Grower Summary

HNS 157

Optimising defoliation in young trees

Final Report 2010

Disclaimer

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

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.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

HDC
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

HDC is a division of the Agriculture and Horticulture Development Board.

Headline

- Natural leaf abscission is promoted by consistent (day and night) low (chilling) temperature; brief warm periods during the autumn delay the response.
- Once young trees meet the specification for height, it is important to encourage dormant bud formation; continued shoot extension results in leaf abscission being delayed.
- The project confirmed that Copper EDTA, a foliar feed fertiliser (known by some growers internationally as the product 'Leaf Fall') is effective as a defoliant. <u>However, Copper EDTA is not registered for use within plant protection products in the UK and therefore cannot be used as a defoliant.</u>

Background and expected deliverables

There is concern in the industry that natural leaf abscission on field-grown trees is occurring later each year, due to milder autumns. A consequence of this is that tree lifting can be delayed with nurseries failing to meet early demand from the landscape sector, or that some nurseries are being forced into lifting trees to meet orders whilst the foliage is still attached.

This project aimed to investigate what factors promoted or delayed natural leaf fall and how, through a better understanding of these, growers could better predict when leaves would be shed and the crop lifted. Through a review of literature, a number of cultural approaches were identified and the most promising were examined within the project. A second objective was to determine whether there were any management tools, chemical or cultural, that growers could exploit to aid defoliation and help crop scheduling. Investigating non-chemical approaches was desirable due to pressure to reduce the reliance on agro-chemicals, and the costs incurred to register new products. Nevertheless, both chemical and non-chemical approaches were explored to compare effectiveness.

Work focused on trying to defoliate field-produced stock through a number of field trials at both commercial holdings and the University of Reading. Experiments in controlled conditions were also utilized to help determine the relationship between potential defoliants and the physiological stage of the crop at the time of application. One of the key triggers for leaf abscission in nature is thought to be exposure to frost and this project aimed to verify the effect of low temperature and whether other abiotic stress factors, such as controlled drought or waterlogging, could substitute for this stimulus.

Summary of the project and main conclusions

Important note – *None of the fertilisers, fungicides, adjuvants or disinfectants mentioned are currently approved as growth regulators or defoliants (see Table 1). Only products officially approved for use as plant protection products should be applied to control pest, disease and weed problems and provide growth control. You should consult your BASIS-registered agronomist for advice on appropriate products to use on your crops.*

Physiology of the young tree

A key objective of the project was to try to optimise leaf defoliation treatments through a better understanding of when the trees would be responsive. Young nursery trees tend to be juvenile in character, and this combined with cultivation techniques that maximise growth (to meet the market specification), promote continued shoot activity late into the growing season. Data indicated that defoliation techniques were often only effective after the shoot extension had slowed, or that a resting bud was forming. The relationship was not absolute – leaves adjacent to dormant buds did not always abscise, but in general acquiring dormant shoots aided defoliation (Figure 1). Figure 1 (*Crataegus*) also alludes to the fact that in most species tested, it is the younger leaves in the upper part of the stem that are least likely to defoliate when the plant is still active. This implies that a second factor, probably the plant growth regulator auxin, is determining leaf abscission potential. When auxin transport is disrupted within the plant (e.g. by stopping transport from the apical meristem or across the leaf petiole using the auxin blocker TIBA), then leaves become better disposed to abscission (e.g. after the application of a defoliating chemical such as Copper EDTA ('Leaf Fall') – Figure 2; or on subsequent exposure to chilling temperatures).

In practical terms, growers need to monitor for the development of a resting apical bud and the end of leaf expansion before they can be assured that any subsequent defoliation treatment will be effective.

Environmental stress

Anecdotal evidence suggests that exposure to frost is the primary inducer of leaf abscission (and the current problem is exacerbated by the lack of autumn frosts). In an attempt to understand the action of frost and whether other environmental stress factors could be substituted for it, experiments investigated how stress affected defoliation. Exposing trees to simulated chilling and frost conditions indicated that sub-zero temperatures (-2^{o}C) were much more effective than merely chilling (+2^{o}C).

