HDC Tree Fruit Agronomist's Handbook

2011

A Guide to Current Tree Fruit Research and Communications

Contents

Introduction

The HDC was set up in 1986 to collect a levy from commercial horticultural producers to fund near market research projects to find solutions to growers' ever changing production problems. Stone fruit growers have been members of HDC from its inception but apple and pear R&D was looked after by the Apple and Pear Research Council until 2003 when it became part of the HDC levy system. All tree fruit growers now work collectively through the HDC Tree Fruit Panel to ensure their levy is spent wisely and that they profit from the research they fund. In recent times they have benefited from some essential research projects which have tackled the problems that seriously affect their productivity.

Sadly, growers are not always fully aware of the breadth of research undertaken with their levy money, or indeed the results that emanate from the vast number of projects being funded. There are currently 16 tree fruit research projects in progress with a further nine due to start this year. HDC reports on the progress of all its projects in the HDC News magazine as well as through press releases, presentations at conferences and on the HDC website. However, most growers are so busy throughout the year producing their crop and seeking to satisfy their customers' numerous demands that many don't make time to avail themselves of such information.

It is for this reason that in 2010, we first produced a 'Tree Fruit Review' magazine to provide abbreviated summaries of the progress being made in the full range of projects being undertaken by HDC on tree fruit. In so doing, it is hoped that growers can quickly assimilate all of the important information emanating from the research. In addition, HDC must rely upon agronomists that work with fruit growers on a daily basis to help to disseminate the results of the projects by word of mouth. To this end, we have organised an HDC Fruit Agronomists' Day to ensure that all agronomists are fully briefed on the current projects and important results to date.

To complement this day, we have produced this short handbook which will provide agronomists with a useful reference guide to HDC research on tree fruits.

I hope you find the handbook to be a useful aide memoir during the coming season.

Scott Raffle
HDC Communications Manager

Current Tree Fruit Projects (February 2011)

Project no.	Title	Duration	Contractor
TF 170	Plums: Te determine performance of 6 new plum varieties	November 2007 – January 2013	James Carew (FAST)
TF 172	Evaluation and development of new rootstocks for apples, pears, cherries and plums	June 2006 – May 2012	Feli Fernandez (EMR)
TF 176	Cherries and Plums: Evaluation of new and promising scion varieties/selections	April 2008 – March 2011	Gary Saunders (EMR)
TF 177	Apples: Long term effects of applied composted green waste mulch on the cropping of Braeburn and Cox	February 2008 – January 2013	Tim Biddlecombe (FAST)
TF 179	Pear: The effect of soil moisture on fruit storage quality	April 2008 – March 2011	Tim Biddlecombe (FAST)
TF 181	Exploiting semiochemicals, conservation biocontrol and selective physical controls in integrated management of pear sucker (LINK)	April 2008 – March 2012	Jerry Cross (EMR)
TF 182	East Malling Rootstock Club	April 2008 – March 2013	Feli Fernandez (EMR)
TF 183	Apples and Pears: The use of biological control, plant health promoters and copper to effect control of fireblight (*Erwinia amylovora*)	April 2008 – March 2011	James Carew (FAST)
TF 189	Optimum treatment timing to reduce overwintering codling moth populations	April 2009 – March 2011	Jerry Cross (EMR)
TF 190	An investigation of any correlation in the sensitivity of scab isolates to different fungicides	April 2009 – March 2011	Xiangming Xu (EMR)
TF 191	The effect of ethylene control strategies on the development of rotting in Bramley's Seedling apples	April 2009 – September 2011	Debbie Rees (NRI)
TF 192	Modulating the storage temperature for Cox apples for improved quality and control of rotting	July 2009 – June 2012	Richard Colgan (NRI)
TF 193	Apple – Sustainable management of storage rots	January 2009 – March 2011	Angela Berrie (EMR)
TF 194	Developing biocontrol methods and their integration in sustainable pest and disease management in plum and cherry production (LINK)	April 2009 – March 2014	Jerry Cross (EMR)
CP 62	Carbon storage in orchards	October 2008 – March 2011	Gareth Edwards-Jones (Bangor University)
CP 73	The role of chemicals in location of host plants by midge pests of UK fruit crops	September 2010 – November 2013	David Hall (NRI)
CP 77	Sustainable crop and environment protection – targeted research for edibles – SCEPTRE (LINK)	October 2010 – September 2014	Tim O'Neill (ADAS)

Summary of Results from Existing Projects

TF 170 - Plums: To determine performance of six new plum varieties
From: November 2007 to January 2013
Project leader: James Carew, FAST
Location: Brogdale Farm and Mount Ephraim, Faversham, Kent

Background

With crop manipulation difficult to achieve in plums, the most obvious way to produce higher yields of quality fruit over an extended season is to breed and develop new varieties. The UK industry currently relies on five main varieties to spread its season. A number of promising new varieties have been developed in mainland Europe, but these have not yet been assessed in the UK.

Six new varieties, Anita, Ferbleue, Haganta, Jojo, Meritare and Valerija were planted in 2008 on two sites near Faversham in Kent. Co-ordinated by FAST, they were planted on both St. Julian A and Plumina rootstocks, with the purpose of assessing their fruit size, fruit number, tree establishment and rootstock requirement for UK conditions.

Progress so far

Meritare, Ferbleue and Haganta show the most promise so far.

Meritare emanates from France and has been the earliest variety with picking starting on 5th August, coinciding with Opal in the trial. However, it is about double the size of Opal, so picking costs will be much less. The flavour was very good and it looked and tasted very similar to Victoria. It is definitely an option worth considering for early production.

Ferbleue, again from France, is undoubtedly the variety with the best flavour in the trial and brix is around 24^{o}. However, the yield was the lowest of any of the varieties with some trees producing less than 20 fruit. Skin finish is also poor and the fruit is sensitive to splitting following rain.

Haganta which originates from Germany, is the last variety to start fruiting in the trial with picking beginning in 2010 on 15th September, around the same time as Marjorie's Seedling. Its yield was one of the highest in the trial, with average fruit size larger than Victoria. It had a good flavour with a brix of around 20^{o}. It is resistant to Sharka.

TF 172 - Evaluation and development of new rootstocks for apples, pears, cherries and plums
From: June 2006 to May 2012
Project leader: Gary Saunders, EMR
Location: East Malling Research

Background

Rootstocks currently used in the UK have been grown for decades and have limitations. There is a strong need for new rootstocks for apples, pears, cherries and plums which are dwarfing, precocious, high yielding and offer some measure of drought tolerance. A number of new rootstocks have been bred in the UK and overseas, which are becoming available to growers.

This project, led by Gary Saunders of EMR aimed to acquire new apple, pear cherry and plum rootstocks from EMR and abroad, and evaluate and develop them in the UK growing conditions. Specifically in apple the objective is to find a rootstock with intermediate vigour between M27 and M9, find a replacement for M26 and develop dwarfing rootstocks with resistance to drought, replant and soil borne diseases. In pear, a more dwarfing rootstock than Quince C is required along with a dwarfing Pyrus rootstock that is easy to propagate. In plums, a dwarfing rootstock that induces precocity and high yields is required while cherries require more dwarfing than Gisella 5.

