaps between the no compost, control trees.

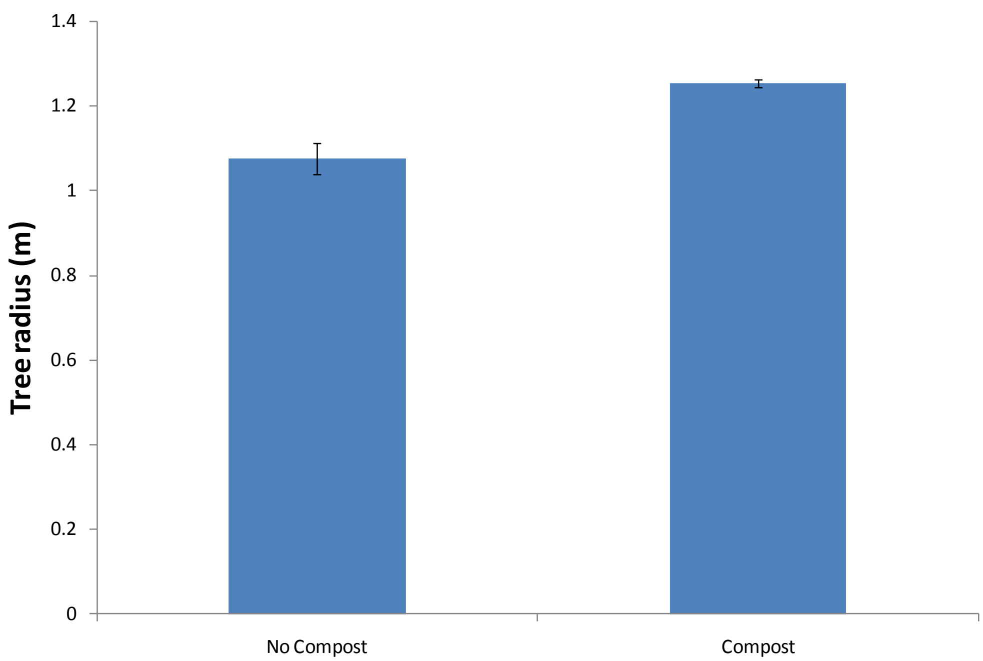

Figure 12. The effect of compost on tree radius of Braeburn in 2010. Standard error bars are shown.

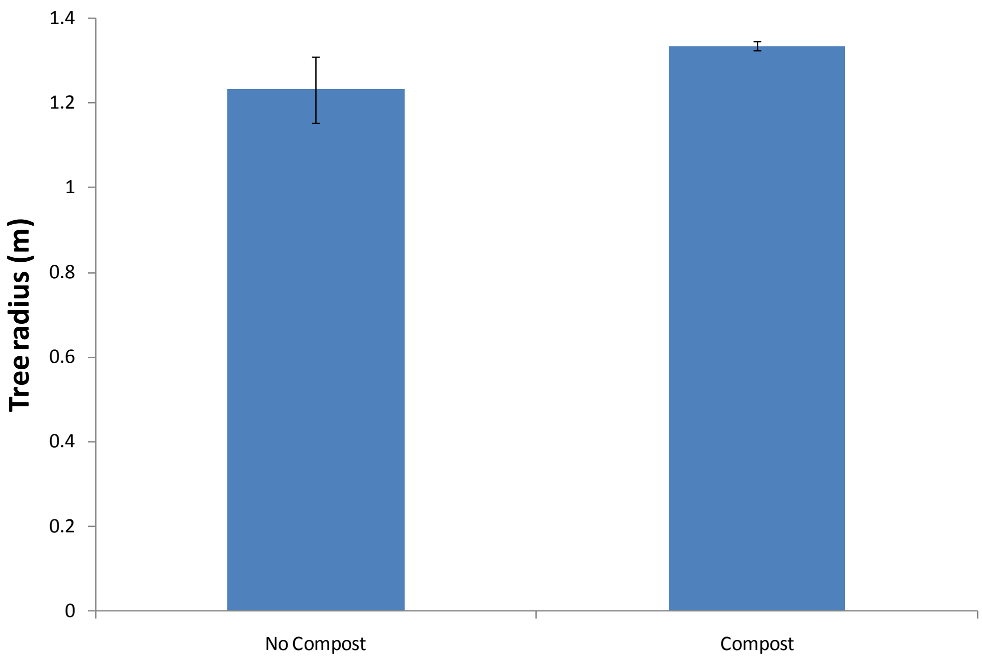

Figure 13. The effect of compost on tree radius of Cox in 2010. Standard error bars are shown.