Figure 1. *Crataegus monogyna*. The relationship between shoot activity and percentage defoliation in upper and lower sections of stem. *(Plants with dormant apical buds are more likely to shed their leaves. When buds are still active, young leaves in the upper sections are the most difficult to remove).*

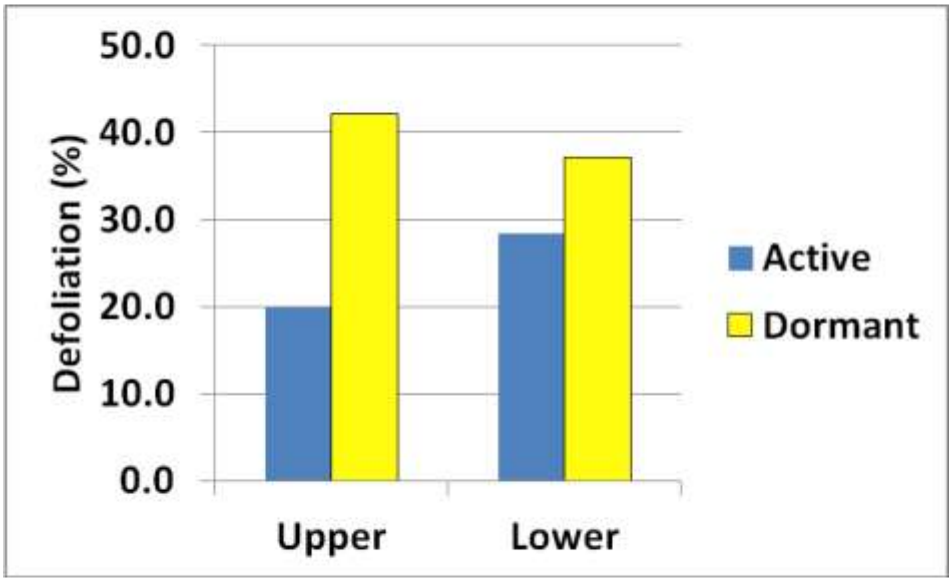
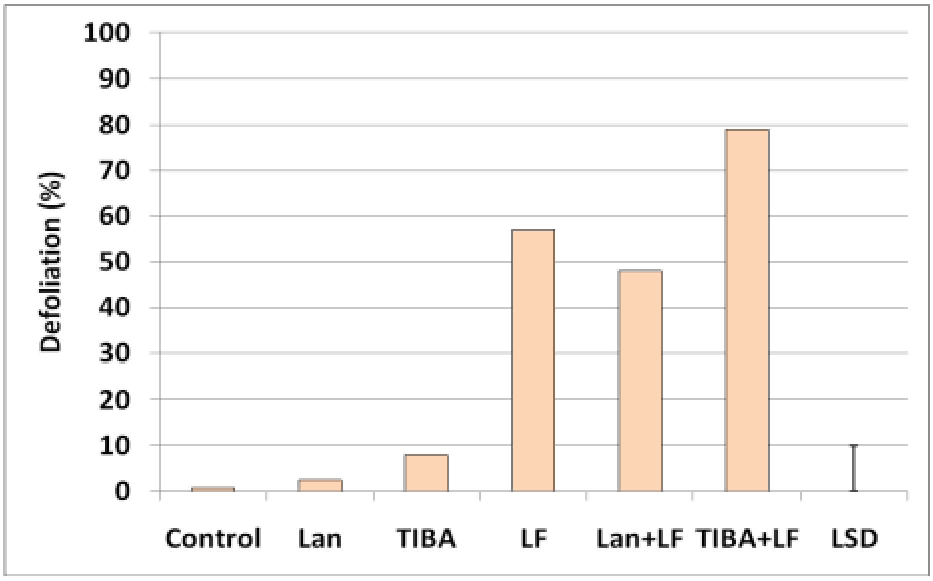


Figure 2. *Crataegus monogyna*. Defoliation percentage on 3 November 2009, after treatments with the 'non active' Lanolin or auxin-blocker TIBA in August and subsequently sprayed with water or Copper EDTA ('Leaf Fall -LF') on 13 October.