Progress so far

In apples, rootstock AR 801-11 initially showed promise. When using Cox (La Vera) trees on AR 801-11, vigour was less than on M9, but yields were similar. However, more recent results show no significant differences between M9 and AR 680-2 or AR 801-11. A wide range in vigour is being provided by the new rootstock selections for Bramley, but M27 has greater yield efficiency than the tested selections. Two further plots were planted in spring 2010 with a further range of rootstocks.

In pears, the EMR dwarfing quince rootstock C132 has again performed well with a significantly greater yield than Quince C (Conference).

In cherries, Russian ‘Krymsk’ rootstock LC-52 has produced significantly greater yields than VSL-2. LC-52 continues to be more vigorous than VSL-2 but is more yield efficient and produces fewer suckers. The EMR rootstock selection C113-3 on ‘Sunburst’ continues to be more dwarfing than ‘Tabel Edabriz’ but the yield so far has been poor in comparison. The work is ongoing and further information and results will be made available later in 2011.

TF 176 - Cherries and Plums: Evaluation of new and promising scion varieties and selections

From: April 2008 to March 2011
Project leader: Gary Saunders, EMR
Location: East Malling Research

Background

For some years, HDC has funded breeding and development of new varieties of plum and cherry. A range of seedlings have been bred and raised at East Malling Research by breeder Ken Tobutt and trials are needed to evaluate their performance.

This trial is being led by Gary Saunders at EMR. Data from a number of years is required for a complete evaluation as seasonal differences in climate have a marked effect on fruit yield and quality. The plum trial is evaluating 6 selections which were planted in 2002. The cherry trial is evaluating 26 selections which were planted in 2004, 2005 and 2006.

Progress

In the plum trial, all selections were grown on St. Julian A rootstock. In the 2009 harvest, EM32 performed particularly well, producing the highest yield per tree (32kg) and highest mean fruit weight (70.4g). It also had a lower number of rots than the other selections. Little cracking occurred in this variety, although overall in 2009, there was little cracking in any of the varieties.

In the cherry trial, all selections were grown on G5 rootstock and compared to Penny. From the 2004 planting, C269-8 was the most promising. Compared to Penny, it produced slightly smaller fruit size, but was more precocious. It had greater soluble solids and suffered a lower incidence of cracking and rotting. From the 2005 planting, C261-52 was most promising. Although yield per tree and mean fruit weight were slightly less than for Penny, soluble solids were greater and it had a lower incidence of cracking and rotting. From the 2006 planting, none of the selections produced a higher overall quality than Penny.

Factsheets 28/10 (plums) and 27/10 (cherries) have been distributed to growers and summarise the full results of the 2009 harvest.

TF 177 - Apples: Long term effects of applied composted green waste mulch on the cropping of Braeburn and Cox
From: February 2008 to January 2013
Project leader: Tim Biddlecombe, FAST
Location: North Court Farm, Old Wives Lees, Canterbury, Kent

Background

A previous WRAP (Waste and Resources Action Programme) funded project on green waste mulches concentrated on the benefits of using green waste compost mulch in the years immediately following planting. The compost was shown to have significant effects on yield and fruit size. The HDC commissioned this extension to the WRAP project to look beyond this initial phase of establishment to the longer term effects on two varieties. Both a Braeburn and Cox orchard in Kent have been included in the study, comparing trees with a bare herbicide strip to those mulched with composted green waste.

Led by Tim Biddlecombe of FAST, the project is comparing the effects on fruit size, weight, number/tree, maturity, mineral analysis, storage potential and soil moisture. Machinery suitable for application will be considered and a cost benefit analysis conducted at the end of the project.

Progress so far

The work has demonstrated that even seven years after the initial compost application, the impact continues to be significant. Compost is still causing significant increases in shoot growth meaning the trees have filled their spaces more quickly, resulting in the production of more fruit and larger fruit with a corresponding 30% yield increase. However, having now filled their spaces, the extra growth is actually unhelpful as it has led to increased pruning costs and less light penetration to the canopy which could have an adverse effect on fruit quality. This will be monitored closely as the project continues. The compost has improved water retention in the soil. It also appears to increase soil nitrogen and potassium which has subsequently given rise to an increase in both nutrients in the fruit, making it more predisposed to storage disorders and softening in store.

However, at present, it seems that the beneficial effects on tree establishment and cropping would far outweigh any reduction in fruit quality especially in orchards where growth is poor and is restricting yields. As the project continues the effect of compost on growth, yield, fruit development and quality will be examined in more detail.

TF 179 - Pear: The effect of soil moisture on fruit storage quality
From: April 2008 to March 2011
Project leader: Tim Biddlecombe, FAST
Location: Commercial orchards in Kent

Background

Past research and experience has demonstrated the benefits of pear irrigation in reducing tree stress, delaying harvest, improving fruit size and quality and particularly storage life. The tree fruit panel felt that further investigation into the use of water in relation to these characteristics was warranted. As not all UK pear orchards have irrigation facilities, it was also decided to investigate the use of mulches as soil water conservation measures and the subsequent effect on crop size and quality. This will be particularly important if the current trend for less rainfall each season continues as it will be vital that the little water available is used most efficiently to produce a crop of high quality.

Led by Tim Biddlecombe of FAST, this project aimed to determine the effect of soil moisture on fruit size and quality, particularly in relation to storage by the use of three irrigation regimes. Coupled to the irrigation regimes, comparisons between no mulch, straw mulch, compost mulch and polythene cover were made to assess the value of these mulches as soil moisture conservation measures and their relation to fruit quality.

Progress

In this project, the irrigation treatments had little effect which was surprising. This could possibly be explained by the fact that the project was undertaken in a well established orchard. More impact may have been seen on a younger, newly planted orchard where the root systems are not as well developed.

In the work assessing the use of mulches, the effect was clear and was similar to what has been seen in apples. The compost and straw mulches increased fruit size whereas the plastic mulch actually decreased fruit size because of relative differences in soil moisture content. The use of these mulches was also compared to fruit number and yield, but the effect on these was minimal compared to fruit size. The nitrogen content was generally higher in fruit from the compost treatments, suggesting a lower storability would be expected, but this was balanced somewhat by calcium levels, resulting in very similar pressures from store.

TF 181 (Horticulture LINK HL0194) - Exploiting semiochemicals, conservation biocontrol and selective physical controls in integrated management of pear sucker
From: April 2008 to March 2012
Project leader: Jerry Cross, EMR
Location: Various commercial orchards

Background

Pear sucker is a devastating pest of pears and growers currently rely on routine sprays of pesticides and other products which act physically to control the pest. However, many of these are non-selective or only partially effective treatments and take no consideration of the effect on important natural enemies that are vital in pear sucker management. Anthocorids are known predators of pear sucker, but they don't over-winter in orchards in large numbers and their influx in spring is variable and often too late to offer satisfactory control. Better sources of these important natural enemies need to be provided in or around pear orchards. Dutch research has identified plant volatiles which attract anthocorids. These could be harnessed in future. The identification of the pear sucker sex pheromone would also help future control strategies.