Over the last 6 years there has been a continuous effect of compost treatment on vegetative growth in both varieties which has resulted in very different tree sizes. The photographs shown in Figures 14 and 15 demonstrate very clearly how compost has increased growth resulting in larger trees which have filled their spaces. Any further increases in growth could now be viewed as undesirable.

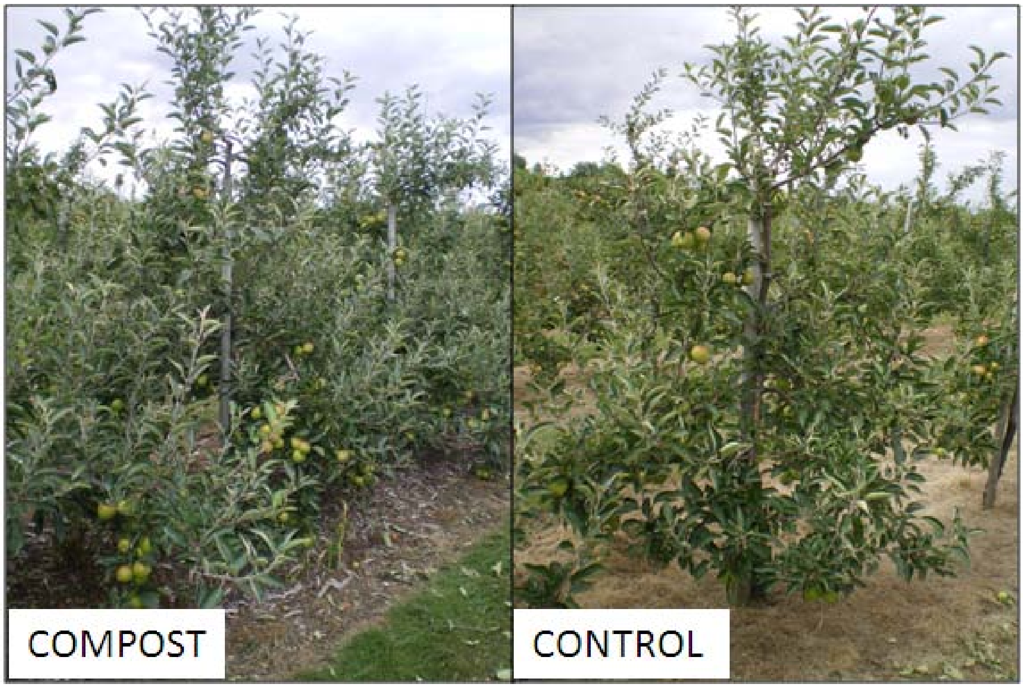

Figure 14. Braeburn trees which had been treated with compost mulch (L) and control trees which had been not been treated with compost mulch (R).

Figure 15. Cox trees which had been treated with compost mulch (L) and control trees which had been not been treated with compost mulch (R).

Fruit maturity

In 2009, fruit maturity was tested for Braeburn to determine whether the compost caused a significant difference in maturity of fruit (Table 2). In 2010, maturity tests were conducted for both Cox and Braeburn to determine any varietal differences. For Braeburn, the total soluble solids (^{o}Brix) level was greater in the no compost treatment, as was pressure. These differences were significant ($P<0.05$). However, starch percentage was unaffected by compost treatment ($P>0.05$).

	SUGAR (^{O}BRIX)	PRESSURE (KG)	STARCH (%)
COMPOST	9.52 (0.13)	12.91 (0.22)	99.1 (0.53)
NO COMPOST	9.92 (0.12)	13.37 (0.17)	99.4 (0.31)

Table 2. Effect of compost treatment on fruit maturity for Braeburn in 2010. Standard errors are given in brackets.

When the maturity test was conducted on Cox (Table 3), the fruit was closer to harvest and so greater differences can be observed in pressure, in particular with the compost treated trees having a lower pressure than control, untreated trees ($P<0.05$). However, starch and total soluble solids were unaffected by compost treatment.

