Project title:	Blackcurrants: Evaluation of mulching with PAS 100 compost in establishing plantations
Project number:	SF 012 GSK227
Project leader:	John Atwood, ADAS
Report:	Final report, November 2012
Previous report:	None
Key staff:	John Atwood Harriet Roberts Chris Dyer
Location of project:	Coggeshall Hall Farm, Kelvedon
Industry Representative:	Rob Saunders, Cherry Tree House, Dorothy Avenue, Cranbrook, Kent, TN17 3AL
Date project commenced:	1 March 2012
Date project completed (or expected completion date):	1 November 2012

DISCLAIMER

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with 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.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

John Atwood
Principal Horticultural Consultant
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Signature John Atwood Date 1 November 2012

Harriet Roberts
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Report authorised by:

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CONTENTS

GROWER SUMMARY

Headline

- Application of PAS 100 green waste as a mulch to one year old blackcurrants did not improve growth in the unusually wet conditions experienced in 2012.

Background and expected deliverables

Considerable benefits have been recorded in young apple orchards following the application of PAS 100 grade compost. These included; improved extension growth, blossoming, leaf quality and increased cropping both in number of fruit and fruit size. Experimental data suggests that improved growth is linked to elevated soil moisture content under compost applied areas of commercial orchards as well as some addition in nutrients. Compost mulching has not been tested in established blackcurrant plantations due to concern about possible contamination of fruit by the compost in the machine harvested crop. There is however the potential to utilise compost mulches safely and effectively in the early pre-cropping stages of plantation establishment where initial growth needs to be promoted and many growers fail to achieve an optimum establishment.

This project aimed to evaluate the benefit of using PAS 100 compost as a mulch during blackcurrant crop establishment. The specific objectives were to:

i) assess the effect of mulching on second season growth;
ii) evaluate the effect of mulching on soil water, organic matter and soil and crop leaf nutrient levels;
iii) quantify differences in weed control achieved within mulched and un-mulched rows.

Summary of the project and main conclusions

PAS 100 green waste compost was applied as mulch to rows of one year old blackcurrants cv. Ben Dorain on 13 April 2012. The mulch was applied as a 7.5 cm thick layer extending 0.2 m either side of the blackcurrant row (Figure 1). This was compared with un-mulched rows for soil moisture, soil mineral nitrogen and nutrient analysis, weed control, blackcurrant growth and leaf nutrient content. Soil samples for nutrient analysis and soil mineral nitrogen (SMN) were taken prior to mulching and at the end of the growing season. Soil moisture was recorded throughout the season by Enviroscan^{TM} supplied by Soil Moisture Sense Ltd. Weed control and leaf nutrient analysis was assessed in July. Blackcurrant growth along with the end of season soil sampling was carried out in October.

Figure 1. PAS 100 green waste mulched rows with Enviroscans^{TM} – 13 April 2012 Coggeshall Hall Farm, Essex

There were no differences in the growth or nutrient status of the blackcurrants in the 2012 trial (Table 1), which can largely be attributed to high level of precipitation during the experiment. In effect there was no sustained period of water stress conditions during the establishment phase for this blackcurrant crop. The moisture retaining properties of the mulch treatments were therefore not properly tested within this single year experiment. The mulch also made no detectable difference to weed control. It is possible that the mulch was too shallow to provide a barrier to germination of the seed bank beneath. The application rates however were limited by the nitrate vulnerable zone (NVZ) regulations on how much green waste can be applied in a season. A thicker layer may confer some weed suppression, but the green compost did not stop wind blown seeds germinating on its surface.

Table 1. Blackcurrant height assessment 8 October 2012 – Coggeshall Hall Farm

Treatment	Plant height (cm)	Average of % weed cover
Untreated	81.27	1.11
Mulched	77.38	1.71
P value	ns	ns
LSD (3df)	6.790	1.591

A routine fertigation programme increased soil nutrient indices from one in April to two in the untreated rows by October but there was also a useful increase in levels of P, Mg and particularly K as well as maintenance of soil organic matter from the mulch in the surface soil (top 15 cm) of the treated rows. The green mulch was analysed prior to application and did show that the mulch was particularly rich in potassium. The overall N status of the soil was not affected (Table 2). This however is likely to be a longer term benefit of the mulch once it has been broken down by soil biota and incorporated into the soil.

Table 2. Soil analysis sampled over whole trial area at the start (13 April 2012) and taken from treated and untreated rows at the end of season (8 October 2012) – Coggeshall Hall Farm. Figures in brackets indicate soil nutrient index.

	13 April	**8 October**	
	Start of trial	**Untreated**	**Mulched**
pH	7.5	6.1	7.0
P mg/l (index)	14.9 (1)	16.8 (2)	21.6 (2)
K mg/l (index)	107.5 (1)	122.0 (2)	302.0 (3)
Mg mg/l (index)	44.0 (1)	62.0 (2)	87.0 (2)
% OM	1.6	1.0	1.9

Soil moisture profiles generated by the Enviroscans™ provide a comparison between the treatments but did not reveal consistent differences between the mulched and untreated plots. This is in part because of the amount of precipitation but also the low temperatures and light levels in 2012 which have probably limited any effect of the mulches on water uptake or surface evaporation. Mulches can have a significant effect on reducing moisture lost through evaporation, particularly in soils prone to shrinkage and cracking.

Comparing the soil moistures directly is difficult as the soil is of variable density and make up, so every installation will produce slightly different values irrespective of the mulching treatment, due to the presence of stones and air pockets. It is therefore important to look for relative changes between the treatments (i.e. rate of drying rather than the specific values). Figure 2 shows the changes in soil moisture over the growing season down to a soil profile depth of 50 cm. Here the wetting and drying profiles match quite closely over the season. Figure 3 shows the profile in the top 10 cm during May. At this shallower level, the green lines representing the mulched rows (particularly mulched 1 plot 7) show a slower rate of drying in the second and drier half of May, suggesting that the mulch is allowing less

evaporation from the soil surface and retaining more water, which will be beneficial to the young blackcurrants in a drier year.
Apart from the situation at the end of May, the very wet year experienced in 2012 may have masked the potential of using green compost on moisture retention. Comparison in a drier year may yield more conclusive evidence.

As the compost breaks down over time and becomes incorporated into the soil matrix a little more then the green waste is likely to have further beneficial effects on the nutrient status and humus content of the soil. Improved moisture retention properties and increased nutrient availability under selected conditions may well benefit the growth and biomass accumulation of young blackcurrants.