A Horticulture LINK project has been set up to develop an integrated management programme for pear sucker to reduce reliance upon the routine spray programme currently used. Led by Jerry Cross of EMR, the project aims to identify and exploit the pear sucker sex pheromone for pest monitoring, develop conservation biocontrol methods to maximise anthocorid populations and other natural enemies, exploit plant volatiles to attract anthocorids into orchards and develop more selective, physically acting spray programmes that are safe to anthocorids.

Progress so far

The first surprising finding of the project was that the species of pear sucker in many intensively managed pear orchards is be *Cacopsylla pyri* and not *C. pyricola* which was found in the 1970's when the last survey was done*. C pyricola* appears to predominate in less intensively managed orchards, but at low levels. This could have important consequences for pear sucker management.

To identify the pear sucker's sex pheromone, work has been investigating the volatiles from males and females. No sex specific compounds that might be pheromones have been identified to date, despite intensive searching. An interesting long chain (rather involatile) hydrocarbon from the insects cuticle, present in both males and females and claimed to be attractive to *C. pyricola* by researchers in the USA, has been found to be present in *C pyri.* It was synthesised and tested in 2010, but the scientists could not demonstrate attraction of either species.

The suitability of different tree and herbaceous species as early season sources of anthocorids and other pear sucker predators has also been extensively

investigated. Pussy and grey willow, hawthorn, hazel and stinging nettle have been identified as excellent sources of anthocorids whereas many other tree species have been shown to be of little or no benefit, including Italian Alder, widely used for windbreaks. An important practical finding of this project is the importance of providing hedgerows/windbreaks rich in a mix of these subjects round pear orchards, and, by implication, of making sure that pear orchards are not too big so that the sources are not too distant. Cutting nettles rich in anthocorid adults to foster their migration into adjacent pear orchards is being investigated. The importance of preserving predators by avoiding the use of harmful pesticides throughout the season, even those materials that may only have limited adverse effects, is stressed.

The characteristic bouquet of volatiles emitted by pear sucker infested pear trees has been quantified and work is ongoing to exploit lures containing synthetic compounds. To date, none of the compounds or mixtures tested has attracted anthocorids, but one compound has been shown to be highly attractive to hoverflies, which are important predators of aphids in many crops.

The efficacy of current physically acting control materials such as sulphur, magnesium sulphate and non-ionic wetters .has also been investigated. A non-ionic wetter has been shown to have useful insecticidal properties, but only at higher rates than those recommended. Early season sprays of kaolin have also been shown to significantly reduce the numbers of eggs laid on treated trees by pear sucker in the late dormant and early season. Multiple applications (at high doses) are needed for best results.

TF 182 - East Malling Rootstock Club
From: April 2008 until March 2013
Project leader: Feli Fernández
Location: East Malling Research

Background

Improved rootstocks are necessary to maintain sustainable and profitable top-fruit production. Dwarfing remains a main factor for growers as a means to reduce production costs during picking and pruning. Other desirable characteristics include induction of precocious and reliable cropping, ease of propagation, freedom from suckers, resistance to pests and diseases and good anchorage. Current concerns over changing weather patterns also point to the need for both drought and flood tolerance.

However, only a handful of breeding programmes world-wide continue to develop top-fruit rootstocks. Following the withdrawal of government funding for ‘near-market’ research, the East Malling Apple and Pear Breeding Club (1992 – 2007) took over the development of new top-fruit rootstocks and scions. The Apple and Pear Research Council and more latterly the HDC were the UK Licensees for the material developed as part of the APBC, which included two new rootstocks releases, M.116 for apple and EMH, a quince rootstock for pear.

East Malling Research, together with the HDC and the INN (International New varieties Network), announced the formation of the new East Malling Rootstock Club (EMRC) in June 2008. The club continues to evaluate germplasm generated at EMR during previous funding arrangements and aims to develop outstanding rootstocks for growers in the UK and overseas. To do so, EMR draws on a wealth of breeding lines encompassing wide agronomic variation as well as a range of genes for pest and disease resistance. Defra, for the time being, continues to fund underpinning research at EMR on genetic mapping of rootstocks and the development of molecular markers for pre-selection of key rootstock characters and the programme benefits from EMR's expertise in marker development and deployment (e.g. DNA fingerprinting).

Progress so far

Ten apple rootstock selections, some very dwarfing, are being bulked up for multi-site trials as well as three vigorous rootstocks for pear. Additionally, stool beds are being established for nine apple stocks and one pear. Nine Pyrus selections and 17 quince new selections from the breeding programme, grafted with Conference, were planted in a selection plot at EMR in spring 2006 and cropping recording is ongoing. Since the club has been in operation, propagation for preliminary trials has started on 19 apple rootstocks as well as on 20 *Pyrus* rootstocks. A further 4 apple seedlings were selected in 2010 for propagation in 2011-12. Sixteen other apple progenies and seven pear progenies are also in the pipeline and continued to be evaluated in 2010. The club management committee decided to prioritise the apple programme that will in future constitute approximately 75% of seedlings planted. As a consequence, no new pear families were planted and the entire seedling population (~ 1,000) was raised from four new apple progenies. In the crossing programme, we have continued our efforts to incorporate improved fireblight-resistance into new apple families and heat tolerance and scion-graft compatibility in pears and have produce seed to raise eight apple and four pear families in the coming spring.

TF 183 - The use of biological control and plant health promoters to effect control of fireblight (*Erwinia amylovora*)
From: April 2008 to March 2011
Project leader: James Carew, FAST
Location: Ham Green Farm, Upchurch, Sittingbourne, Kent

Background

Fireblight, caused by the bacterium *Erwinia amylovora* is a widespread destructive bacterial disease of apples and pears, causing significant yield loss every year. Control methods in the UK are limited to hand pruning diseased shoots, which is costly, and use of copper sprays, which can lead to russeting of fruit. The industry is desperately seeking new and improved control methods.

A range of novel biocontrol agents and health promoters are available which offer potential control. James Carew of FAST is assessing these in a commercial Concorde orchard in Kent. Treatments include two bacterial products Sentry P (*Bacillus pumilis*) and Serenade ASO (*Bacillus subtilis*), Cuprokylt FL (Copper oxychloride) and a novel product containing a protein as its active ingredient which is produced by bacterial plant pathogens. The treatments were applied in a randomised block experiment and compared to a control. The novel product and bacterial products were applied at bud burst and repeated weekly, fifteen times. Copper was applied at bud-burst. These products were applied over three seasons and the percentage of fireblight infected shoots assessed.

Progress

Serenade ASO was found to be the most effective treatment and provides growers with an alternative control option. It did not completely eliminate the disease, but its effectiveness may be improved through timing application according to prediction models. As long as fireblight is present within an orchard however, pruning out wood along with good hygiene practices remains an important part of suppressing the disease. 2006 and 2007 saw significant outbreaks of fireblight. Whilst the disease has not been as severe over the last two or three years, the results from this project indicate that and improved control option is available should the severity of fireblight increase again.