	SUGAR (^{O}BRIX)	PRESSURE (KG)	STARCH (%)
COMPOST	11.48 (0.24)	9.20 (0.21)	88 (1.9)
NO COMPOST	11.64 (0.26)	10.67 (0.25)	92 (2.3)

Table 3. Effect of compost treatment on fruit maturity for Cox in 2010. Standard errors are given in brackets.

Fruit nutrient analysis

Fruit were sampled from each variety in August for nutrient analysis. For Braeburn (Table 4), fruit phosphate was higher in fruit from the no compost, control trees than in fruit from the compost treated trees. Conversely potassium level was higher in fruit from the compost treated trees. This was inversely correlated with calcium level which was higher in fruit from the no compost control trees. Fruit nitrogen levels were higher in the compost treated trees than the no compost control trees. For both treatments the high nitrogen and potassium content of the compost treatment would have reduced the predicted potential storage duration.

Treatment	N	P	K	Mg	Ca	B	Fe	Mn	Zn	Cu
Compost	105.85	15.93	155.29	8.56	14.53	2.83	2.22	0.74	0.93	0.60
No Compost	94.53	17.14	121.28	8.14	16.94	3.95	2.29	0.80	0.83	0.56

Table 4. Effect of compost on fruit nutrient analysis of Braeburn fruit in 2010. Shaded values highlight differences between treatments.

For Cox, there was a slightly different effect of compost treatment on fruit nutrient content (Table 5). The fruit phosphorus content was also higher in the control treatment than in the compost treatment, as it was in Braeburn. However, there was very little difference in potassium content between the two treatments. The nitrogen content of the fruit was much greater in fruit from the compost treated trees than the control trees. There was a much greater difference in predicted storability of Cox between the two treatments than for Braeburn. The predicted potential storability of the compost treatment was reduced by both high nitrogen and low phosphate levels in the fruit.

Treatment	N	P	K	Mg	Ca	B	Fe	Mn	Zn	Cu
Compost	120.62	16.42	174.26	9.22	11.08	3.68	3.21	0.81	0.61	0.59
No Compost	68.36	18.41	179.15	9.15	11.18	4.22	1.99	0.93	0.55	0.53

Table 5. Effect of compost on fruit nutrient analysis of Cox fruit in 2010. Shaded values highlight differences between treatments.

Leaf nutrient analysis

The leaf analysis results were similar from both varieties (Tables 6 and 7). Nitrogen, calcium, phosphate and potassium levels in leaves were higher in the compost treatment than the no compost, control. It is interesting that these results are different to the fruit analysis results.

	N	Ca	Cu	Fe	K	Mg	Mn	P	Zn	B
Compost	2.85	0.76	12.06	92.17	1.42	0.22	22.19	0.32	180.59	27.92
No Compost	2.75	0.64	11.42	85.34	1.06	0.19	20.90	0.27	235.40	35.14

Table 6. Effect of compost on leaf nutrient analysis of Braeburn fruit in 2010. Shaded values highlight differences between treatments.

	N	Ca	Cu	Fe	K	Mg	Mn	P	Zn	B
Compost	2.74	0.60	12.16	81.75	1.32	0.24	27.28	0.32	145.62	33.61
No Compost	2.42	0.49	13.24	90.39	1.28	0.19	24.38	0.31	222.55	49.84

Table 7. Effect of compost on leaf nutrient analysis of Cox fruit in 2010. Shaded values highlight differences between treatments.

Soil analysis

Samples of soil were taken from the uppermost 15cm in both the control and the compost treatments. For the compost treatment, the compost mulch was removed by hand prior to taking the samples from the soil beneath the compost. Two analyses were conducted. Table 8 shows data from samples collected in 2010 and Table 9 shows data from samples collected in 2007, both analysed using an ammonium nitrate extraction.

Treatment	pH	P	K	Mg
No Compost	5.7	41	215	122
Compost	5.9	46	207	123

Table 8. Effect of compost application on soil nutrient content (2010 data) obtained using an ammonium nitrate extraction method.

