Grower Summary

PC 285a

Assessing the benefits of deleafing in peppers

Final Report 2011

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Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

- Deleafing sweet pepper crops saves energy and has no detrimental effect on plant growth, health, pests and yields
- Labour costs can be high and growers considering deleafing should carry out a financial appraisal before making the final decision.

Background and expected deliverables

Sweet pepper plants grow 70-100 mm per week throughout the growing season resulting in a very large total leaf area which can be eight times the floor area of the glasshouse by the end of the season. As the year progresses, the lower leaves become largely redundant in terms of production of assimilates but continue to transpire and to have an impact on the environment within the crop canopy.

Removing lower leaves may have no detrimental impact on yield and may save water and energy, as water efficiency would improve resulting in less heat being required to drive transpiration.

There could also be a lower risk of disease because of lower relative humidity and the fact that the lower stems would be cleaner and drier, although wound sites from deleafing could increase stem fungal disease. In addition deleafing might change the microclimate around flowers and developing fruit affecting the incidence of fruit rot.

Deleafing might also influence the populations of pests and beneficial species which might otherwise inhabit the lower leaves.

Project PC 285 “Assessing the benefits of deleafing in peppers” was extended for an additional year. Work carried out in 2009 showed that deleafing saved around 8% of weekly energy use towards the end of the season (approximately 5 kWh/m^2 of gas annually) without any loss of yield or fruit quality or an increase in disease incidence.

However in 2009 there were problems with the reliability of drain measuring equipment because it kept blocking with debris and there was a sparsity of plant measurements. Results were therefore not necessarily representative so the project was extended for another year to more accurately assess water consumption.

The extension was an opportunity to validate previous results on humidity, energy saving and financial benefits. An assessment of the effect of deleafing on pests and biocontrols was also made.

Summary of project and main conclusions

In 2010 the same commercial crop of cultivar Cupra was used at the same site, Valley Grown Nurseries (VGN). The crops were grown in the same blocks 4, 5, and 6. However, the blocks used previously as the control and deleafing block were switched to make comparisons more robust. Table 1 lists the block treatments and Figure 1 depicts the control and treatment blocks.

Table 1. Block treatments in 2009 and 2010

Block	2009 treatment	2010 treatment
Block 4	Control	Deleafed
Block 5	Control	Deleafed
Block 6	Deleafed	Control

Since it was proven in 2009 that deleafing causes no decrease in yield, leaves were removed up to the V in all three blocks in week 22 in 2010. No more leaves were removed in the control block 6, whilst additional deleafing was carried out in blocks 4 and 5 starting from week 30 as given in Table 2 below:

Table 2. The timing of deleafing and the approximate height of leaves removed per stem

Week number	Amount of leaf removed per stem (cm)
22	50 (in all blocks)
30	60 (in blocks 4 and 5)
33	40 (in blocks 4 and 5)
37	30 (in blocks 4 and 5)

Figure 1. Control to the left and deleafing to the right

The environmental control of the 3 blocks was carried out in the same way with the same configuration of measuring boxes as in 2009 with the addition of independent sensors in all 3 measuring boxes in both block 5 (deleafed) and in block 6 (control).

A Martin Drop Drain Water Logger (DWL) was installed and used to measure water take up of whole rows in addition to the Priva tipping spoon method used in 2009.

The yield (class 1, class 2 and waste) and other crop data were recorded and analysed by block and the plants were monitored at regular intervals for disease and for pest and beneficial species activity.

Environmental conditions

- Deleafing made no difference in temperatures in the blocks over and above the inherent block differences
- Deleafing caused no difference to CO_2 levels
- Deleafing improved humidity conditions (lower RH and higher HD)

External air temperature and solar radiation in 2009 and 2010 were very similar making data comparable across the two years.