TF 189 Optimum treatment timing to reduce over-wintering codling moth populations
From: April 2009 to March 2011
Project leader: Jerry Cross, EMR
Location: East Malling Research

Background

Codling moth is the most important pest of apples in the UK and many commercial orchards receive multiple insecticidal sprays through the season to control it, at substantial cost. Despite this, the problem is not reducing and populations appear to persist from year to year. The success of a control programme can be judged not only in terms of the reduction in fruit damage, but by the size of overwintering populations that give rise to the next year’s attack

The objective of this work was to study the egg laying dynamics of codling moth through the season in relation to pheromone trap catches and forecasts given by the RIMpro Cydia model to determine the optimum timing for treatments to reduce over-wintering codling moth populations. The results should guide control strategies for long-term reduction of moth populations.

Progress

It was found that though there are two generations each year, the second generation does not complete its development. The first stronger generation occurs between mid-May and late July, followed by a weaker generation between August and October. The second generation, though damaging to the crop, does not contribute to the following year's population.

Both sex pheromone and pear ester traps gave a useful indication of the activity of the first generation of codling moth although it was found that they could not be relied upon solely for monitoring populations and timing spray application.

Weekly egg monitoring by direct counting of eggs on fruitlets *in situ* is the only reliable and accurate way of determining the timing and need for sprays. At least 600 fruitlets per orchard per sampling is required, so the procedure is time consuming and costly, but given the current control cost of £300/ha, it could be cost effective.

The RIMpro-Cydia model is currently the most sophisticated one available. It gave broadly correct predictions for the first generation, but failed to predict the second generation, in both years – a serious failing on one trial site, where a significant level of attack occurred in August and September.

Control measures should focus on the first generation in June and July, using a range of insecticides with different modes of action to minimise the risk of resistance developing. Use of codling moth granulovirus against the first generation is important as it can persist in the population from one season to the next. Protection should also be maintained through August and September when ripening fruit is very susceptible to attack by small numbers. A lower sex pheromone trap threshold, perhaps of 2 moths per trap, would be appropriate.

TF 190 - Are (in) sensitivities of scab isolates to different fungicides correlated?

From: April 2009 to March 2011
Project leader: Xiangming Xu, EMR
Location: East Malling Research

Background

The overuse of some fungicides can give rise to the selection of fungal strains less sensitive to the fungicides. In the USA and Canada, overuse of the DMI fungicides has led to the emergence of scab strains less sensitive and in the UK, anecdotal evidence suggests that isolates from DMI-sprayed orchards have an overall reduced sensitivity to myclobutanil (Systhane). The tree fruit panel felt that research was required for particular fungal populations of *Venturia inaequalis* (the cause of scab) to understand the potential of cross-resistance to particular fungicides.

The project, led by Xiangming Xu of EMR, seeks to generate new information on the sensitivity of UK apple scab populations to the commonly used scab fungicides. This will help to reappraise the long term future of each fungicide. The information uncovered about the presence or absence of cross-resistance among these fungicides will allow growers to develop more sustainable anti-resistance strategies to control scab.

Progress so far

More than 100 single-spore scab isolates from scab lesions have been collected on eight UK sites. These isolates are being held in vitro and are currently being tested against all the UK registered scab fungicides. No valid conclusions regarding scab insensitivity have yet been drawn. Fungicide residues have been quantified on leaves both immediately and eight days after application. Results suggest that fungicide residues in treated leaves should be sufficiently high to be effective against even those insensitive isolates for at least eight days after application, in the absence of rain. Further results will be made available later in 2011.

TF 191 - The effect of ethylene control strategies on the development of rotting in Bramley's Seedling apples
From: April 2009 to October 2011
Project leaders: Angela Berrie, EMR and Debbie Rees NRI (pictured)
Industry representative: Edward Newling (Turnover Farm)
Location: East Malling Research

Background

Late stored Bramley apples are prone to fungal rotting with many growers commonly experiencing losses of 10% or more of their crop, particularly through *Nectria galligena*, the fungus that causes apple canker in the orchard. To improve quality in store, many growers have adopted the 5% CO_2, 1% O_2 regime, particularly to control bitter pit and superficial scald, but this has the adverse effect of promoting Nectria fruit rots. With the loss of DPA, the use of storage protocols capable of controlling scald, such as SmartFresh™ and ethylene scrubbing, becomes even more important. It is important to assess these technologies in terms of their effects on rot development.

In this project, run by the Jim Mount Centre, a collaboration between EMR and NRI, the use of SmartFresh™ and ethylene scrubbing (Bi-On and catalytic scrubbers) are assessed for their effect on quality and the development of fungal rots in CA-stored Bramley apples under commercial conditions. The trials include fruit distributed among commercial stores as well as storage on a smaller-scale within experimental CA chambers at EMR.

Progress so far

Ethylene scrubbing by catalytic methods and by Bi-On were found to be very effective within commercial stores, maintaining ethylene concentrations below

100 ppb. In the first year of trials there were no differences observed between storage protocols in incidence of natural rot in commercial stores, but the rate of rot development in Nectria inoculated fruit was slightly reduced by ethylene scrubbing compared to SmartFresh™ treated fruit. This is not unexpected as ethylene is a signalling compound within fruit for the mobilisation of defence mechanisms against pathogens. In this case ethylene action within the fruit is blocked by the use of SmartFresh™ but not by scrubbing which affects ethylene movement between fruit and not within individual fruit. The trials are being repeated in the second year of the project.

TF 192 - Modulating the storage temperature for Cox apples for improved quality and control of rotting
From: July 2009 to June 2012
Project leaders: Angela Berrie, EMR and Richard Colgan, NRI
Location: East Malling Research

Background

Cox remains the principal dessert apple grown in the UK, but despite following optimum harvesting and storage recommendations, the firmness of stored fruit at the point of sale can be marginal in relation to specifications set by multiple retail customers. Reducing storage temperatures could alleviate this problem and although this could lead to development of low temperature breakdown (LTB), research overseas has shown that modulating store temperature to provide shorter periods at lower temperatures can provide the benefits without inducing LTB.

This project run by the Jim Mount Centre, a collaboration between EMR and NRI, will test the strategy of modulating store temperature to improve quality and reduce wastage of Cox due to fungal rots. In addition, the impact of SmartFresh™ on sensitivity to chilling and susceptibility to rotting will be assessed.

Progress so far

Assessments of fruit quality during the first season of trials found that Cox's apples stored for 4 months (January) at 1.5°C without SmartFresh™ (SF) treatment were approximately 1 kg firmer than Cox stored at 3.5°C. SF-treated Cox assessed immediately ex-store were approximately 2 kg firmer than non-treated Cox, but in this case storage at lower temperatures did not affect firmness immediately ex-store. During shelf-life SF-treated and non-treated Cox stored previously in low-temperature storage (1.5°C) had reduced the rates of softening. The first incidence (5%) of low-temperature breakdown LTB were recorded in consignments of SF-treated and non-treated fruit after 4 months storage at 1.5°C.