Treatment	pH	P	K	Mg
No Compost	6.5	66	232	205
Compost	7.3	116	516	222

Table 9. Effect of compost application on soil nutrient content (2007 data) obtained using an ammonium nitrate extraction method.

Table 8 and 9 therefore compare data from 2007 and 2010 to show how the soil nutrient content has altered during this period. Between 2007 and 2010, phosphorus, potassium and magnesium all decreased. The greatest change was in the soil potassium in the compost treatment which decreased from 516 to 207mg/kg. pH also decreased in both treatments.

Table 8 shows the effect of compost on soil nutrient content in 2010. The effect of compost on soil nutrient content was actually quite small. Phosphorous increased but potassium decreased in the compost treatment but these differences were small.

Effect of compost on soil moisture content

In 2009, there were clear differences in soil moisture content between the two treatments and whilst less significant, there were still differences between the two treatments in 2010. The effect of compost on soil moisture for the growing season between July and September 2010 is shown in Figures 16 and 17. These data were collected using probes set at 10cm intervals from 10cm to 40cm. Comparing data from the compost and no compost treatments, it can be seen that the overall soil moisture contents were very similar. During July the moisture level in both treatments decreased gradually at all depths. Following this there were five main rain events which resulted in increases in soil moisture. These can be seen in Figure 18 which shows rainfall during this period taken from a weather station about 3 miles from the experimental site.

However, there is still evidence that the no compost control trees were showing signs of water deficit. For example, between 14th July and 13th August, there were no rainfall events recorded. Throughout this period, the compost treated trees were able to withdraw water from down to 40cm whereas in the no compost control treatment, this was not the case. Towards the end of the period the rate of decrease in soil moisture content slows, showing that the trees were not able to take up water from this level at this point. Following each rain event, there is clearly more drainage through the soil profile in the no compost control than in the compost treatment. Finally, at 40cm during the period shown here, the overall soil moisture content fell from 33.5mm to 26.9mm in the no compost control whereas it increased in the compost treatment from 41.1mm to 44.7mm.

That there were less significant differences between the two treatments in 2010 than in 2009 is important. In 2009 the compost treatment caused a much greater soil moisture content than the no compost, control treatment and whilst there are differences in 2010, these are not as great as in 2009. During 2010 there was 201mm rain but in 2009 there was only 123mm rain. The difference in the effect of compost on soil moisture content in 2009 and 2010 must therefore be an effect of this difference in rainfall between the two years.