In all previous years, block 6 (then subject to deleafing) recorded lower temperatures than block 5. In 2010 temperatures were once again lower in block 6 (now the control) than in block 5 (deleafed), both at the left and right hand side of the path, and at the top and bottom of the canopy. It therefore appears that the temperature differences between the blocks 6 and 5 were due to inherent differences between the blocks rather than to the effect of deleafing.

Findings for CO_2 were similar, with block 5 showing higher daytime concentrations than block 6 no matter which block housed the deleafed plants.

In terms of humidity, the data from the independent humidity sensors showed a very similar RH at the top of the canopy on the right hand side in both blocks with no clear difference in RH after the deleafing treatment started.

However there was a reduction in the RH at the bottom of the canopy in the deleafed block 5 which does appear to be related to the deleafing treatment. Prior to deleafing the RH in both blocks at the bottom of the plant were very similar. After deleafing started the RH at the bottom in block 5 (deleafed) was on average 3% lower – see Figures 2 and 3 below:

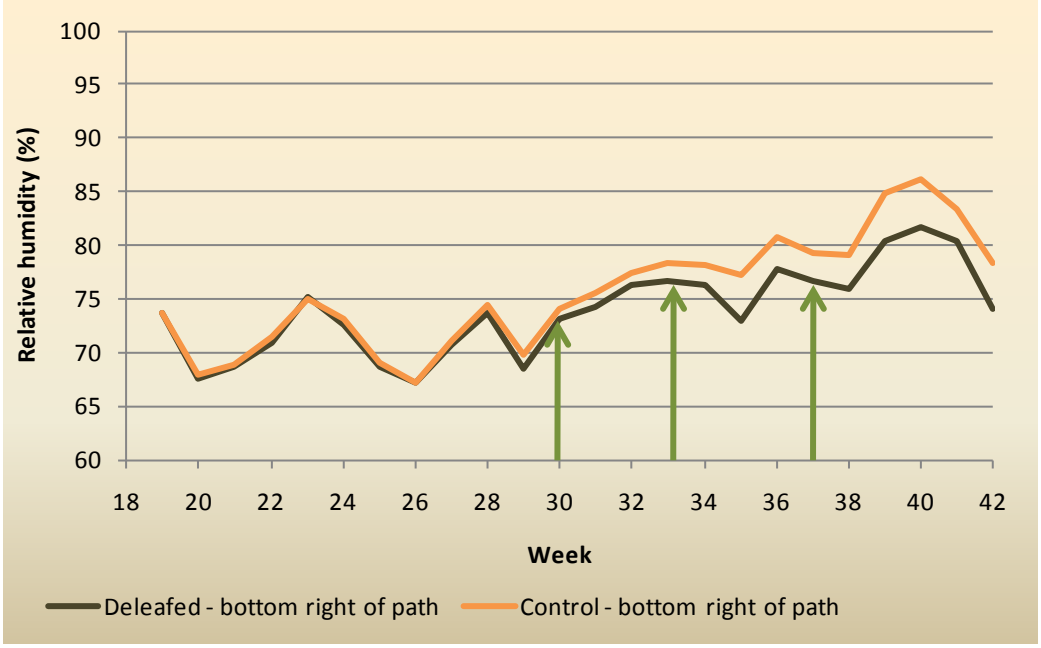

Figure 2. The average weekly relative humidity at the bottom of the plant to the right hand side of the path