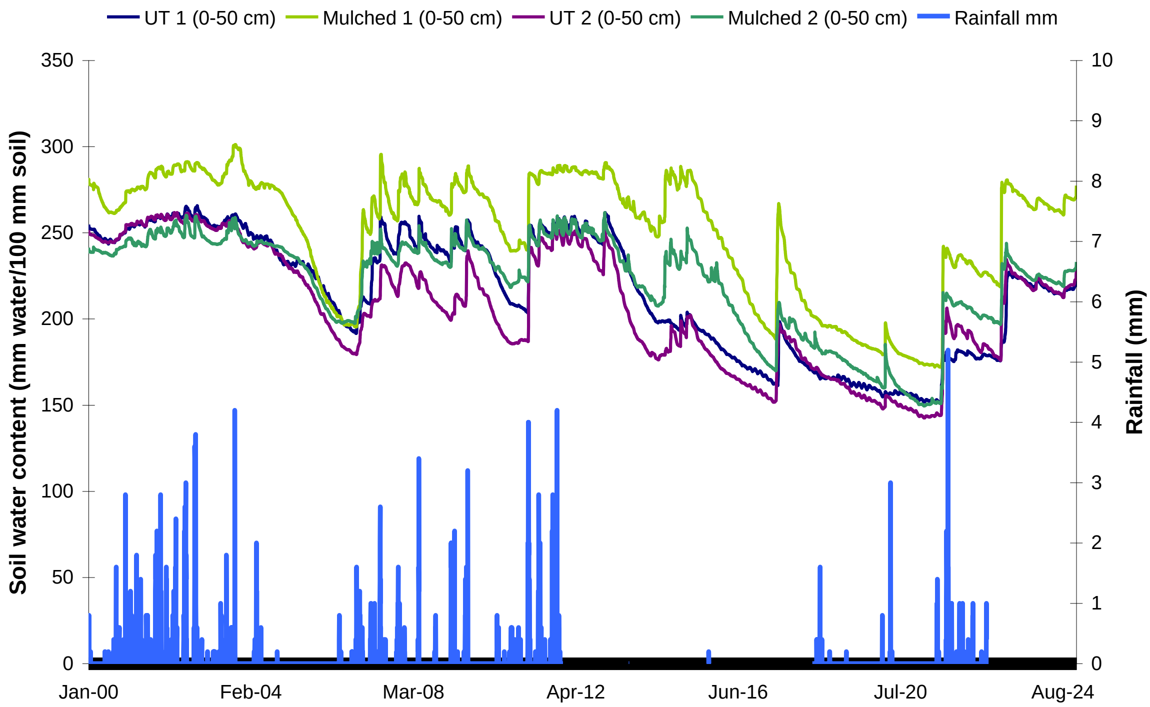


Figure 2. Soil profile water content (0-50 cm) over the season – Coggeshall Hall Farm 2012 (note, rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

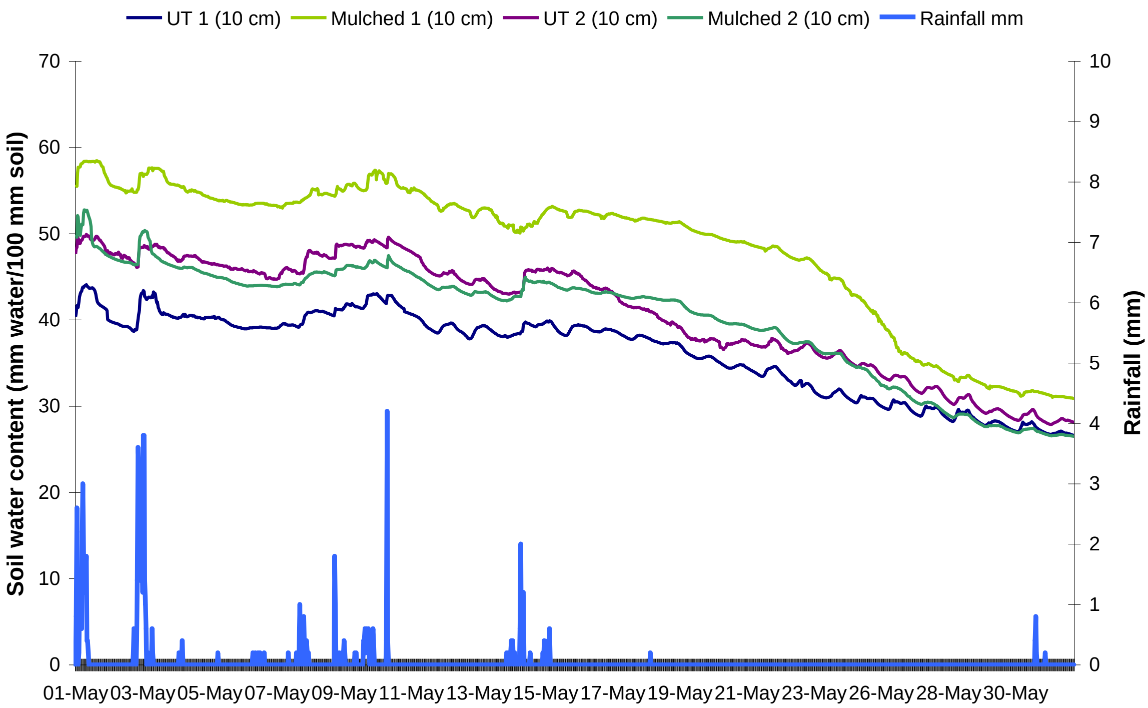


Figure 3. Soil profile water content 0-10 cm during May – Coggeshall Hall Farm 2012 (note, rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

The scheduled work has been completed this season however it would be beneficial to continue the study for further years using the same plots. Further work could include further soil sampling and studies on longer term effects including changes in the soil structure, organic matter and soil fauna, further soil moisture investigations and more detailed analysis of the soil moisture data thorough calculating rates of drying. In addition crop yield response could be quantified in 2013

Financial benefits

To achieve current market requirement for quality, it is more important than ever to replant plantations regularly and reduce average plantation life. For economic viability this process requires efficient establishment and early cropping. Achieving good growth in the early years of establishing a blackcurrant plantation is a key factor to optimise early cropping potential.

Frequently, bush growth in the second and third year after planting, fails to match up to grower expectations thus delaying the first full harvest by one year or more with serious consequences for cash flow. If mulching proves to be an effective means of improving early growth without practical drawbacks, the benefit to the industry could be considerable, potentially advancing the first full crop.

Action points for growers

As the mulching failed to improve growth there are no action points resulting from the trial at this stage. It is proposed to monitor the mulched blackcurrant rows through another season to see if there are any longer term beneficial effects on soil moisture retention under mulched areas.

SCIENCE SECTION

Introduction

Considerable benefits have been recorded in young apple orchards following the application of PAS 100 grade compost (Lock *et al.* 2008). Benefits noted include improved extension growth, blossoming, leaf quality and fruit size and increased numbers of fruit. Measurements have indicated that much of the improvements could be due to improved soil moisture levels.

Compost mulching has not been tested in established blackcurrant plantations due to concern about possible contamination of the machine harvested crop. There is however, potential to utilise compost mulches safely and effectively in the early pre-cropping stages of plantation establishment where there is a need for initial growth to be maximised. Using current approaches many growers fail to achieve a satisfactory growing result during early crop establishment. This project aimed to critically assess whether similar benefits from mulching could be achieved in newly established blackcurrant plantations by collecting and analysing data on bush growth and leaf nutrition and monitoring soil moisture and nutrients in treated and untreated plots.

To achieve current market requirement for quality it is more important than ever to replant plantations regularly and reduce average plantation life. For economic viability this process requires efficient establishment and early cropping. Achieving good growth in the early years of establishing a blackcurrant plantation is an essential factor in maximising early cropping potential. Frequently, bush growth in the second and third year after planting fails to match up to expectations, delaying the first full harvest by one year or more with serious consequences for cash flow. If mulching proves to be an effective means of improving early growth without practical drawbacks the benefit to the industry could be considerable, potentially bringing forward the first full crop.

The specific objectives were:

- To assess the effect of mulching with green waste compost on second season growth in a newly established blackcurrant plantation;
- To evaluate the effect of mulching on soil water, organic matter and soil and plant leaf nutrient levels in a newly established blackcurrant plantation;
- To quantify differences in weed control achieved within mulched and un-mulched rows..

Materials and methods

A one year old plantation of cv. Ben Dorain, in a clay loam soil with uniform first year growth, was selected for the experiment at Coggeshall Farm, Essex. There were two treatments:

- PAS 100 compost mulch applied as a 0.4 m band (0.2 m either side of row) to a depth of approximately 7.5 cm;
- An un-mulched control.

The experiment was replicated four times with treatment plots consisting of single rows of 150 m. Soil moisture sense Ltd. was contracted to install Enviroscan™ soil moisture monitoring probes in two untreated rows and two green waste compost treated rows at four depth profiles down to 0.5 m, monitoring from mid April to mid September. Green mulch was applied on 13 April 2012 by hand (Figure 4).

Figure 4. Hand application of PAS 100 green compost – Coggeshall Hall Farm 2012

At the start of the experiment soil samples were taken from the area of the field where the trial plots were to be located, these were analysed for pH, % organic matter and nutrient analysis, further samples were taken for soil mineral nitrogen (SMN) to depths of 0-30 cm and 30-60 cm. A representative sample was also taken of the green waste compost for analysis. All analyses were carried out by NRM Ltd.