Maximum defoliation was observed when sub-zero conditions were combined with the application of the auxin blocker. To maximise responses, low temperature exposure during the day appeared important, i.e. it was not sufficient just to expose trees to low temperatures at night. The formation of abscission zones was enhanced when plants were kept at 10^{o}C day and night, and then sprayed with a chemical defoliant (in this case Copper EDTA 'Leaf Fall'), rather than to allow the day temperature to rise to 20^{o}C.

Both controlled 'moderate' drought stress and waterlogging, imposed on containerised plants for 6 weeks in autumn, encouraged leaf abscission, with waterlogging being particular effective in the trial. Admittedly, the use of such techniques is unlikely to be feasible in large scale field production (although the results do provide some indication of responses in either a very wet or dry summer / autumn), but for those businesses who can manipulate irrigation such additional factors may help substitute for the lack of frost.

Chemical approaches

<u>The use of Copper EDTA</u>

Copper EDTA, available within UK as a foliar fertiliser (Protex Chemicals Ltd) and known by some growers internationally as the product 'Leaf Fall' (not available within the UK), was the most effective chemical trialled which induced defoliation. For some species, such as *Crataegus monogyna* and *Malus* 'Profusion Improved', defoliation rates were as high as 60-97%. Results, however, were not consistent across different species, locations or seasons; in the case of *Malus* 'Bramley' for example, defoliation varied between 17 and 57%. None of the potential alternative chemicals tested proved to be as effective as Copper EDTA. Combinations of chemicals or mechanisms to manipulate the crop growth, however, may go some way to improving the efficacy of Copper EDTA products.

With the difficult to defoliate *M*. 'Bramley' adding the wetting agent Activator 90 to the spray mix with Copper EDTA improved defoliation rates from 15 to 40%; suggesting that part of the difficulty with using Copper EDTA is ensuring penetration to the leaf. Indeed, the youngest leaves were the most difficult to remove in this cultivar and this may be due to juvenility, but also the fact that such leaves / petioles were heavily pubescent (hairy) (Figure 3) which retards the penetration of defoliants. Unlike other copper compounds used regularly in crop protection the copper in Copper EDTA contains copper in solution, which defoliates the young trees more effectively than insoluble copper compounds found in some fungicides. The disadvantage of this however is that the compound may be more prone to being washed off by rainfall.

In an attempt to determine the effects of lower concentrations of Copper EDTA (e.g. to facilitate repeat applications or save costs) field trials were carried out in 2007 on *Crataegus* using a reduced strength application (10 ml/l rather than 20 ml/l). This proved equally effective as the full concentration on this species, however, further reductions to a 5 ml/l application in 2008, were ineffective on *M.* 'Bramley' even with the addition of a wetter. The effectiveness of chemical defoliants such as Copper EDTA was optimized when plants were in a more 'favourable' physiological state prior to application. This could include pre-treatment with other chemicals, a reduction in shoot activity or disruption to endogenous auxin (plant hormone) supply, or exposure to moderate levels of environmental stress (chilling, drought, waterlogging etc.).

Figure 3. *Malus* 'Bramley'. Young leaves and stems showing their pubescent nature which retards the penetration of defoliants such as Copper EDTA.

(Note also the damage to leaf tips where the defoliant has run-off the leaf surface and accumulated. These young shoots and leaves are likely to be the source of endogenous auxin that is inhibiting the formation of abscission zones).

Alternative chemical defoliants

Of the potential alternative chemicals to Copper EDTA which induced defoliation (see Table 1), none performed as well and inconsistencies were apparent based on concentration applied and crop growth stage. Nevertheless, urea at 90g /l, the plant growth regulator Cerone (2-chloroethylphosphonic acid), and the triazole fungicide Folicur (tebuconazole) all showed some promise, as did Jet 5 (peracetic acid) at 50ml/l. The wetting agent Silwet L-77 also showed some potential as a defoliant. In contrast, other copper compounds such as copper sulphate (Cuproxat FL) and copper oxychloride (Cuprokylt FL) showed only very limited defoliation potential. Chelated Iron (iron EDTA e.g. micronutrient fertilizer Librel Fe-LO) also appeared a far less effective defoliant than Copper EDTA, its copper equivalent.