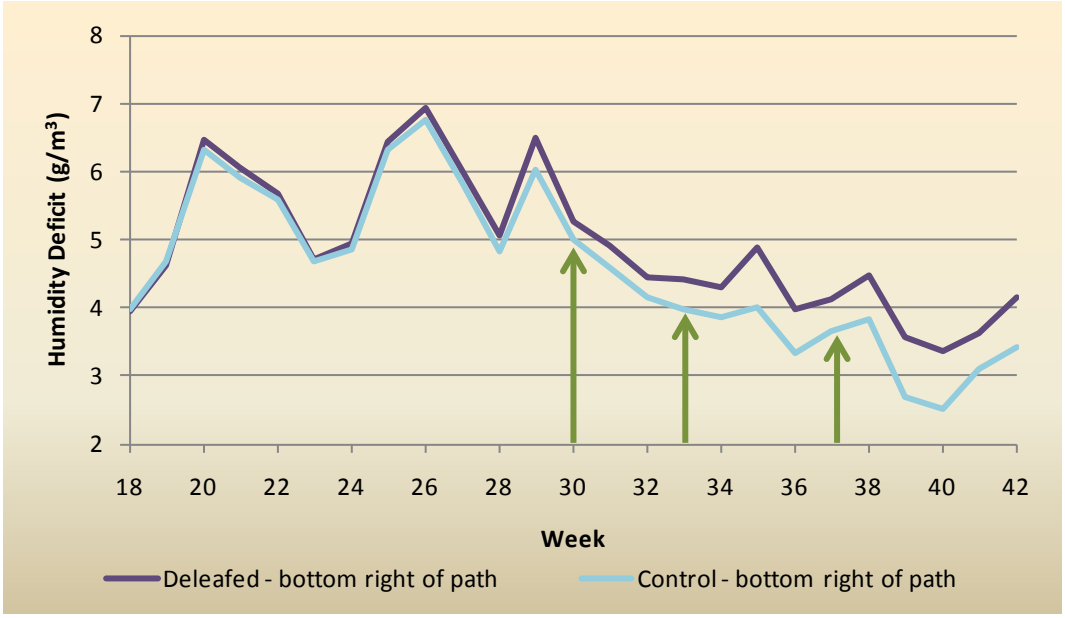

Figure 3. The average weekly humidity deficit at the bottom of the plant to the right hand side of the path

Energy use

The 2010 results support those of 2009 and show that deleafing can deliver savings in energy use

- Energy savings of 1.1% were measured during deleafing periods resulting in a 0.25% saving over the whole season
- More stringent humidity control has the potential to save further energy

The energy used in blocks 5 (deleafed) and 6 (control) was very similar up to the beginning of week 23.

- From that point on up to the start of deleafing in week 30 the control block used an average of 3.8% more energy
- From the start of deleafing to week 42, the control block used an average of 4.9% more energy - an increase in savings of 1.1%

Energy saving figures are given in Figure 4 and Table 3.