In July, leaf samples were taken from untreated and green compost treated plots taking three combined samples of 200 g of leaf tissue (leaf blade excluding petiole) from all plots in each treatment. A weed assessment was made for all plots recording weed percentage cover and noting species present. An assessment was made of total shoot growth on 25 randomly selected plants within each plot when growth had ceased in October 2012. Further soil samples were taken at this time from untreated and green compost treated plots and analysed for pH, % organic matter nutrient concentration (P, K, Mg) and for soil mineral nitrogen again to depths of 0-30 cm and 30-60 cm.

Results

Over the duration of the trial no visual differences were observed between the blackcurrants in the mulched and untreated rows. An assessment of plant growth was carried out in October (Table 5) measuring the height of 25 plants in each plot, there was a slight spatial variation in the field along each row where height of all the plants across treatments was suppressed most probably due to the gravelly nature of the soil in this part of the field. No significant difference was shown between the plant heights between treatments, however the untreated plots showed on average slightly more growth.

Table 3. Blackcurrant height assessment 8 October 2012 – Coggeshall Hall Farm

Treatment	**Plant height (cm)**
Untreated	81.27
Mulched	77.38
P value	ns (0.166)
LSD (3df)	6.790

SMN was analysed prior to the start of the trial and at the end of the growing season. No clear differences have emerged in terms of soil nitrogen as a result of the green compost application except there appears to be slightly less N (of all types) at the 30-60cm level compared to the untreated rows (Table 4).

Table 4. Soil mineral nitrogen (SMN) sampled over whole trial area at the start (13 April 2012) and end of season SMN sample taken from treated and un-treated rows (8 October 2012) – Coggeshall Hall Farm

	Dry matter %w/w		**Nitrate nitrogen mg/kg**		**Ammonium nitrogen mg/kg**		**Available nitrogen mg/kg**	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Start of trial	88.08	86.58	4.48	1.66	1.29	0.99	23.10	10.60
Untreated	87.10	86.30	1.64	1.52	0.97	0.86	10.40	9.50
Mulched	86.00	85.20	1.72	1.05	0.92	0.63	10.60	6.70

Soil analysis of pH, P, K, Mg and % organic matter in the top 15 cm of soil was carried out prior to the start of the trial and at the end of the growing season in October (Table 5). Initially the soil was low (index 1) in phosphorous, potassium and magnesium. Following the routine fertigation programme the indices improved to index 2 in the control rows but in the mulched rows all three nutrient levels increased substantially, particularly for potassium where the index was raised to 3. Analysis showed that the mulch was particularly rich in potassium (Appendix 4). Percent organic matter in the soil prior to the start of the trial was generally low and ranged between 1.4 % and 1.9 %, this decreased to 1 % in the untreated plots over the season. In the mulched rows soil organic matter was maintained and even potentially increased a little to an average 1.9 %.

Table 5. Soil analysis sampled over whole trial area at the start (13 April 2012) and taken from treated and untreated rows at the end of season (8 October 2012) – Coggeshall Hall Farm. Figures in brackets denote soil nutrient index.

	13 April	**8 October**	
	Start of trial	**Untreated**	**Mulched**
pH	7.5	6.1	7.0
P mg/l (index)	14.9 (1)	16.8 (2)	21.6 (2)
K mg/l (index)	107.5 (1)	122.0 (2)	302.0 (3)
Mg mg/l (index)	44.0 (1)	62.0 (2)	87.0 (2)
% OM	1.6	1.0	1.9

Leaves were sampled in July and no obvious differences were observed in the leaf nutrient status between mulched and untreated plots (Table 6). Weed cover was also assessed in July no differences were observed between mulched and untreated plots with both annual and perennial weeds growing vigorously on and through the green compost (Table 7).

Table 6. Leaf analysis from leaves sampled from mulched and untreated rows 9 July 2012 – Coggeshall Hall Farm

Leaf analysis	**Untreated**	**Mulched**
Total N %w/w	2.92	2.91
Total P mg/kg	3471.33	3300.67
Total K mg/kg	21183.00	22643.00
Total Ca mg/kg	9768.00	8704.33
Total Mg mg/kg	1706.00	1693.00
Total S mg/kg	2786.67	2633.33
Total Mn mg/kg	38.40	42.07
Total Cu mg/kg	5.40	5.73
Total Zn mg/kg	19.93	21.13
Total Fe mg/kg	98.40	161.67
Total B mg/kg	19.90	20.20

Table 7. Assessment of % weed cover per 10 m sub plot and average number of weeds per square metre – Coggeshall Hall Farm 9 July 2012

Treatment	**Average of % weed cover**	**Average of No weeds/m2**
Untreated	1.11	2.36
Green mulched	1.71	2.69
P value	ns (0.440)	ns (0.600)
LSD (3df)	1.591	1.308

Figure 5. Close-up of green mulch at application in April 2012

Figure 6. Green mulch at application in April 2012

Figure 7. Green mulch in August 2012

Figure 8. Close-up of green mulch in August 2012

Figure 9. Close up green mulch in October 2012

Figure 10. Green mulch left hand side, untreated right hand side in October 2012, demonstrating similar levels of weed establishment along the rows

Four Enviroscans™ were installed in the soil profile with 2 in each treatment; each probe had 5 sensors, one reading taken for each depth (10 cm, 20 cm, 30 cm, 40 cm and 50 cm) every 30 minutes. The values recorded closely relate to millimeters of water in 100 mm of soil, whereby a value of 30 mm at 10 cm means that the top 10 cm of soil holds 30 L of water within a square meter. Each 30 minute reading therefore is a snapshot of the moisture content at that specific depth at that particular time.

Figures 11 – 14 compare the soil moistures over different depths through the season for the four Enviroscans™. Note that the soil has highly variable physical attributes and that the specific moisture values of two sensors in close proximity, with the same moisture content can give different readings; therefore it is important not to compare specific figures but rather the trends. To determine whether soil is retaining more moisture as a result of the mulching it is more important to compare the rate of soil drying and therefore water retention than the overall moisture reading.

Figure 11 shows the water content in the top 10 cm of soil along with rainfall on site over the duration of the trial. The top 10 cm is where it is expected that the mulching will have most impact on soil moisture in this first year. Irrigation was applied for 20 minutes, 4 times a day throughout the duration of the trial. Soil moisture wetting and drying in this top 10 cm zone appears overall to be very similar in the mulched and untreated plots however the mulched data appears to extend beyond the blue un treated lines after some rain events in late May and early July.

Figure 12 shows the same data just for May, May was chosen as the second half of the month was relatively dry compared to the rest of the season. Here it is clearer that the surface soil in the mulched plots is taking longer to dry after rain events suggesting that soil moisture is being retained in these mulched plots.

At 20-30 cm (Figures 13 and 14) the trend seems to be the same with mulched soils exhibiting slower drying again particularly around mid May. At 40-50 cm (Figure 15) soil moisture is less well matched with the mulched plots appearing to have more consistent moisture at this level, particularly earlier in the season. This suggests that the mulch was providing moisture retention higher up the profile causing less water to be drawn by roots from this deeper level. Original graphs from Soil Moisture Sense Ltd with irrigation trigger points can be found in Appendix 3 please note the trigger points are specific to each probe and cannot be directly compared.