Financial benefits

The work highlights that there are alternatives to natural frost in encouraging leaf abscission in young trees. Chemicals, particularly Copper EDTA ('Leaf Fall') have potential to induce defoliation, but costs for registration as a pesticide are generally prohibitive (currently, Copper EDTA is used as a fertiliser to avoid copper deficiency, but is not registered as a plant protection product).

Reduced sales potential due to poor leaf abscission has been estimated at £510,000 per annum (assuming a 1% direct loss within tree, hedging and rose crops, but not including any secondary costs such as extra labour for manual stripping of leaves, storage or transport problems etc.).

As Copper EDTA can only currently be used as a fertiliser to avoid copper deficiency other techniques that disrupt apical activity in the latter part of the growing season should be considered (undercutting, moderate drought imposition, lower fertiliser concentrations), leaving the crop in a more favourable physiological state. Associated costs will vary with area and value of the crop, but the key challenge will remain that of ensuring the crop meets specifications for height and quality at the end of the season.

Action points for growers

- Once the crop specification is met, look for opportunities to reduce growth vigour, e.g. via lower fertilisation or irrigation rates or checking growth again via under-cutting. This will aid natural defoliation.

- Be aware that a range of environmental factors, not just frost can influence both late season growth and the likelihood of leaf defoliation. Look to exploit both periods of particularly dry or wet weather from late August onwards to schedule earlier lifting. Moderate levels of stress in the crop during late summer / autumn will encourage earlier abscission.

Table 1. Approval status (during the period of the project) and technical data for compounds referenced within the Grower Summary

Product	Active ingredient	Use	Crop use	Approval status on ornamentals
'Leaf Fall'	Copper EDTA Ethylene-diaminetetra-acetic acid copper (II) diammonium salt ($Cu(NH_4)_2$.EDTA)	Fertiliser	Various	Fertiliser only, not approved as a plant protection product
Librel FE-LO	Iron.EDTA 13.2%	Fertiliser	Various	Fertiliser only, not approved as a plant protection product
Urea	Urea	Fertiliser	Various	Fertiliser only, not approved as a plant protection product
Cerone	2-chloroethyl-phosphonic acid (480g/l)	Growth regulator	Cereals, ornamentals, tree fruit and tomatoes	SOLA approval for growth control
TIBA	2,3,5-Triiodobenzoic acid	Growth regulator	None	Not approved as a plant protection product
Copper sulphate (available commercially as Cuproxat FL)	Copper sulphate	Fungicide	Potatoes	Not approved
Cuprokylt FL	Copper oxychloride (270g/l)	Fungicide	Top fruit, tomatoes and a range of other horticultural crops	Permissible under LTAEU for disease control
Folicur	Tebuconazole (250g/l)	Fungicide	Cereals, rape and a range of horticultural crops	Permissible under LTAEU for disease control
Nativo 75WG	Tebuconazole (500g/kg), trifloxistrobim (250g/kg)	Fungicide	Brassica crops, carrot and leek	Permissible under LTAEU for disease control
Activator 90	Alcohol ethoxylates (750 g/kg), natural fatty acids(150 g/kg)	Adjuvant	Cereals, fruit, vegetables	Permissible as a wetting agent
Silwet L-77	Polyalkylene-oxide modified heptamethyl-trisiloxane (80-85%)	Adjuvant	Cereals, fruit, vegetables	Permissible as a wetting agent
Jet-5	Peracetic acid (5%), hydrogen peroxide (20%), acetic acid (10%)	Disinfectant	Hard surfaces	Permissible for use as a disinfectant on hard surfaces only

SOLA – Specific Off-Label Approval. LTAEU –Long Term Arrangements for Extension of Use