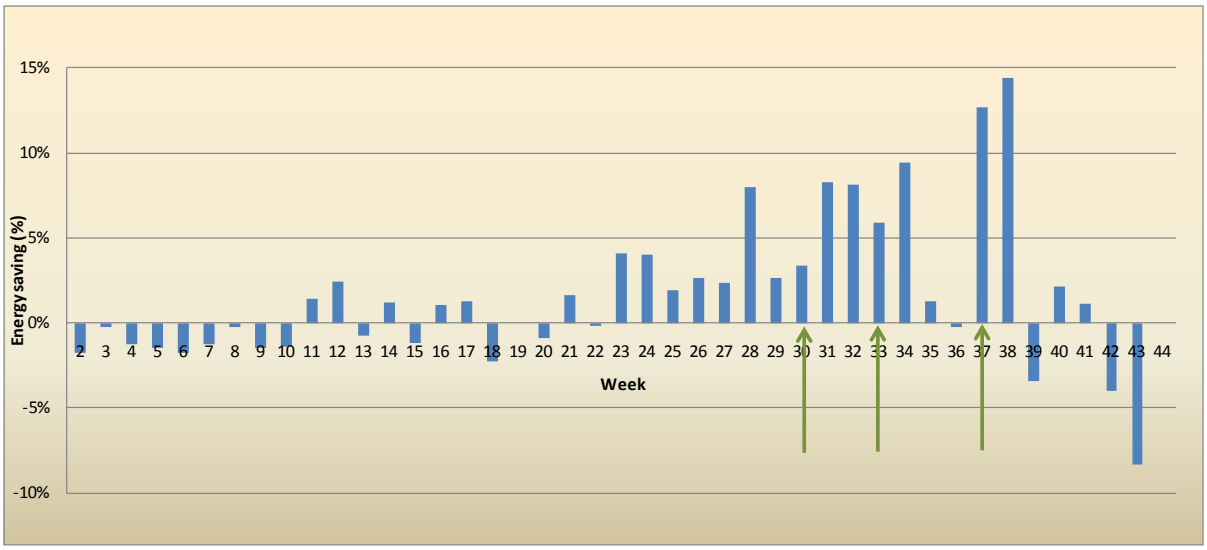

Figure 4. Percentage energy saving (positive values) in the deleafed block by week

Table 3. The effect on energy consumptions during relevant periods

	Deleafed kWh/m^2	**Control kWh/m^2**	**Difference kWh/m^2**	**% saving**
Energy consumption - sum from week 1 to end week 22	202.27	201.20	-1.1	-0.53%
Energy consumption - sum from week 23 to end week 29	31.75	33.01	1.3	3.81%
Difference 1st deleafing (week 30 - 32)	*13.97*	*14.95*	*1.0*	*6.60%*
Difference 2nd deleafing (week 33 - 36)	*18.48*	*19.31*	*0.8*	*4.31%*
Difference 3rd deleafing (week 37 - week 42)	*32.97*	*34.54*	*1.6*	*4.52%*
Energy consumption - sum after deleafing started (from week 30 to week 42)	65.42	68.80	3.4	4.91%
Energy consumption as whole season total	299.4	303.0	3.6	1.18%

Whilst a 0.25% energy saving is not significant for most nurseries, further energy savings can be realised by better humidity control. Indications from this experiment have shown that an annual saving of 3.4% is possible (12kWh/m^2/year of gas).

Water use

- Data from on site measurements shows little effect of deleafing on water use
- Longer term water data shows reduction in water use in deleafed areas, although this is attributed to increased monitoring of water use and action taken to reduce high levels of drain

The primary and best method of recording the change in water use by plants in each block proved to be the Martin Drop Drain Water Logger (DWL) i.e. the whole row system.

However, while the uptake in block 5 (deleafed) might have been expected to fall as the leaf area was removed, this was not supported by the data. Block 6 (control) showed a greater uptake than block 5 (deleafed) during the whole season but once deleafing started, the difference between the blocks actually reduced, instead of increasing. No firm conclusions can be drawn from this as it contradicts all accepted thinking regarding the influence of deleafing on uptake.

Long term water consumption data provided by the nursery shows a 11% reduction in water use for years when deleafing was carried out. This is unsubstantiated as a direct result of deleafing but it shows the benefit of close monitoring of water use and the reductions than can ensue.

Crop growth and yield

- Plant height was unaffected by deleafing
- Total flowers, fruit sets and fruit cuts per plant were also unaffected
- There was a small improvement in yield of Class 1 fruit but this was less than 5% and so statistically insignificant
- There were more Class 2 fruit in the control block but this is thought to be unrelated to deleafing

There was very little evidence for any significant effect of deleafing on weekly growth as recorded by VGN staff and this is supported by crop heights measured by FEC/Warwick HRI. There was no significant impact on the total number of flowers, fruit set and fruits cut per plant over the course of the growing season or indeed in any given week after the treatment

started. Although there were some small differences in yields between the control and deleafed blocks, these were also statistically insignificant.

Disease monitoring

- Deleafing had no effect on the number or location of stem lesions
- Deleafing had no effect on the incidence of internal fruit rot caused by *Fusarium* sp.
- There was a similar quantity of fruit wastage due to disease in both the control and deleafed blocks

Overall, the results relating to disease confirm those found in 2009 and indicate that deleafing neither increases nor reduces the incidence of Botrytis stem rot or Fusarium internal fruit rot.