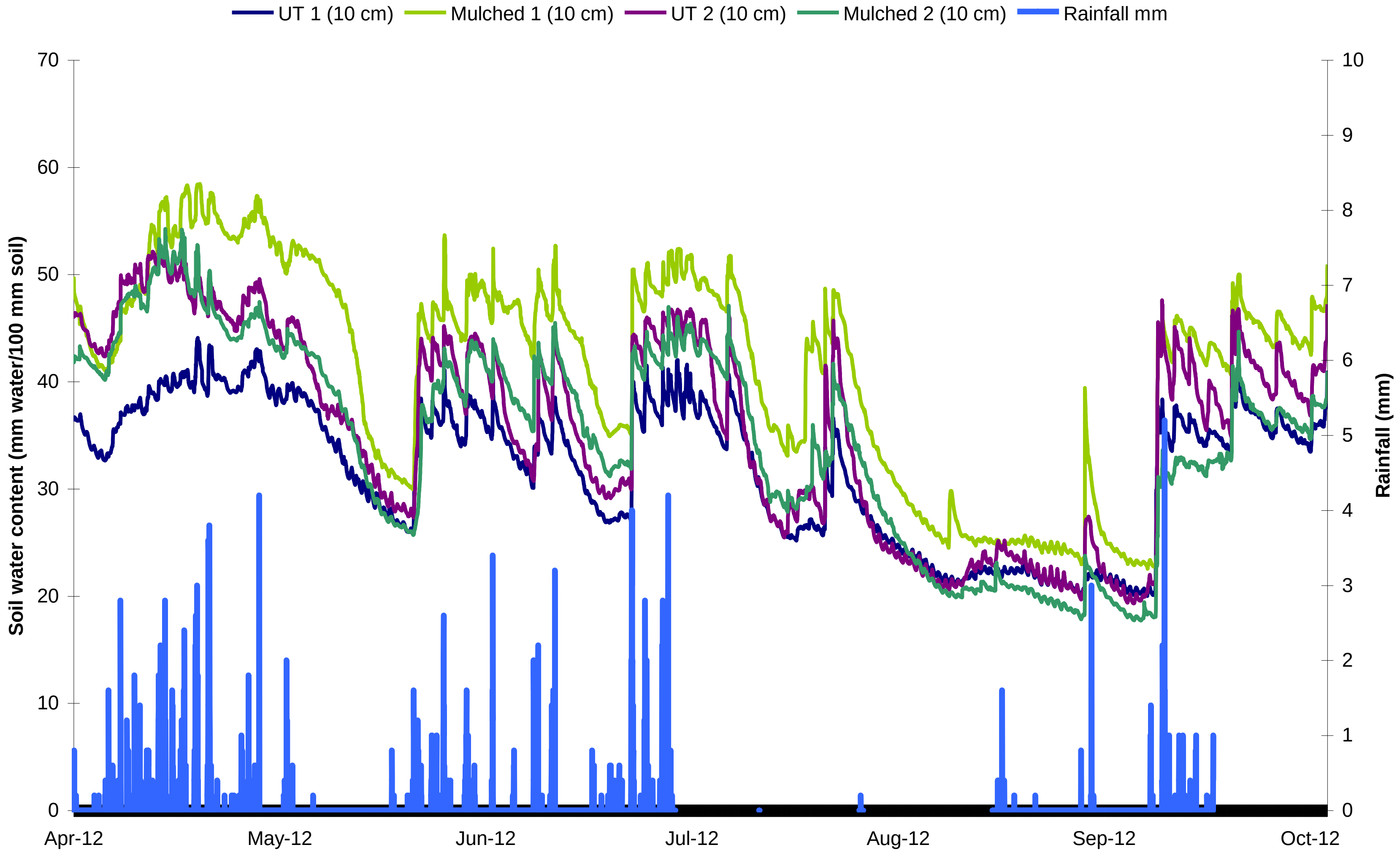


Figure 11. Soil water content 0-10 cm over the season – Coggeshall Hall Farm 2012 (note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

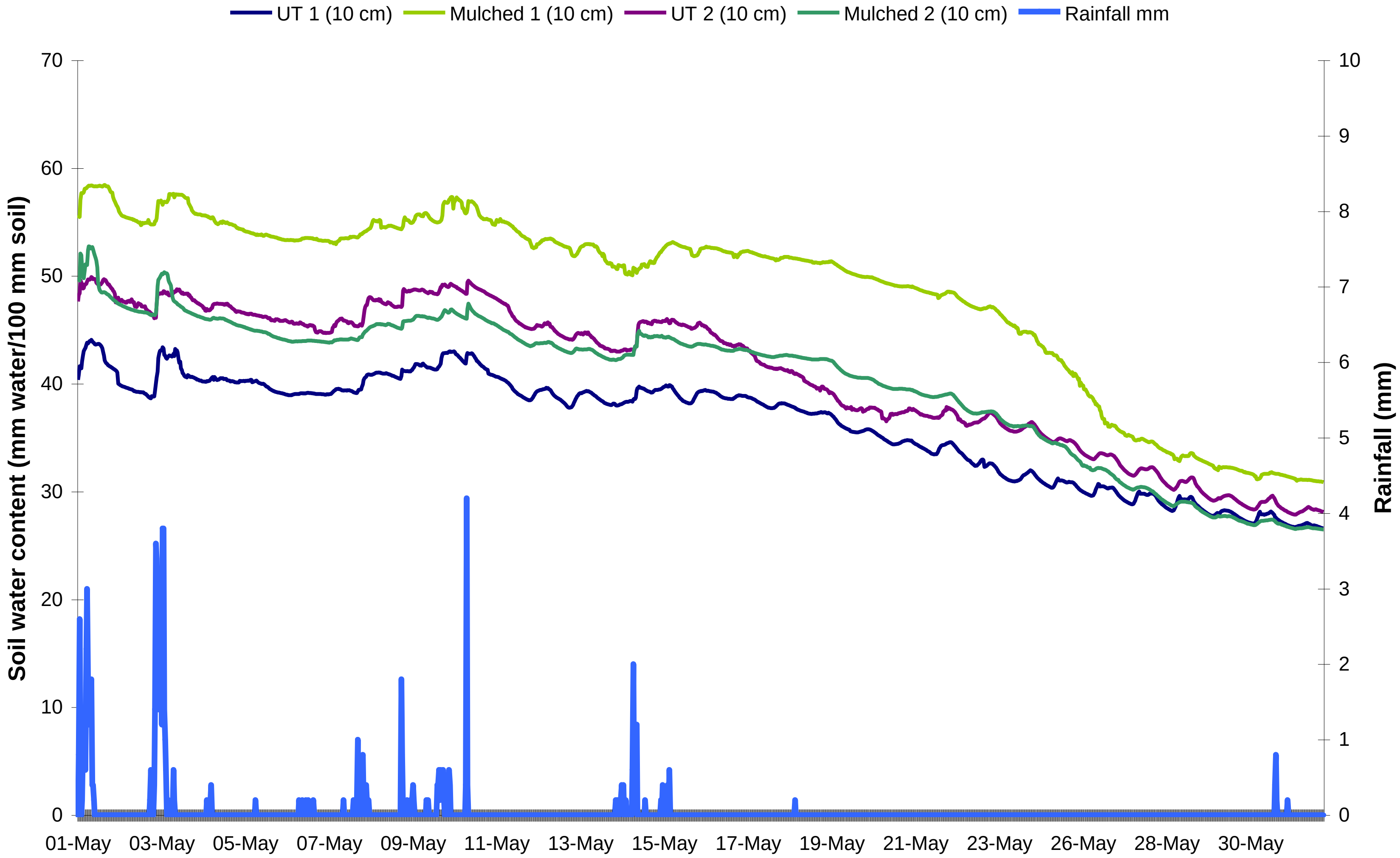


Figure 12. Soil water content 0-10 cm during May – Coggeshall Hall Farm 2012 (note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