Continuous storage of Cox at 1.5°C until March resulted in significant amounts of LTB which was worse in SF-treated fruit. Although this treatment reduced the

rate of softening the high incidence of LTB precluded the use of continuous 1.5°C beyond January in future trials. LTB was not prevented by intermittent warming for two months to 3.5-4 ºC. Intermittent cooling to 1.5-2 ºC for two months during six months storage at 3.5-4 ºC also gives no benefit in terms of fruit quality. It has been decided to discontinue these treatments along with continuous low temperature storage, so that the second year of trials is concentrating on five two-stage temperature storage regimes on fruit picked over three picking dates.

The incidence of *Nectria* rots was reduced with SF when combined with lower storage temperatures, SF-treated Cox that received at least four months at 1.5°C had less rots. Interestingly, SF did not affect the incidence of rotting when Cox was stored at 3.5°C for the whole period. Rotting in untreated Cox was more variable and no clear trend in temperature regime was evident; however, fruit stored for the whole storage period at 1.5°C had the lowest incidence of rots.

TF 193 Apple – Sustainable management of storage rots
From: January 2009 to April 2011
Project leader: Angela Berrie, EMR
Location: East Malling Research

Background

The increasing pressure on growers to supply fruit to customers that is free from pesticide residues has focussed the need to re-evaluate storage rots and the use of pre-harvest orchard sprays. In the past decade, new rots caused by Botryosphaeria, Phomopsis and Colletotrichum species have started to appear.

This project aimed to identify the major rots currently responsible for losses in store and evaluate the optimum timing of orchard sprays for control. Treatments at blossom time only were compared with pre-harvest only and a combination of both. In addition, blossom time only sprays, were combined with cultural methods (selective picking). It was hoped to establish if there is scope to avoid the use of pre-harvest sprays and reduce the risk of residues occurring in the fruit.

Progress

In the first year of the project, a rot survey was undertaken at seven packhouses in Kent and Herefordshire, using the varieties Cox, Gala, Braeburn, Jazz and Bramley. Actual losses due to rots in Cox, Bramley and Gala were very low (less than 2%), but most were due to brown rot (*Monilinia fructigena*), with *Nectria*, *Botrytis* and *Gloeosporium* also important. Fusarium was also present in Bramley, mainly occurring as a cheek rot that appeared to have originated in the core. In Braeburn and Jazz, losses due to rots were negligible, but brown rot was the principal cause in all cases. However, *Phytophthora*, *Botrytis*, *Penicillium*, *Nectria*, *Gloeosporium*, *Fusarium*, *Colletotrichum*, *Mucor* and *Phomopsis* were also present. In pears, rot incidence was also low, with *Botrytis* and brown rot accounting for over three quarters of the rotting.

In the replicated orchard trial, significantly less rotting was recorded in treated plots compared to untreated plots for *Nectria*, *Phomopsis* and *Botryosphaeria*, but the incidence of rots was too low for differences between individual treatments to be identified. Further results from the second year of the trial will become available in 2011.

TF 194 (Defra Horticulture LINK HL0191) Developing biocontrol methods and their integration in sustainable pest and disease management in plum and cherry production
From: April 2009 to March 2014
Project leader: Jerry Cross, EMR
Location: East Malling Research and various commercial sites

Background

Brown rot, aphids, plum fruit moth and light brown apple moth are the main pest and disease problems of UK stone fruit production and are very common wherever and however stone fruits are grown in the UK. In combination, they lead to very significant crop and marketable yield losses every year. Growers currently employ conventional pesticides to gain control, but these regularly lead to detectable pesticide residues which growers are under increasing pressure to reduce.

This Defra Horticulture LINK project will investigate new biocontrol methods and in future, it is hoped to combine these with existing non-chemical methods in an integrated pest and disease management (IPDM) programme. Specifically, the work will assess a microbial biocontrol agent for brown rot, sex pheromone based systems for controlling plum fruit moth and light brown apple moth, a novel biocontrol approach for aphids which exploits the vectoring of entomopathogenic fungi by ants and use of entomopathogenic nematodes for plum fruit moth.

Progress so far

To determine the relative importance of external inoculum for fruit infection by brown rot infection in orchards, many isolates of brown rot have been collected from 4 commercial orchards and these are being used for molecular (DNA) population comparison. Approximately 200 yeast and bacterial strains have been obtained from mummified fruit and their potential as biocontrol agents (BCAs) against brown rot is currently being tested. So far, 5 strains with potential have been identified and are being tested against the fungus on mummified fruit. In the same work, formulated BCA products and another BCA from a Portuguese research group have been obtained and are currently being screened with several other alternative products.

The common black ant defends aphids against attack by predators including ladybirds, hoverfly larvae, earwigs, predatory bugs, spiders etc. We have shown that, if ants are excluded, aphids are much less of a problem on fruit trees

because they are eliminated by these voracious natural enemies. We have found that hoverfly larvae are especially important for the cherry blackfly. Possible ways of manipulating ants to control important pest aphids are being developed. Strategies to provide alternative food sources for the black ant, including baits rich in the sugars that aphids excrete as honeydew, or providing plants that have other more attractive aphids, are been investigated as promising strategies. Twelve strains of entomopathogenic fungi that were designated as less harmful to the black ant have been selected for evaluation for vectoring by ants to colonies of aphids. The aim is to identify the best one or two EPF strains for use in biocontrol. Complete ant colonies including a queen, eggs, larvae and workers in artificial terraria are being used.

Effective methods for autumn control of the aphid pests of plum and cherry are also being developed. Large scale replicated experiments in commercial cherry orchards have given good results from autumn treatment with thiacloprid, but the plum experiments, now being repeated, were inconclusive because, following a wet autumn and cold winter, aphid populations were near zero even in the untreated plots

Large scale orchard experiments investigating the efficacy of the oriental fruit moth sex pheromone sprayable and laminate Mating Disruption formulations have demonstrated good results against plum fruit moth. The oriental fruit moth and plum fruit moth have common pheromone components and it is encouraging that these products widely used in southern Europe are effective against plum fruit moth in the UK. Analyses of volatiles from plum fruits and foliage by gas chromatography linked to electroantennographic recording from the antenna of a female plum fruit moth were carried out but no consistent EAG responses were observed to either the natural collections or to synthetic compounds. Further electroantennagram studies of the volatiles are in progress.

Large scale orchard experiments investigating the efficacy of the Exosect Mating Disruption system for control of light brown apple moth in 4 commercial cherry orchards in Kent have been completed. Populations of light brown apple moth were very low at all sites and the results of the trials were inconclusive. However, a harvest assessment showed that high populations of the summer fruit tortrix moth were present in the growing shoots at 3 of the 4 sites and growers reported some damage to fruit on late picked varieties.

After one more year working on specific control measures, in the final 2 years of the project Integrated Pest and Disease Management strategies for plums and cherries combining the biological methods developed above with best crop husbandry practices will be evaluated in commercial orchards, including their economic and environmental impact.