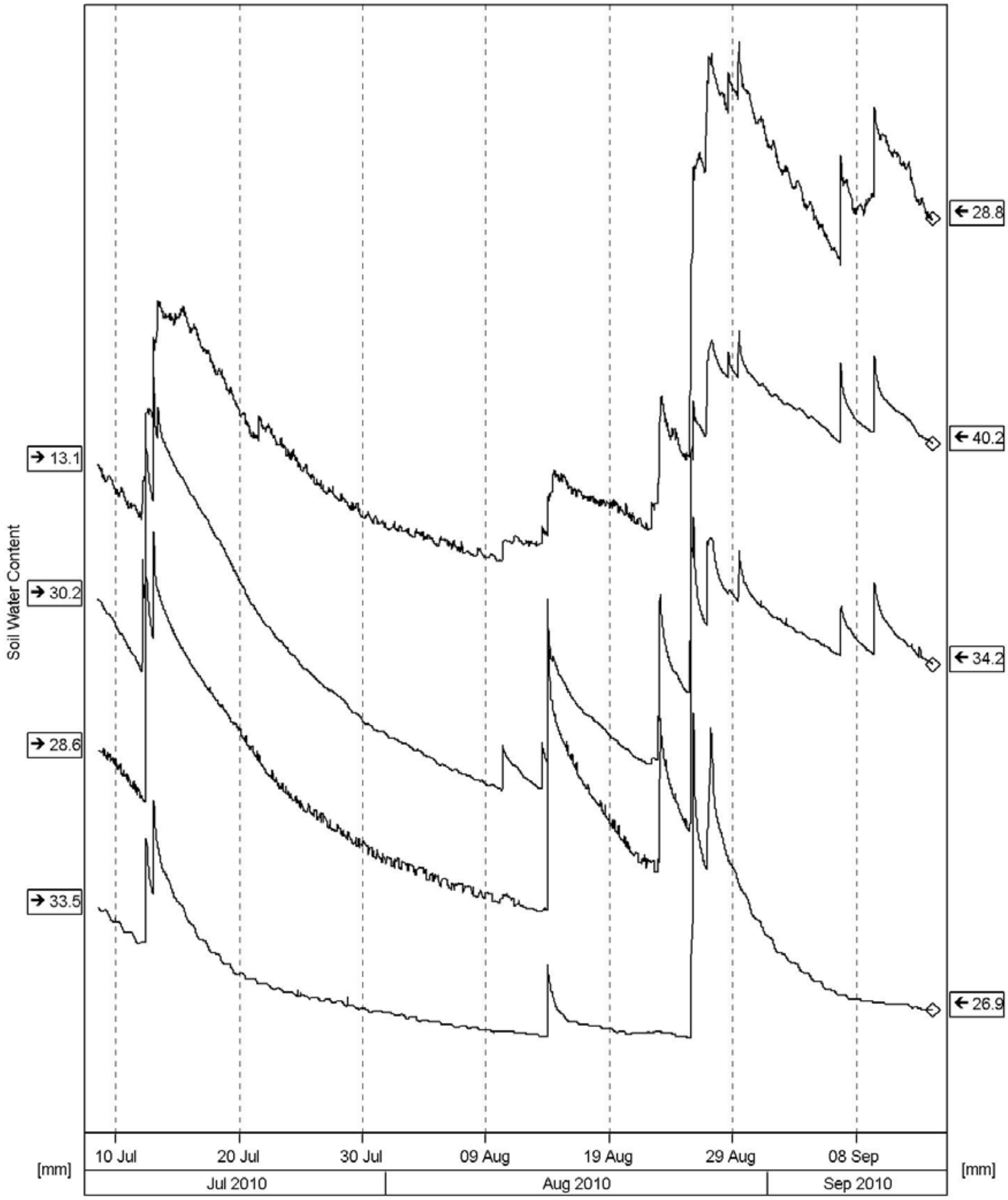

Figure 16. Soil water content as recorded at 10, 20, 30 and 40cm in the control, untreated trees. Data was recorded using an Enviroscan Soil water logger.