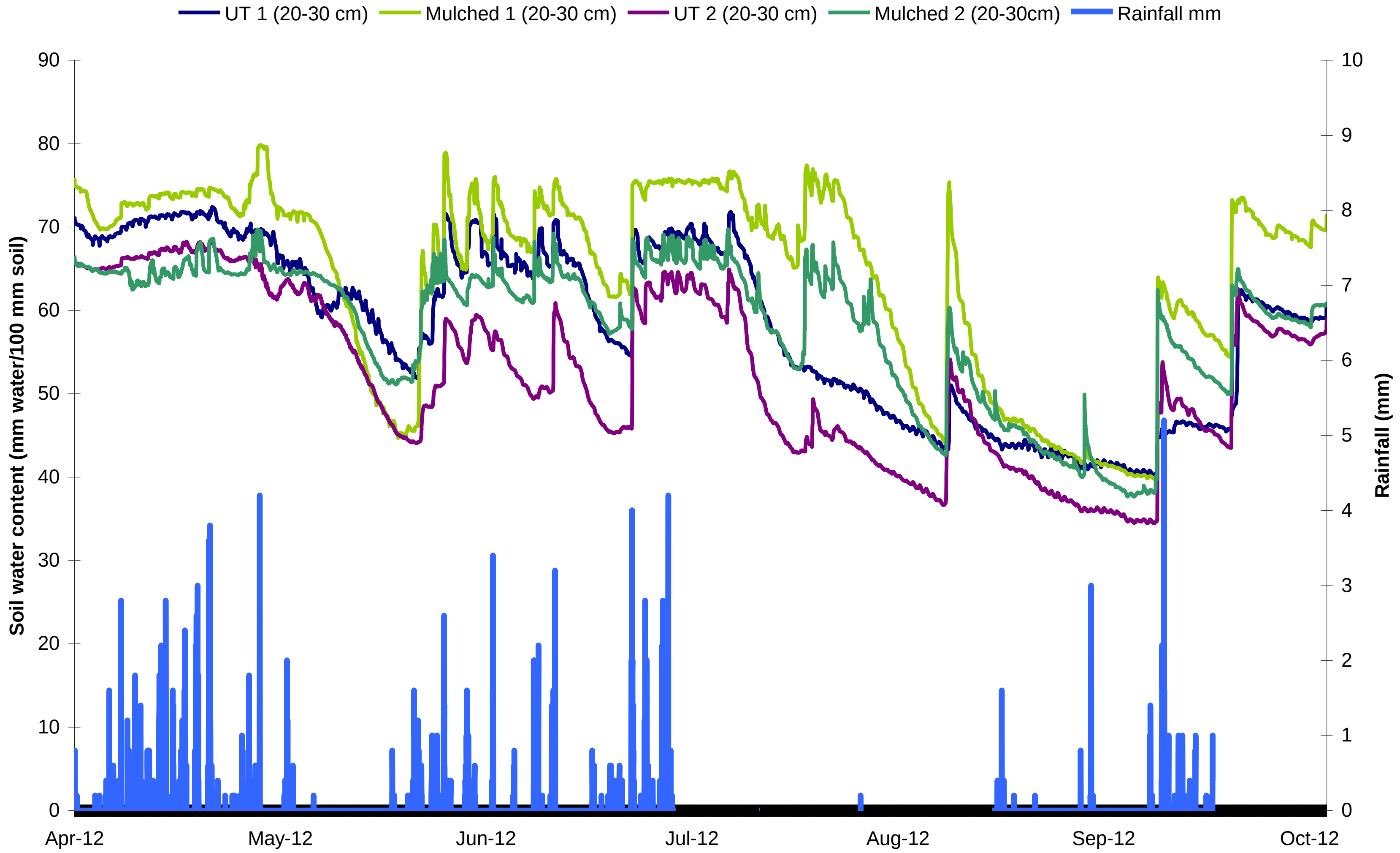


Figure 13. Soil water content 20-30 cm over the season – Coggeshall Hall Farm 2012 (please note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

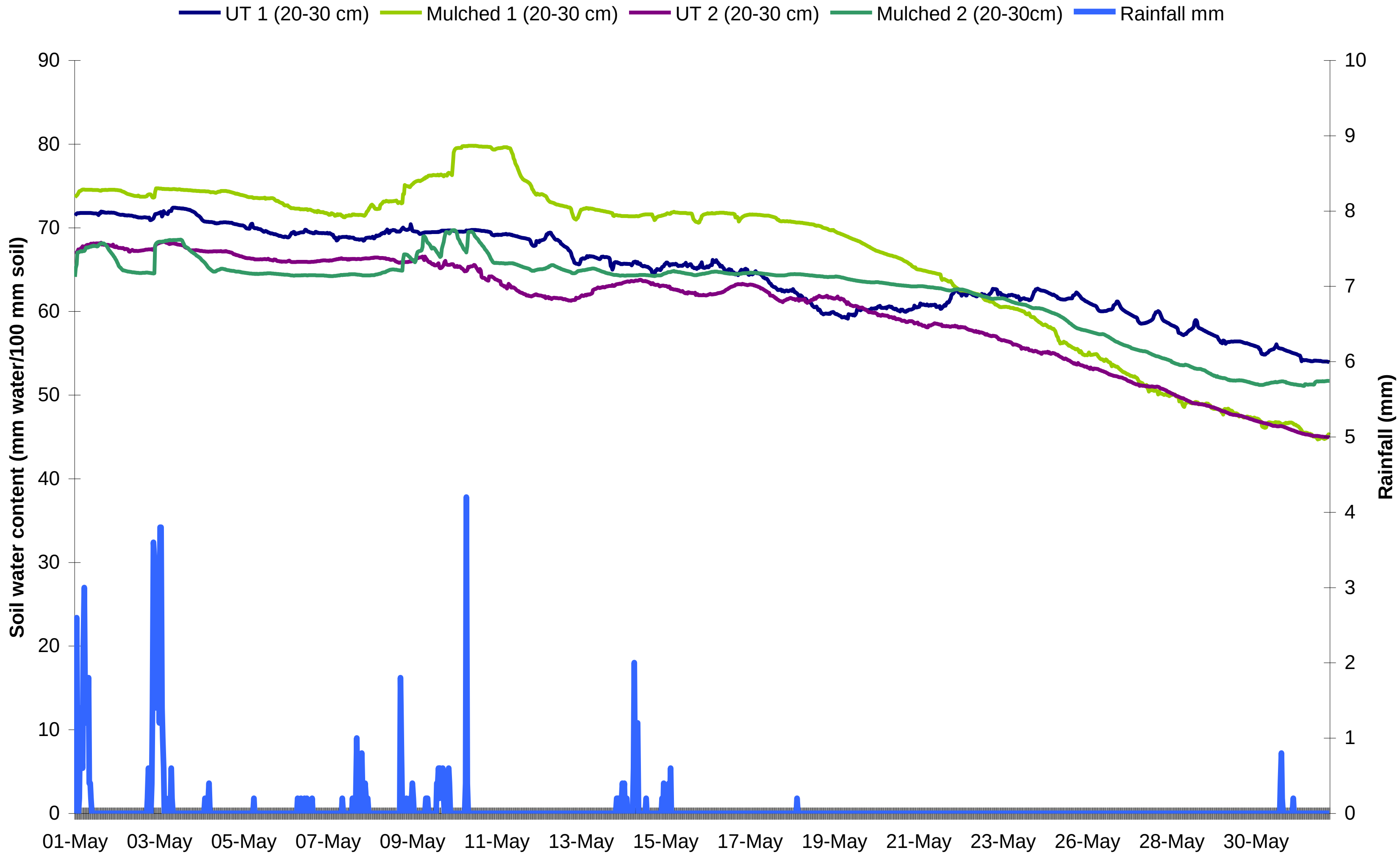


Figure 14. Soil water content 20-30 cm during May – Coggeshall Hall Farm 2012 (please note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