New Projects Starting in 2011

Nine new R&D projects will begin in 2011. They were all commissioned by the Tree Fruit Panel after considering a range of proposals from researchers – the work they chose to fund was in the areas judged to be of the highest priority to the industry.

TF 195 - Sensitivity of apple powdery mildew (*Podosphaera leucotricha*) populations to triazole and strobilurin fungicides
From: April 2011 to March 2014
Project leader: Angela Berrie, EMR
Location: East Malling Research

Apart from apple scab and canker, powdery mildew is probably the most important apple disease in the UK. All varieties are affected, but worst are Cox, Bramley, Gala, Jonagold and Braeburn. Powdery mildew has been particularly prevalent in recent seasons, none more so than in East Kent where badly affected orchards have contained 50-100% mildew-infected shoots on average. This could be attributed to a number of reasons including a limited range of effective fungicides, changes in shoot growth pattern after harvest due to a warmer climate, milder winters leading to improved survival of overwintering mildew, warm wet summers, poor spray cover or insufficient monitoring of mildew development. However, this project will investigate whether there is a significant reduction in the sensitivity of mildew populations to common fungicides (triazoles and strobilurins). It will develop a practical method for assessing the sensitivity of mildew to fungicides and use it to assess the extent of the problem in commercial apple orchards. The information generated will provide the industry with a clearer understanding of apple powdery mildew and the current factors affecting it and how to manage it in the future.

TF 196 - Investigation of the effects of commonly used insecticides on earwigs, important predators in apple and pear
From: April 2011 to March 2013
Project leader: Michelle Fountain, EMR
Location: East Malling Research

Earwigs have long been known to be important predators of tree fruit pests including woolly aphid and other aphid pests, mussel scale, codling moth and pear sucker. Reports that earwigs are declining in some orchards has raised concern, which has been further heightened by research in other European countries which has indicated that thiacloprid, spinosad, indoxacarb and flonicamid are harmful to earwigs. However, the timing of spray applications and the effects of combinations of compounds used in growers' spray programmes have not been considered and UK earwig populations have not been tested against some of these new insecticides. This project will further investigate the

lethal and sub-lethal effects of these and other commonly used insecticides on different earwig life stages. The effects of programmes of insecticide sprays typically used in UK apple and pear production will be investigated. The results will help growers to judge which insecticides to use for vital pest control tasks such as control of codling moth, aphids, mussel scale and pear sucker.

TF 197 - Determining the cost benefit of a range of thinning strategies for apple
From: February 2011 to January 2012
Project leader: Gary Saunders, EMR
Location: East Malling Research

Reducing the cost of hand thinning apples continues to be a major priority for the industry. Finding cheaper and effective methods which lead to an increased grade out of class 1 fruit, would also lead to a reduction in picking costs at harvest time. This project aims to evaluate five different thinning strategies in Gala and compare them to an untreated control. The strategies will include hand thinning at 12-15mm, application of Exilis (6-benzyladenine) at 8-12mm fruit size, application of Exilis at the same stage followed by a quality thin 3 weeks later, application of Exilis at the same stage combined with conventional hand thinning at 12-15mm and thinning in the first week of June by removing wood from the tree.

TF 198 - Developing water and fertiliser saving strategies to improve fruit quality and sustainability of irrigated high-intensity, modern and traditional pear production
From: April 2011 to March 2013
Project leader: Mark Else, EMR
Location: East Malling Research

Irrigation of high-intensity pear orchards is essential if optimum yields of high quality class 1 fruit are to be achieved. The modern high intensity pear system trial at East Malling is comparing four different growing systems which have varying canopy area and structure. Data collected in 2010 using sensors that measure soil matric potential, have demonstrated that the systems have very different irrigation requirements, with significant drainage occurring in some. It would therefore help to develop targeted irrigation strategies to optimise water use efficiency, yields and fruit quality for each growing system. In this project, irrigation test regimes (ITR) will be developed that match demand with supply and reduce losses of water and fertiliser past the rooting zone. Soil matric potentials that ‘set’ the terminal bud without reducing fruit size or quality will also be identified. The effects of the ITRs on shoot extension, fruit yields and quality will be determined and compared to unscheduled commercial controls. Similar trials will be carried out in traditional and modern commercial orchards in Kent. The project will develop guidelines for optimum water and nutrient use efficiencies in traditional, modern and high intensity growing systems on different soil types in the UK.

TF 199 - Optimising the rate of establishment of controlled atmosphere (5/1) Bramley's Seedling stores to improve storage quality
From: August 2011 to September 2013
Project leaders: Angela Berrie, EMR, Debbie Rees and Richard Colgan, NRI
Location: East Malling Research

Since the advent of 5/1 Bramley storage, growers have succeeded in improving the quality of Bramley that is marketed, whilst also gaining improved control of bitter pit and superficial scald. The use of SmartFresh^{TM} or ethylene scrubbing further improves scald control. However, one disadvantage of 5/1 storage, even where SmartFresh^{TM} or ethylene scrubbing are used, is the propensity of the fruit to suffer from CO_2 injury. Previous research has found that to avoid this, establishment of controlled atmosphere conditions for SmartFresh treated fruit should be delayed for 3 weeks. There is concern however that this delay can compromise the quality of fruit stored long term, so some growers have adopted a practice of sealing immediately after loading and scrubbing CO_2 while oxygen levels drop to 10% for 21 days, before 5/1 conditions are allowed to establish. This project aims to define an optimum practice for Bramley during the early period of storage which achieves a quicker establishment of conditions without compromising the control of CO_2. The optimum practice would still achieve improved background green colour, firmness retention and improved scald control. The effect of different establishment regimes on development of core rots will also be assessed.

TF 200 - Determining the effectiveness of novel calcium products to increase fruit calcium in apple, increasing storage potential and potentially reducing bitter-pit
From: February 2011 to July 2012
Project leader: Gary Saunders, EMR
Location: East Malling Research

Calcium levels in apples are known to affect fruit storage potential and the risk of bitter pit development in store. The K:Ca ratio recorded during fruit mineral analysis is also known to influence the storage potential of fruit. A large percentage of orchards regularly suffer from low levels of calcium in the fruit and a high K:Ca ratio predisposing them to poor storage potential. To improve storage potential, growers therefore use a programme of foliar applied calcium sprays during the growing season to improve the levels of calcium in the fruit by harvest. A range of calcium products are sold, but little information is available on the relative effectiveness of each. This project will evaluate eight foliar calcium products on Bramley apple to determine their relative effectiveness at increasing fruit calcium and storage potential and their effectiveness at reducing bitter pit.