The crop was examined for disease on three occasions:

1. 27 May (in week 21 before the start of deleafing)
2. 18 August (in week 33 during deleafing)
3. 13 October 2010 (in week 41 after the completion of deleafing)

No stem lesions were found at the crop inspection in May and only a few in August. In October, the incidence of stems with spreading lesions combined with the number of missing stems accounted for 1-2% of total stem numbers. *Botrytis cinerea* was recovered from three out of four spreading lesions tested and Fusarium sp. from the other.

In August around 100 visibly healthy fruit from each of the leafed and deleafed areas of crop were examined for internal infection by Fusarium sp. There was no significant difference between blocks in the proportion of fruit affected by Fusarium, which ranged from 40% to 45%, mostly affecting the seed only.

The levels of fruit wastage by weight based on nursery picking records for the three blocks showed that wastage was largely due to Fusarium fruit rot. As in 2009, wastage in block 4 was greater than in blocks 5 and 6, even though blocks used for control and deleafing had changed. This strongly indicates that block 4 has a different environment to the other blocks (supported by grower observations), more favourable to development of Fusarium fruit rot, than blocks 5 and 6.

Pest monitoring

- Deleafing had no significant effect on pest or beneficial species activity
- There were more spot sprays to block 6 (control) which implied deleafing was beneficial but results overall were inconclusive

Numbers of pest and beneficial species were estimated on four occasions and the results from the control and deleafed blocks compared:

1. 8 July (in week 27)
2. 29 July (in week 30)
3. 31 August (in week 35)
4. 12 October 2010 (in week 41)

At the start of the experiment pest populations were quite small and similar throughout the three blocks, the most important beneficial insects could be found everywhere, and pest activity remained low throughout the year. This was largely due to well managed IPM during the first half of the season.

There was very little invertebrate activity in the lower canopy from July onwards, showing that the lower leaves did not house a reservoir of pest or beneficial species.

More spot sprays were applied against *Aulocorthum solani* in the control block than in the other two blocks. Although this implied that there was a benefit from deleafing, the effect was not supported by the counts in the main assessments.

Overall, the formal pest monitoring did not reveal any evidence to suggest that the removal of lower leaves had any detrimental effect on IPM.

Financial benefits

To ascertain the true benefit to the nursery from deleafing all the factors need to be considered in financial terms e.g. reduced spray applications, increased labour etc.

Table 4 is a financial appraisal of deleafing in 2010.

Table 4. Overall economic appraisal for 2010 season

Type	Description	Saving £/m^2
Energy	0.88 kWh/m^2 gas	£0.03
Crop protection	Reduced application of sprays	£0.10
Labour	End of year turnaround	£0.05
Waste removal	1 fewer skip	£0.10
Labour	Removal of leaves	-£0.30
Balance		**-£0.02**

Deleafing will cost the nursery £200 per hectare based on the results of the 2010 season however if savings from better humidity control and water savings are made (as reported by the site water meter) then the following table shows the value of deleafing to the nursery.

Table 5. Overall economic appraisal with increased energy and water savings

Type	Description	Saving £/m^2
Energy	12 kWh/m^2 gas	£0.36
Water	300litres/m^2	£0.52
Crop protection	Reduced application of sprays	£0.10
Labour	End of year turnaround	£0.05
Waste removal	1 fewer skip	£0.10
Labour	Removal of leaves	-£0.30
Balance		**£0.83**

If these savings are possible then the nursery will benefit by £0.83/m^2 or £8,300/Ha per annum.

Action points for growers

- Carry out regular maintenance and checking of measuring boxes to ensure best possible conditions whilst minimising energy consumption
- Install additional measuring boxes to allow humidity control at the bottom of the plant if deleafing for energy saving

- Anyone considering carrying out deleafing should carefully assess their individual circumstances and carry out a thorough financial appraisal before making a final decision.
- Minimise the number of deleafings to two (after deleafing to the V) to ensure lowest labour costs