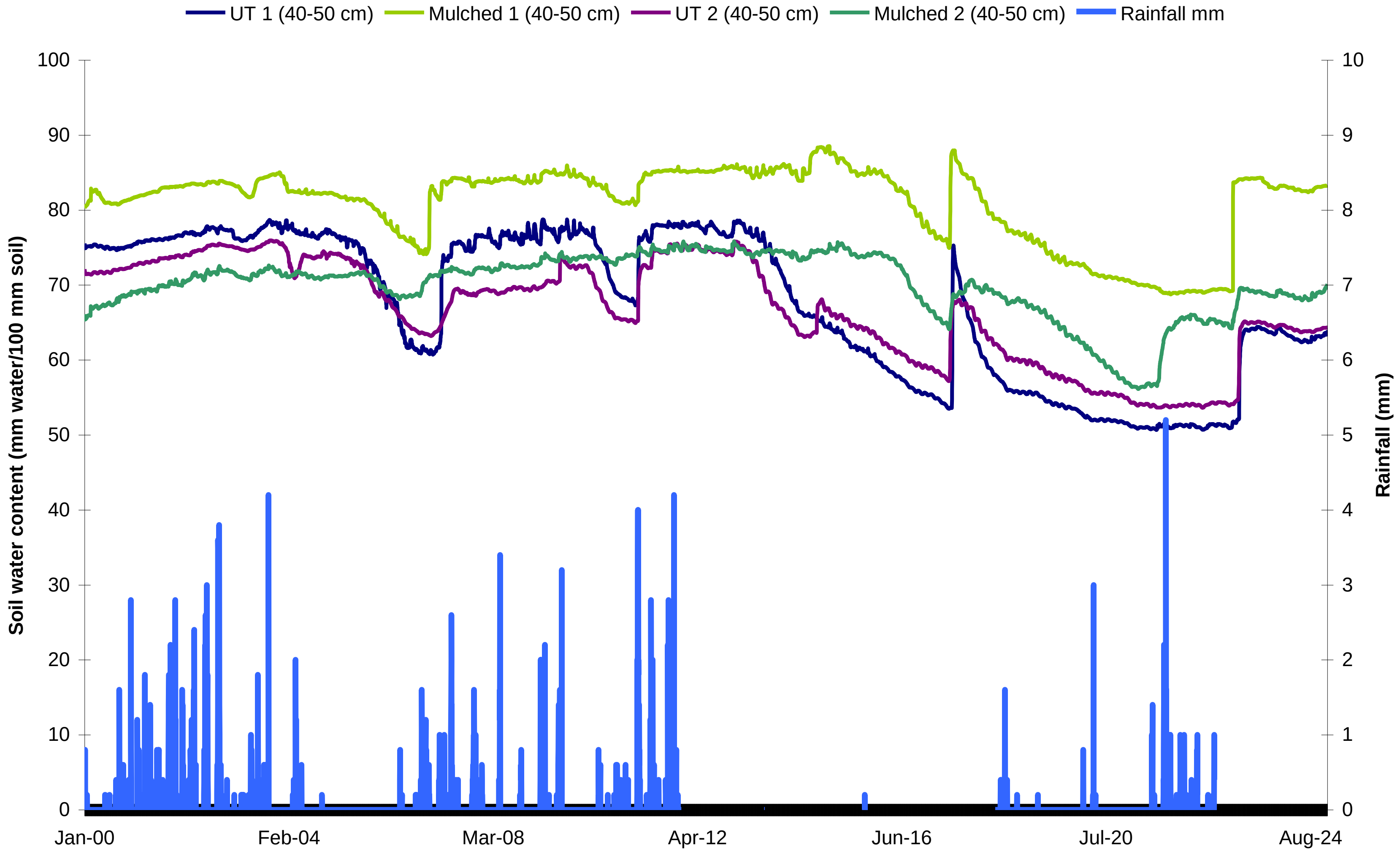


Figure 15. Soil water content 40-50 cm over the season – Coggeshall Hall Farm 2012 (please note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)

Discussion

There were no differences in the growth or nutrient status of the blackcurrants in this year's trial, which can largely be attributed to high precipitation during the experiment. In effect, there was no sustained period of water stress conditions during the establishment phase for the blackcurrant crop for the soil moisture retaining properties of the mulch to be fully tested.

The mulch made no difference to weed control, and so it is possible that the mulch was too shallow to provide a barrier to germination of the seed bank beneath. The application rates however were limited by the nitrate vulnerable zones (NVZ) regulations on how much green waste can be applied in a season. A deeper layer may confer some weed suppression attributes, but observations suggest that the green compost itself will not stop wind blown seeds germinating on its surface.

There was an increase in the concentrations of P, K, Mg and maintenance of soil organic matter from the mulch in the surface soil, but the overall N status of the soil was not affected. There is however likely to be a longer term benefits of mulch application once it has been broken down by soil biota and incorporated into the soil.

The soil moisture sensors provided a comparison of profile water content and suggested that the presence of mulch caused a slower rate of soil drying most probably through reduced evaporation from the soil surface. However due to the amount of rain which fell this season periods of drying were few and far between so this trend was not clearly demonstrated. There are currently limitations in the statistical comparison of soil moisture data due the intrinsic differences in soil physical properties, however ADAS modelers are developing statistical software to compare moisture curves and when available could be used to analyses and compare rates of soil drying.

The scheduled work was completed this season however it would be beneficial to continue the study for further years using the same plots. Other work could include further soil sampling and studies on longer term effects including changes in the soil structure, organic matter and soil fauna. In addition crop yield response could be quantified in 2013

Conclusions

- There were increases in nutrient levels P (28 %), K (147 %) and Mg (40%) from the mulch which was particularly high in potassium.
- Soil organic matter in the top 15 cm of the soil profile was increased to a small extent in mulched plots.
- Soil moisture records appeared to show that mulched plots retained moisture for longer in periods between rain events, most probably by reducing evaporation from the soil surface. However due to the wet season this trend is not distinct.
- Mulching showed no effect on blackcurrant growth, however due to abundant moisture this year the blackcurrants never experienced water stress.
- No effect on weed control was observed between mulched and untreated rows, potentially due to the depth of the mulch applied however this is dictated by NVZ regulations
- No differences were observed in the nutrient status of leaf tissues from mulched and untreated rows

Knowledge and Technology Transfer

None to date

References

Lock, D., Lopez-Real, J., Green, M., Saunders, G. and Wallace, P. (2008). PAS 100 compost applied as a mulch in top fruit. Report for project OAV011-010 Waste Recycling Action Plan (WRAP).

Acknowledgements

Soil Moisture Sense Ltd. and Robert Crayston and staff at Coggeshall Hall.

Appendices

Appendix 1. Trial plan

Block	1	1	2	2	3	3	4	4
Plot	1	2	3 *	4 *	5	6	7 *	8 *
Treatment	1	2	2	1	1	2	2	2

Each plot is one complete blackcurrant row ~150 m with 20cm green waste either side of the crop row.

* Enviroscans™

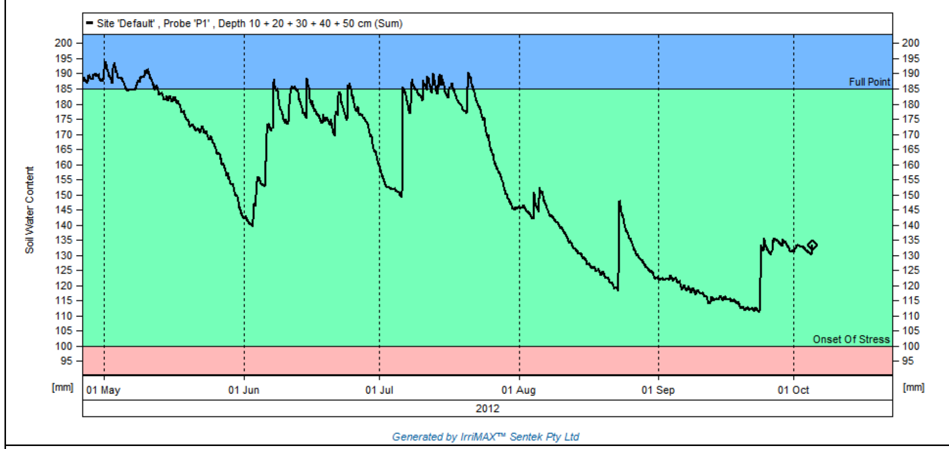
Treatment no.	Treatment
1	Untreated
2	PAS 100 Green waste compost applied as a 20cm band to 7.5cm depth along each side of the row

Appendix 2. Crop husbandry records

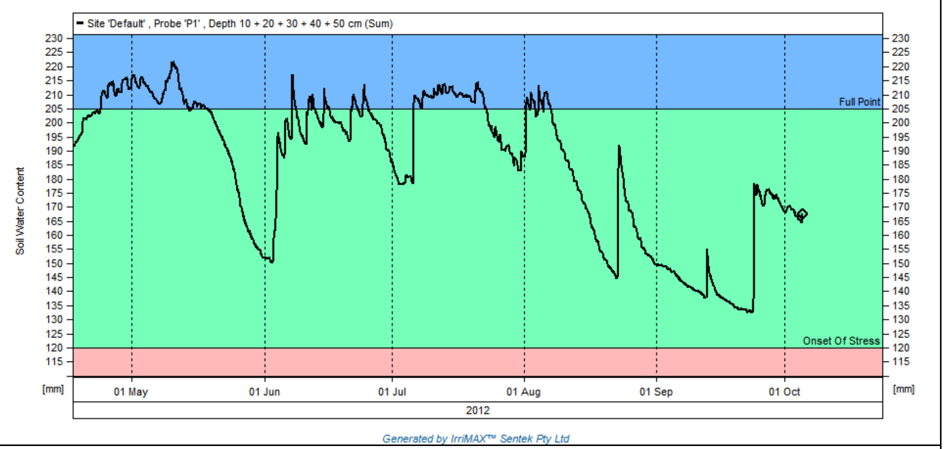
Drip irrigation applied for 20 minutes four times a day throughout the duration of the trial. Fertigation was applied at a rate of 6.25 kg of Kristalon Blue (19-6-20) per ha per week from mid May to end September.