TF 201 - Improving quality and reducing costs of Conference pear storage using SmartFresh™

From: August 2011 to July 2013
Project leaders: Angela Berrie, EMR, Debbie Rees and Richard Colgan, NRI
Location: East Malling Research

SmartFresh™ has recently been issued with a SOLA for use on pears, but early experience with this product on pears has found that they often fail to ripen properly after removal from store and in some cases have lost their ability to respond to ripening cues. Subsequent experimental trials have indicated that by modifying storage temperature, or in the case of long-term storage, by reducing application rates, Conference pears retain their ability to ripen. This project will fully investigate the use of higher than recommended temperatures for the whole storage period and also assess the effects of exposure of fruit to low levels of external ethylene in conjunction with SmartFresh™ treatment. The comparable effects of scrubbing ethylene during storage will also be tested. By increasing storage temperatures, the cost of pear storage could be significantly reduced in future.

CP 73 - The role of chemicals in location of host plants by midge pests of UK fruit crops

From: September 2010 to August 2013
Project leader: David Hall, NRI
Location: Natural Resources Institute and East Malling Research

Midge pests are a major problem in many fruit crops and can be extremely difficult to control. In recent years, HDC funds have been used to help scientists at EMR and NRI to identify the female sex pheromones from a range of midge pests including the apple leaf midge, pear leaf midge, pear midge, raspberry cane midge and blackcurrant leaf midge. These sex pheromones are powerful attractants of males and have proved valuable for use in sex pheromone traps for monitoring populations of their target pests to time insecticide sprays. However, the female-produced sex pheromones only attract males. For many years, there has been good evidence in several species of midge that mated females are attracted to their host plants for oviposition by specific odours from the plants, but the chemicals responsible have not been identified. Their identification and use would allow us to interfere with pest life cycles for control purposes. This project aims to identify the chemicals responsible for attraction of mated female midges to oviposition sites on their host crop for the raspberry cane midge, *Resseliella theobaldii*, the blackcurrant leaf midge, *Dasineura tetensii*, and the apple leaf midge, *D. mali*.

CP 77 - Sustainable crop and environment protection – targeted research for edibles - SCEPTRE (Defra Horticulture LINK project HL01106)
From: October 2010 to September 2014
Project leader: Tim O'Neill,ADAS
Industry leader: Bolette Palle Neve, HDC
Industry representatives: David Piccaver (chair), Harriet Duncalfe and John Sedgwick
Location: Various research and commercial sites

Recent EU reviews of pesticides have eliminated 60% of active substances across member states. Many horticultural crops have been particularly badly affected, because certain active substances have not been included on the EU positive list (Annex 1). Despite work by HDC to secure a range of SOLAs to replace many of the active ingredients lost to the soft fruit industry, it is essential that sustainable long-term crop protection measures are developed. This Defra Horticulture LINK project (known as SCEPTRE) will assess and develop new active ingredients, biopesticides, IPM programmes and novel technologies for sustainable pest, disease and weed control in a range of edible crops. The work will have indirect benefits to the ornamentals sector. Specifically on tree fruit, it will focus on powdery mildew in apple and Botrytis in pear. These areas of work were chosen to reflect the highest priorities given the pending losses of further crop protection products as a result of the EU Reviews.

Other HDC Projects of Interest to the Tree Fruit Sector

The following table lists those projects that have been funded from budgets outside of tree fruit. It includes projects past and present which will be of interest or are relevant to tree fruit growers and agronomists. The reports of all those that are complete can be found on the HDC website at www.hdc.org.uk.

Funding sector	Project number	Project title	Project status
Cross panel	**CP 4**	A review of chemical disinfectants, soil treatment with formalin and water treatments for controlling plant pathogens	Final report - 1992
	CP 6	Integrated use of soil disinfection and microbial/organic amendments for the control of soil borne diseases and weeds in sustainable crop productions	Final report - 2003
	CP 19b	The effect of spectral modified filters on invertebrate pest populations	Final report - 2006
	CP 32	Value chain analysis project	Final report - 2008
	CP 38	An investigation of the sex pheromone ecology of some important midge pests of UK fruit crops	Annual report - 2008
	CP 42	Research studentship in the dunnhumby Academy	Annual report - 2007
	CP 48	Use of potassium hydrogen carbonate for powdery mildew control	Final report - 2005
	CP 49	New opportunities for UK horticultural producers	Final report - 2007
	CP 52	Provision of study of responsibility and cost sharing mechanisms in the quarantine plant health sector	Final report - 2007
	CP 53	The use of sterile insect technique to increase the success of IPM in horticultural crops	Annual report - 2010
	CP 54	Rhizobacteria to reduce water use and enhance crop quality	Annual report - 2009
	CP 56	What are the implications of 'Carbon footprinting' for UK horticulture?	Final report - 2007
	CP 57	Packhouse cooling & crop storage: a commercial demonstration & economic evaluation of ground sink	Final report - 2009

		refrigeration	
	CP 58	The development of a pre-selection system for seasonal horticultural labour	Final report - 2009
	CP 59	The development of a champion supervisor model and training programme to improve the selection and training of key staff	Final report - 2008
	CP 60	Combined thermal and visual image analysis for crop scanning and crop disease monitoring	Final report - 2010
	CP 61	Cross-crop benefits: developing crop combinations to promote conservation biological control in horticulture	Annual report - 2010
	CP 62	Carbon storage in orchards	Awaiting first report
	CP 64	HDC: Development of a water strategy for horticulture	Final report - 2009
	CP 71	A summary report of useful information on soil disinfestation for UK growers	Final report - 2009
	CP 75	A summary report of useful information on irrigation gathered for UK growers	Final report - 2010
	CP 84	A summary report of useful information for fruit growers on biodiversity	Final report - 2010
Protected crops	**PC 170**	Protected crops: the potential of spectral filters for pest control	Final report - 2000
	PC/HNS 255a	Biobeds/biofilters for the safe treatment of pesticide waste and washings	Final report - 2008
Hardy nursery stock	**HNS 119**	Reducing levels of Verticillium wilt and nematodes in soils using green manure crops	Final report - 2004
	HNS 137	Evaluation of chemical and biological pre-plant soil treatments for control of Verticillium wilt in field grown trees	Annual report - 2008
	HNS 139	Control of problem weeds in hardy nursery stock production	Final report - 2009
	HNS 143	Development of a banker plant system to improve the biological control of two-spotted spider mite in hardy nursery stock	Final report - 2007