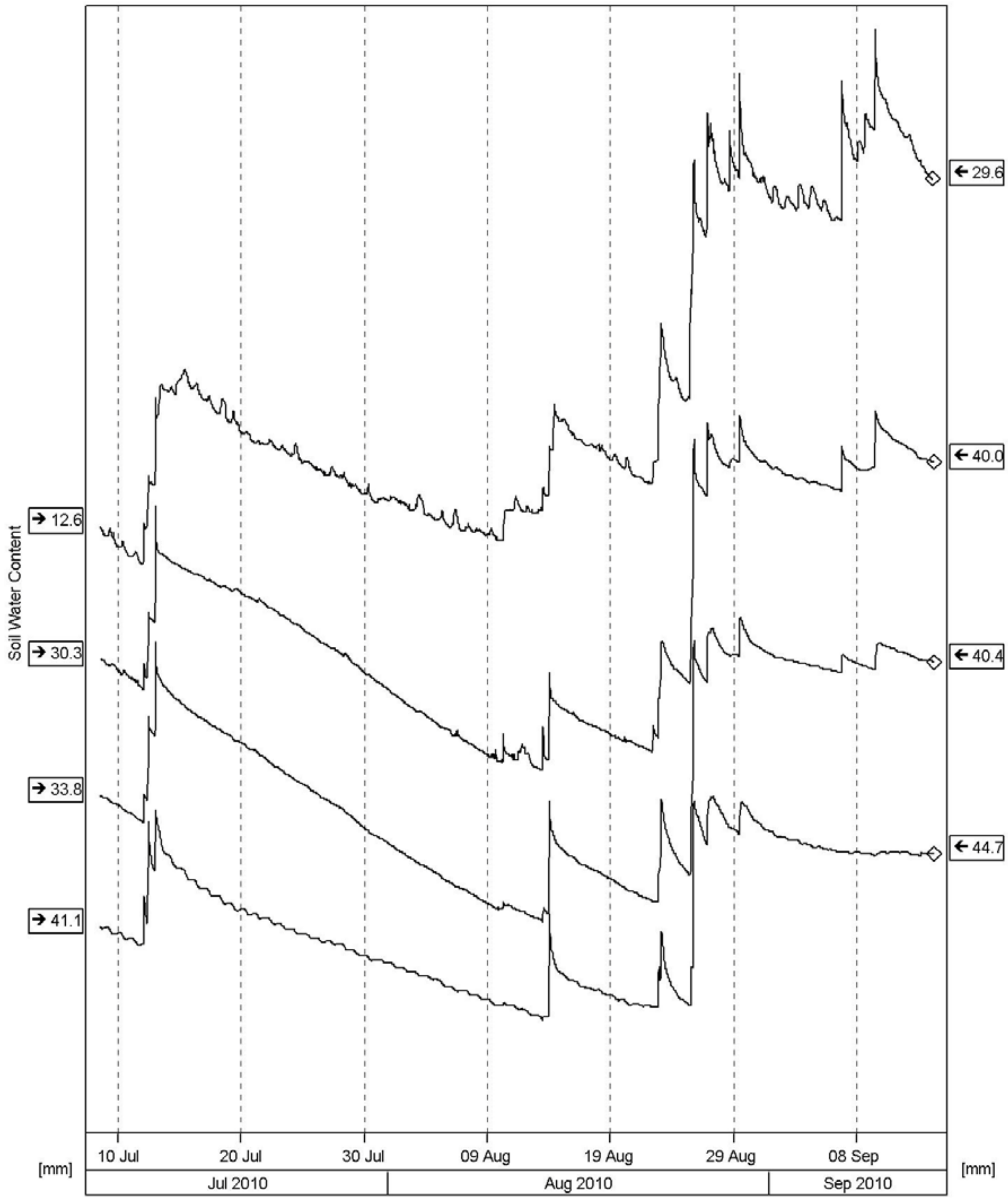

Figure 17. Soil water content as recorded at 10, 20, 30 and 40cm in the compost, treated trees. Data was recorded using an Enviroscan Soil water logger.