Date	Product	Rate
14/3/12	Stomp Aqua	2.9 L/ha
	Artist	2.5 kg/ha
	Harvest	2.9 L/ha
30/4/12	Scala	2.0 kg/ha
23/5/12	Signum	1.5 kg/ha
23/5/12	Switch	1.0 kg/ha
	Aphox	0.28 kg/ha
2/6/12	Teldor	1.5 kg/ha
	Systhane 20EW	0.3 L/ha
25/6/12	Teldor	1.5 kg/ha
	Systhane 20EW	0.33 L/ha
	Aphox	0.28 kg/ha

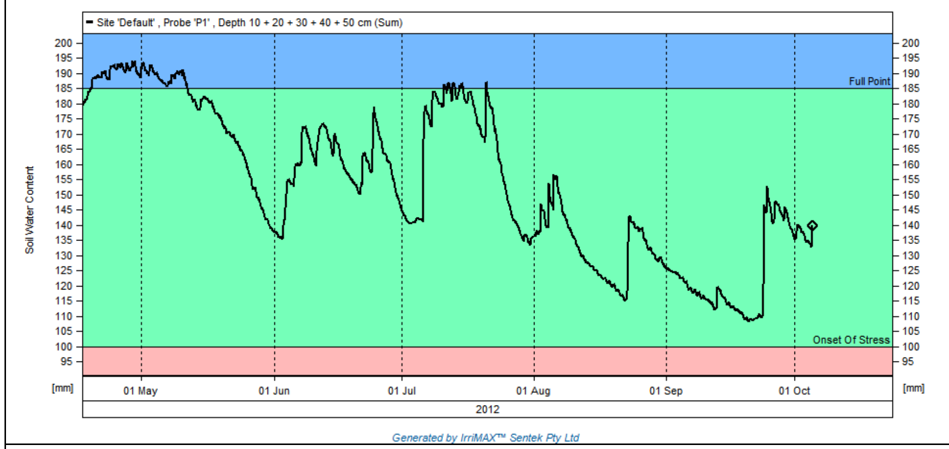
Appendix 3. Enviroscan™ soil water content between April and October with irrigation trigger points (please note the trigger points are specific to each probe and cannot be directly compared)



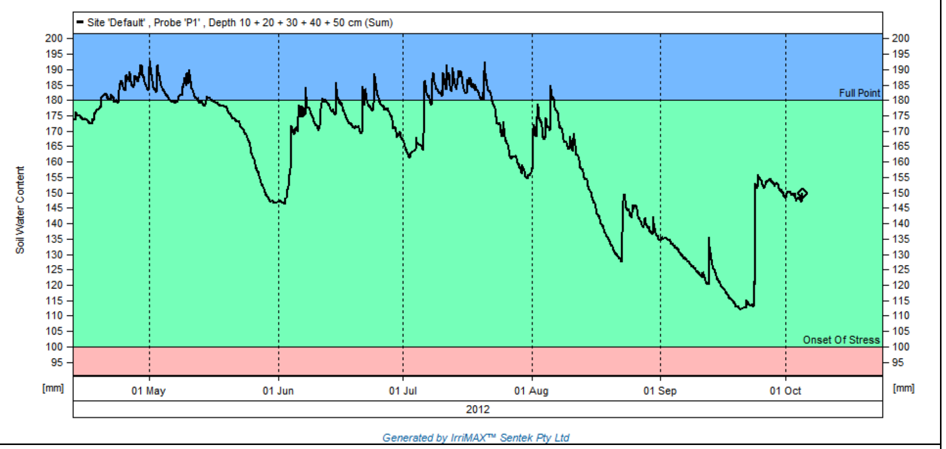
Plot 8 Untreated



Plot 7 mulched

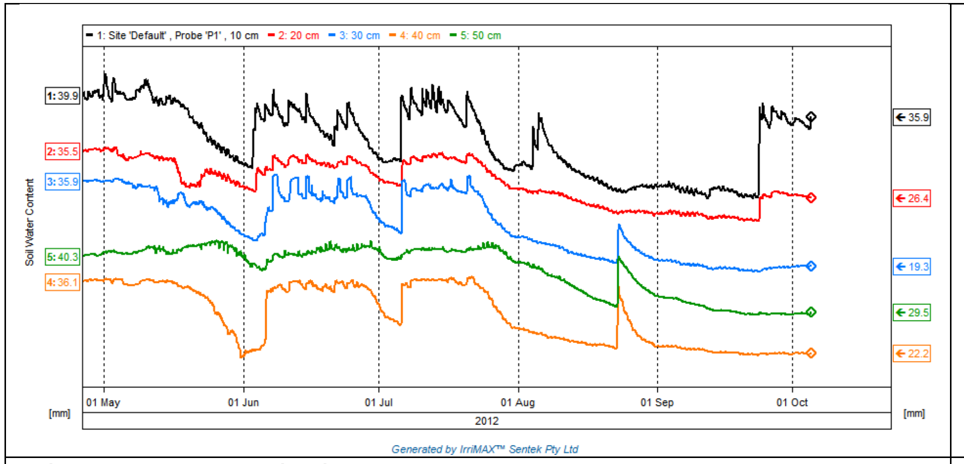


Plot 4 Untreated

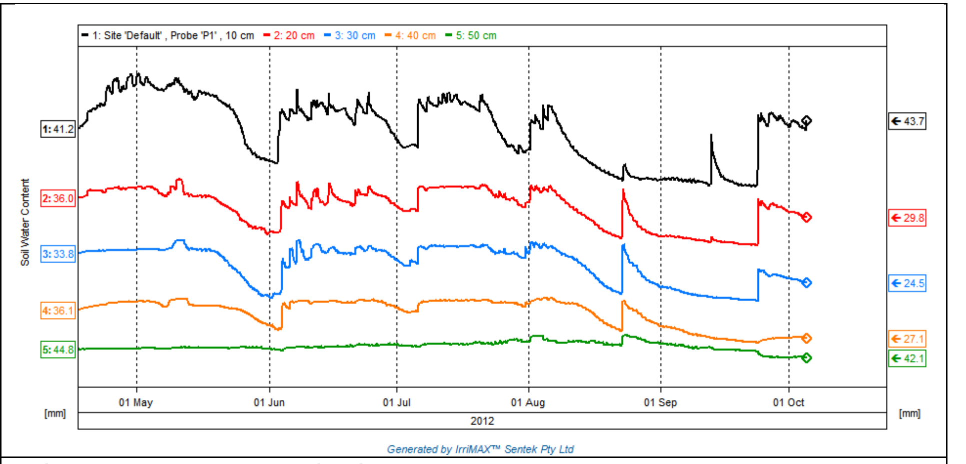


Plot 3 mulched

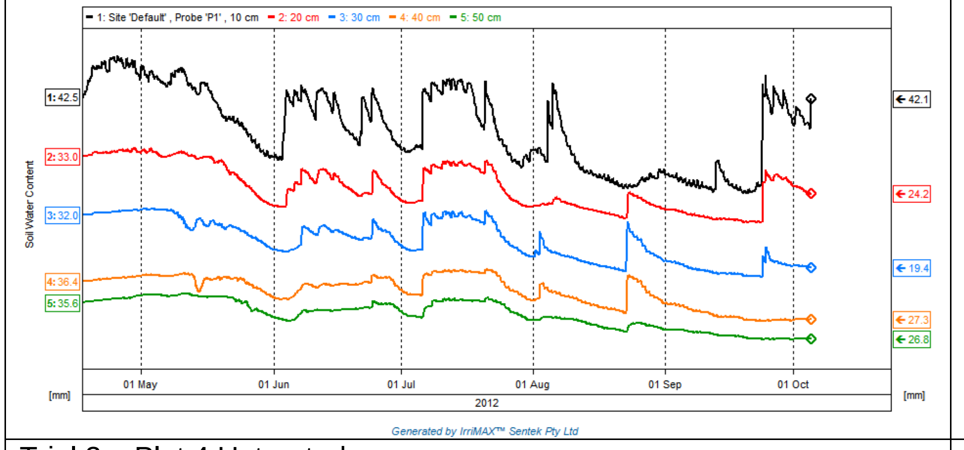
Enviroscan™ soil water content at each soil depth between April and October