	HNS 157	Optimising defoliation in young trees	Final report - 2010
	HNS 185	Understanding and managing crop protection through Integrated Crop Management	Awaiting first report
Field vegetables	**FV 266**	Mechanical weeding for sustainable and organic salad production	Final report - 2007
	FV 272	Soil disinfestations using electromagnetic radiation in microwave range	Final report - 2005
	FV 273	Field grown horticultural crops. A costed study in the use of selected green manures/biofumigants to control selected horticultural crop pests and diseases and their influence on soil nutritional status and the weed population	Final report - 2006
	FV 299	An investigation into the adoption of green manures in both organic and conventional rotations to aid nitrogen management and maintain soil structure	Final report - 2008
	FV 299a	Extension of FV 299 – Investigation into the adoption of green manures in both organic and conventional rotations to aid nitrogen management and soil structure	Final report - 2009
	FV 315	The effects of biostimulants and plant health promoters in leafy salad crops under disease pressure	Final report - 2008
	FV 334	Perennial field margins with combined agronomical and ecological benefits for vegetable rotation schemes	Annual report - 2009
	FV 338a	Review and evaluation of two phosphate stripping materials for reducing phosphorus concentrations in watercress discharge outflows	Awaiting first report
	FV 344	Sustaining the effectiveness of new insecticides against aphid pests in the UK	Awaiting first report
	FV 345	Establishing best practice for determining soil nitrogen supply –	Awaiting first report

		addition of field veg sites to HGCA project 3425	
	FV 346	Desk study for electrical weed control in field vegetables	Final report - 2009
	FV 375	Novel strategies for pest control in field vegetable crops	Awaiting first report
	FV 385	The influence of vegetable production on farmland bird populations	Awaiting first report
Soft fruit	**SF 55**	Alternatives to organophosphorus and carbamate insecticides for control of pests in strawberries	Final report - 2001
	SF 61	Predators and parasitoids to control aphids in protected strawberry cultivation	Final report - 2005
	SF 66	Review of bio-control strategies and novel products for control of key pests and diseases in strawberry and raspberry	Final report - 2005

SOLAs Secured for the Tree Fruit Industry in the Last Year

Apples

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Fubol Gold WG (10184)	mancozeb/ metalaxyl-M	0005/10	Apple (applied to orchard floor)	Phytophthora fruit rot, white blister
Savannah	tebuconazole	1183/10	Apple	Canker
Starpro	tebuconazole	1221/10	Apple	Canker
Fubol Gold WG	mancozeb/ metalaxyl-M	1734/10	Apple and orchard floor	Phytophthora fruit rot
Tomahawk	fluroxypyr	1920/10	Apple (applied to orchard floor)	Volunteer potatoes and broad-leaved weeds
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Dow Shield 400	clopyralid	2080/10	Apple (applied to orchard floor)	Compositae weeds and creeping thistle
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Asteroid	glyphosate	2476/10	Apple (applied to orchard floor)	General weed control
Cerone (09985)	2-chloroethyl phosphonic acid	2501/10	Apple	Plant growth regulator
Cliophar	clopyralid	2682/10	Apple (applied to orchard floor)	Annual weeds, compositae, creeping thistle, groundsel, mayweed, thistle spp.
Dow Shield	clopyralid	2719/10	Apple (applied to orchard floor)	Compositae weeds and creeping thistle
Cerone	2-chloroethyl phosphonic acid	2740/10	Apple	Plant growth regulator
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Lontrel 200	clopyralid	2888/10	Apple (applied to orchard floor)	Compositae weeds and creeping thistle

Pears

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Regulex	gibberellins	1047/10	Pear	Plant growth regulator
Regulex 10 SG (13323)	gibberellins	1050/10	Pear	Plant growth regulator
Savannah	tebuconazole	1183/10	Pear	Canker
Starpro	tebuconazole	1221/10	Pear	Canker
Tomahawk	fluroxypyr	1920/10	Pear (applied to orchard floor)	Volunteer potatoes and broad-leaved weeds
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Dow Shield 400	clopyralid	2080/10	Pear (applied to orchard floor)	Compositae weeds and creeping thistle

Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Smartfresh	1-methylcyclo propene	2424/10	Pear (stored)	Plant growth regulator
Asteroid	glyphosate	2476/10	Pear (applied to orchard floor)	General weed control
Regalis	Prohexadione-calcium	2622/10	Pear	Plant growth regulator
Cliophar	clopyralid	2682/10	Pear (applied to orchard floor)	Annual weeds, compositae, creeping thistle, groundsel, mayweed, thistle spp.
Dow Shield	clopyralid	2719/10	Pear (applied to orchard floor)	Compositae weeds and creeping thistle
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Lontrel 200	clopyralid	2888/10	Pear (applied to orchard floor)	Compositae weeds and creeping thistle
Scala	pyrimethanil	2948/10	Pear	Pear scab

Quince

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Regulex	gibberellins	1047/10	Quince	Plant growth regulator
Regulex 10 SG (13323)	gibberellins	1050/10	Quince	Plant growth regulator
Savannah	tebuconazole	1183/10	Quince	Canker
Starpro	tebuconazole	1221/10	Quince	Canker
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Asteroid	glyphosate	2476/10	Quince (applied to orchard floor)	General weed control
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Dipel DF	Bacillus thuringiensis var. kurstaki	2882/10	Quince	General insect control
Scala	pyrimethanil	2946/10	Quince	Unspecified fungicide

Plums

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Signum	boscalid/ pyraclostrobin	2109/10	Protected and outdoor plum	Blossom wilt, brown rot
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Aphox	pirimicarb	2318/10	Plum	Leaf curling aphid, mealy plum aphid

Phantom	pirimicarb	2355/10	Plum	Leaf curling aphid, mealy plum aphid
Asteroid	glyphosate	2476/10	Plum	General weed control
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Dipel DF	Bacillus thuringiensis var. kurstaki	2882/10	Plum	General insect control
Switch	cyprodinil/ fludioxonil	3092/10	Plum	Blossom wilt, Botrytis, storage rots

Cherries

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Berelex (08903)	gibberellins	1044/10	Protected and outdoor cherry	Plant growth regulator
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Signum	boscalid/ pyraclostrobin	2109/10	Protected and outdoor cherry	Blossom wilt, brown rot
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Asteroid	glyphosate	2476/10	Cherry	General weed control
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Switch	cyprodinil/ fludioxonil	3092/10	Cherry	Blossom wilt, Botrytis, storage rots

Apricots

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Asteroid	glyphosate	2476/10	Apricot	General weed control
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Dipel DF	Bacillus thuringiensis var. kurstaki	2882/10	Apricot	General insect control
Switch	cyprodinil/ fludioxonil	3092/10	Cherry	Blossom wilt, Botrytis, storage rots

Nuts

Product	Active ingredient	SOLA No.	Crops	Target pest/disease
Savannah	tebuconazole	1177/10	Outdoor cobnut and walnut	Canker
Starpro	tebuconazole	1219/10	Outdoor cobnut and walnut	Canker
Tomahawk	fluroxypyr	1920/10	Hazelnut and walnut (applied to orchard floor)	Volunteer potatoes and broad-leaved weeds
Agrovista Reggae	thiacloprid	2034/10	Outdoor top fruit	Unspecified insecticide
Signum	boscalid/ pyraclostrobin	2111/10	Protected and outdoor top fruit	Unspecified fungicide
Cliophar	clopyralid	2682/10	Hazelnut and walnut	Annual weeds, compositae, creeping thistle, groundsel, mayweed, thistle spp.
Markate 50	lambda-cyhalothrin	2880/10	Outdoor top fruit	Unspecified insecticide
Dipel DF	Bacillus thuringiensis var. kurstaki	2882/10	Cobnut, hazelnut and walnut	General insect control
UPL Camppex	2,4-D -/dichlorprop-P/MCPA/ Mecoprop-P	2941/10	Hazelnut and walnut (applied to orchard floor)	Unspecified herbicide