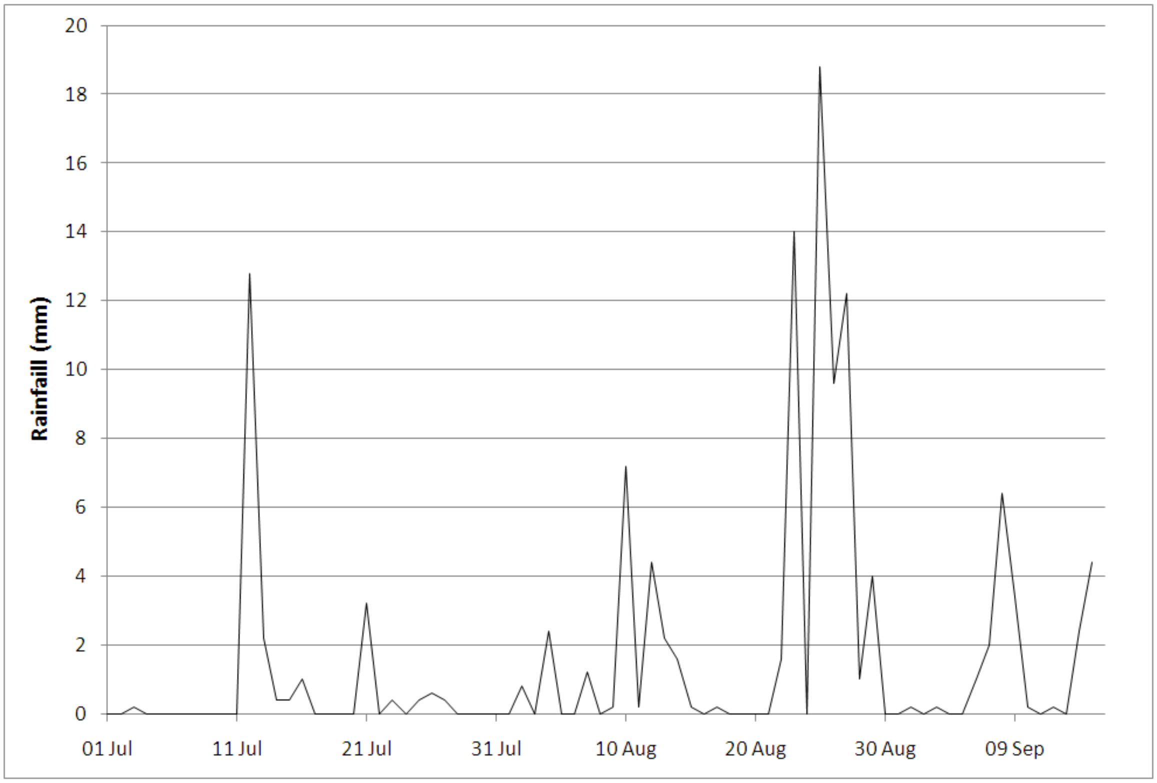

Figure 18. Rainfall during from 1st May to 31st August 2010. Data is taken from a weather station 3 miles from the trial site.

Discussion

In both treatments, soil pH and nutrient content decreased between 2007 and 2010, which is to be expected with the trees' uptake of nutrients. What is surprising is that even though the application of compost had a much less significant effect on soil nutrient than expected, significant differences between the treatments were still seen in fruit and leaf nutrient content. For example, fruit and leaf nitrogen was increased by the compost treatment whereas phosphate content decreased. This would be likely to significantly alter the potential storability of fruit. The implication of this is that compost treated fields need to be treated separately from fields which have not received compost and analysis is necessary to confirm storage potential. Also the application of fertilizers and in particular foliar feeds need to be made bearing this in mind, as differences in fruit nutrient content could be compounded through inappropriate applications. Nutrient availability is also being altered by the compost through changes to soil organic matter content and structure and possibly through increased biological activity.

The effect of compost on soil moisture content was recorded by Enviroscan probes. In 2009, the compost treatment caused significantly greater soil moisture content than the control treatment and it seems likely that this caused the increase in growth and fruiting in the compost treatment. However, because rainfall was greater in 2010, differences between treatments in soil moisture content were less obvious. Similar levels in soil moisture were seen in both treatments and only at certain points were differences apparent. That there were still similar differences in growth and fruiting in 2010 as in 2009 must be due to the tree size being greater in the compost treatment. Growth and yield potential would have been greater and the fact that rainfall was greater than in 2009 simply meant that water was not as great a limiting factor for growth.

The increase in yield arose due to the increase in shoot growth. Increased shoot lengths allowed a greater number of fruiting sites to develop, thereby increasing fruit number. The increase in yield was a factor of both increased fruit numbers and increased fruit size in both varieties. That the fruit size was greater even though fruit number was higher may mean that fruit number can be increased intentionally in compost treated orchards. As fruit size is increased with the use of compost, more fruit could left on the tree at thinning without any detrimental effect on fruit size being seen. This means compost treated fields need thinning differently to fields which have no compost.

The effect of compost was again significant. Compost does offer potential to improve growth and yield of apple trees. However, what is important here is that even seven years after the initial compost application, key effects are still being seen. Possibly through improved moisture availability as seen in 2009 but less in 2010 and altered nutrient content, compost causes significant increases in shoot growth. The potential of this is shown in the fact that in addition to fruit number per tree being increased by compost, fruit size also increased resulting in improved yields. However, the effect on fruit nutrient content was significant and did reduce potential storability. In orchards where growth is poor and is restricting yields though, the benefits of the use of compost mulch far outweigh any reduction in the storability of fruit as the use of compost would result in significant improvements in tree establishment and cropping over a long period. As the project continues we will be further examining the effect of compost on growth, yield, and fruit development and quality.

Conclusions

- The use of compost as mulch can increase fruit number per tree and in 2010 increases in fruit size were seen in both varieties tested.
- Careful management of soil nutrient balance is needed. Applications of foliar feeds in particular need to be made in response to leaf and fruit analysis as significant effects on fruit and leaf nutrient content were seen.
- Growth was significantly increased through the use of compost and this requires careful tree management to maintain fruiting/growth balance.
- The differences described here show the potential of the effects of compost on apple growth and fruiting but this does mean that compost treated fields do need to be treated differently to those not treated with compost. This will affect all management practices from pruning to fruit management and fertilizer applications.

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