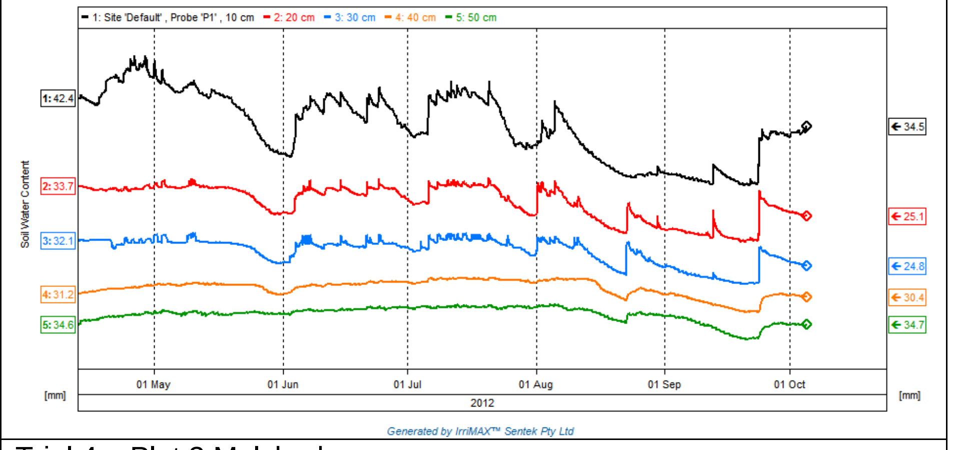
Trial 1 – Plot 8 mulched



Trial 2 – Plot 7 un mulched

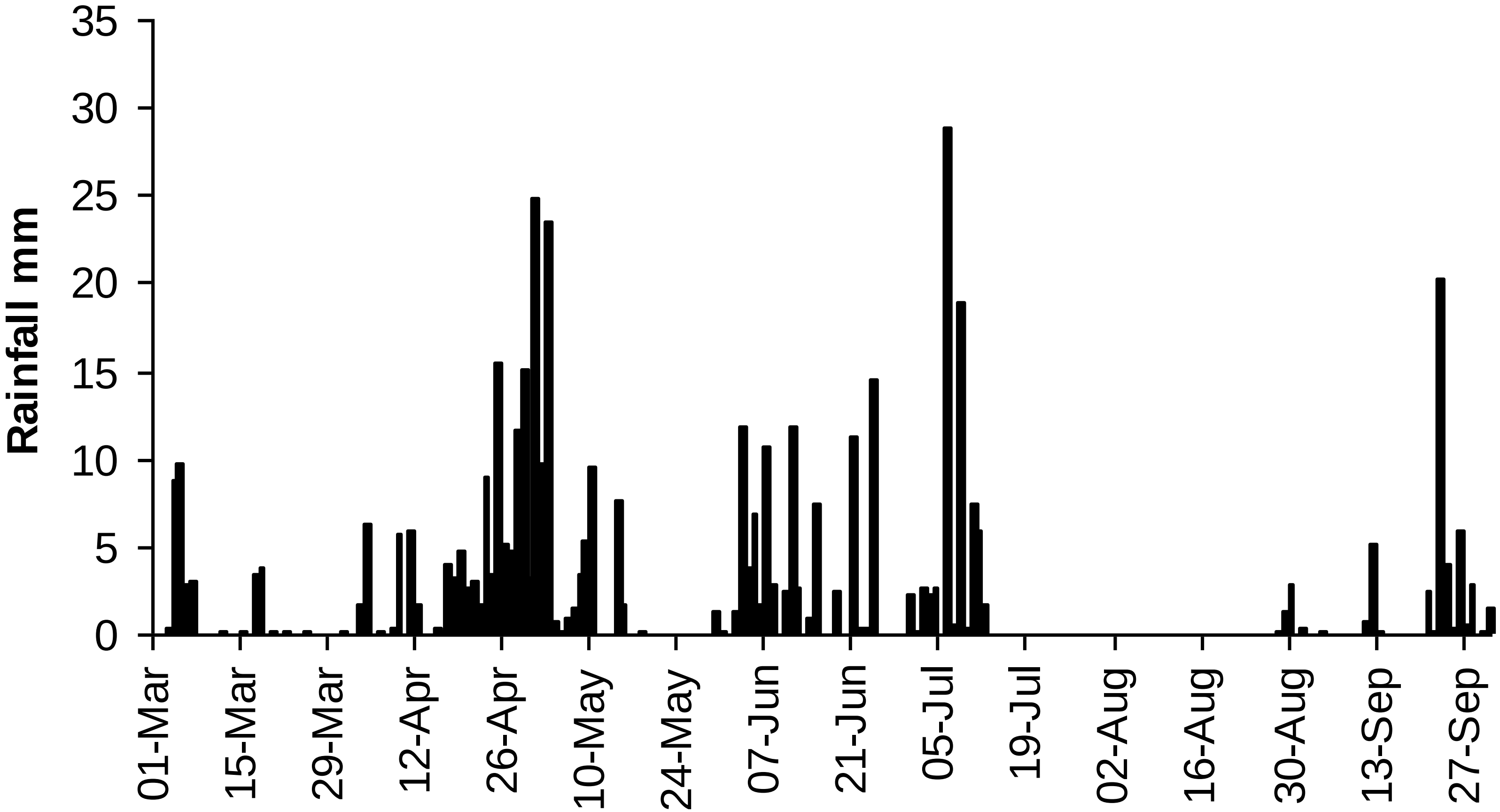


Trial 3 – Plot 4 Untreated



Trial 4 – Plot 3 Mulched

Rainfall recorded between April and October – Coggeshall 2012 (note rain did fall between 12 July and 28 August but was not recorded accurately due to a data logger error)



Appendix 4. Green waste analysis as applied on 13 April 2012

	In the dry matter	**As received (fresh)**
Bulk density g/l		393
Dry matter %		65.9
Moisture %		34.1
Water Soluble Chloride 1:5	4962 mg/kg	1285 mg/l
Water Soluble Nitrate-N 1:5	<1 mg/kg	< 1 mg/l
Water soluble Ammonium N 1:5	222.6 mg/kg	57.7 mg/l
Total soluble Nitrogen	222.6 mg/kg	57.7 mg/l
Ammonium-N:Nitrate-N ration	N/A	N/A
Water Soluble P 1:5	114.9 mg/kg	29.8 mg/l
Water Soluble K 1:5	5500 mg/kg	1424 mg/l
	mg/kg	mg/l
Water sol Ca 1:5	691.7	179.1
Water sol Mg 1:5	291.9	75.6
Water sol S 1:5	611.8	158.4
Water sol Na 1:5	1952	500
Water sol B 1:5	4.7	1.2
Water sol Cu 1:5	<1	<1
Water sol Fe 1:5	144.6	37.4
Water sol Mn 1:5	7.8	2
Water sol Mo 1:5	<1	<1
Water sol Zn 1:5	3.8	<1