

Fungicide Resistance Management in Apple and Pear Pathogens

March 2015



Introduction

Fungicides are used intensively in top fruit production. In apples, routine spray programmes are applied in orchards to control powdery mildew and scab. Other treatments may be used to control blossom wilt, crown rot, collar rot, Nectria canker and a range of storage rots. Fungicides may also be applied to the orchard floor to control *Phytophthora* rots. Pears receive fewer treatments but scab and storage rot control are essential. For further guidance on apple or pear disease management, see the Horticultural Development Company "Apple Best Practice Guide" <http://apples.hdc.org.uk> and "Pear Best Practice Guide" (available in hard copy from the HDC).

Resistance terminology

Resistance occurs when a pathogen becomes so insensitive to a fungicide that the fungicide's field performance is impaired. Resistance can arise rapidly and completely so that disease control is lost in a single step. More commonly, resistance develops gradually so that the pathogen becomes progressively less sensitive. When this happens there is usually no initial detectable loss of control, but it may decline over time.

Current fungicide resistance situation in apples and pears in the UK

Pathogen	Disease	Crop	Fungicide performance affected by resistant or less sensitive strains
<i>Venturia inaequalis</i>	scab	apple	DMIs, dodine
<i>Venturia pirina</i>	scab	pear	none
<i>Podosphaera leucotricha</i>	mildew	apple and pear	DMI
<i>Neonectria ditissima</i>	canker and fruit rot	apple and pear	none
<i>Monilinia laxa</i> f.sp. <i>mali</i>	blossom wilt	apple	none
<i>Phytophthora cactorum</i>	collar or crown rot	apple	none
<i>Botrytis cinerea</i>	fruit rot	apple and pear	dicarboximides
<i>Monilinia fructigena</i>	brown rot	apple and pear	none
<i>Phytophthora syringae</i>	fruit rot	apple	metalaxyl-M
<i>Penicillium expansum</i>	fruit rot	apple and pear	none
<i>Gloeosporium</i> * spp.	fruit rot	apple and pear	none

* Now *Neofabraea* spp.

In addition to the above, resistance to the MBC fungicides developed in the UK in *V. inaequalis* and several of the fungal species causing storage rots, but since MBC fungicides are no longer approved for use on top fruit, this is not of current relevance.

FRAG-UK

The Fungicide Resistance Action Group - UK (FRAG-UK) is a forum to look at fungicide resistance issues and to publish information and advice relevant to the UK. The group combines the expertise of industry with the independent sector to produce up-to-date information on the resistance status of important diseases in UK agriculture and to suggest ways of combating resistance once it has occurred.



Integrated Control and Resistance Management Guidelines

- An integrated approach to disease and crop management should be adopted to avoid over-reliance on fungicides, which increases the risk of selecting resistant pathogen strains.
- **Variety choice:** for apple and pear growers, variety choice is a long-term decision based on market requirements, the end use of the crop and local conditions, but where possible consider disease susceptibility when establishing new orchards. Most of the new varieties (eg Gala, Cameo, Rubens, Kanzi) currently being planted are susceptible to scab and Nectria canker and careful consideration should be given to not planting these in disease-prone sites, especially with respect to Nectria canker.
- **Inspect orchards** regularly to identify pathogen presence and assess disease incidence/severity to determine risk. In most cases a protectant spray programme is used in apple and pear orchards to control diseases, but regular orchard inspections for disease allow the grower to adjust spray interval and fungicide choice according to risk.
- **Optimise fungicide timing:** where available, make use of disease warning systems e.g. for apple scab. RIMpro, which includes a model for ascospore release, is the most widely used scab warning system. The information generated is best used to determine fungicide choice and spray timing.
- **Use fungicides appropriately:** use effective doses, avoid repeated use of fungicides with the same mode of action, choose fungicides appropriate for the growth stage.
- **Make use of cultural controls:** e.g. prune out cankers, remove plant debris e.g. fallen fruit, encourage breakdown of leaves with urea where appropriate.
- **Apply dormant season treatments:** e.g. autumn fungicide applications to protect leaf scars from canker.
- **Storage rots:** Adopt a whole season approach for management of storage rots rather than control immediately pre-harvest. Make use of 'rot risk assessment' (Apple Best Practice Guide) to plan your strategy and identify alternative controls to fungicides.

Disease profiles

Apple Scab (*Venturia inaequalis*)



Apple scab is common and potentially a very damaging disease. It attacks leaves and shoots, but infection is most serious on fruit, as the reduced quality affects crop marketability. Resistance to MBC fungicides was encountered soon after they were first marketed and these fungicides are no longer approved for use on top fruit.

Until the advent of DMIs, growers relied heavily on captan, dithianon and dodine. Resistance to dodine was first reported from the USA. Cases have also been confirmed in the UK, where the scab control programme was reliant on that product. DMIs have been important for scab control, but reduced sensitivity to fenarimol and myclobutanil has been reported. Resistance to QoI fungicides in *V. inaequalis* has been reported from the USA and Poland, and also recently from the UK. Disease control can be maintained by making full use of the range of products with different modes of action available to growers. These include DMIs, dithianon, dodine, captan, the anilinopyrimidines cyprodinil and pyrimethanil, QoIs, the SDHI boscalid, dithiocarbamates and potassium hydrogen carbonate.

Field Performance

- Sensitivity shifts to some DMIs have been reported in apple scab, which, in some cases, may contribute to disease control problems. However, in most cases incorrect spray timing or poor spray coverage may be more significant.
- Where too much reliance has been placed on dodine in a spray programme, reduced disease control has resulted.

Guidelines

- Use a protectant spray programme that makes full use of the available range of fungicides with different modes of action.
- Use scab warning systems to optimise fungicide spray timings and choice of product.
- Use urea sprays before leaf fall to encourage leaf rotting during winter, so minimising overwintering scab inoculum.

Apple Powdery Mildew (*Podosphaera leucotricha*)



After scab, powdery mildew is the most important and widespread disease of apple. The pathogen overwinters as mycelium in fruit and vegetative buds, which emerge in spring as 'primary' mildew. Spores spread to developing leaves and shoots during summer as 'secondary' mildew. In spring the amount of 'primary' blossom and shoot infection reflects the success of the previous season's spray programme and the size of the problem for the coming season. On susceptible cultivars season-long (pre-blossom to end of shoot growth) programmes of 10-15 sprays are required to protect new growth and minimise mildew overwintering in the bud.

Sensitivity to DMIs has been monitored in *P. leucotricha*, and variations detected. Problems with reduced field efficacy can now be attributed directly to the occurrence of pathogen strains with reduced sensitivity to fungicides. However, where poor disease control occurs using fungicides at extended intervals, reduced doses and/or poor spray cover also contribute. In recent years, effective mildew control has become more difficult due to the limited range of active ingredients available and changes to the bupirimate label which have made this product less useful as an alternative. In pear, powdery mildew is much less significant and does not usually affect the leaves, but can appear on fruit of the varieties Comice and Concorde.

As mildew control relies heavily on DMIs, it is important to include alternative fungicides in the routine preventative spray programme to minimise the risk of selection of less sensitive strains developing. Bupirimate, cyflufenamid, kresoxim-methyl, pyraclostrobin + boscalid and pyraclostrobin + dithianon are possible alternatives. Note that no more than two applications of cyflufenamid may be used, and that kresoxim-methyl and pyraclostrobin are both QoIs and subject to label restrictions on the number and timing of applications within the spray programme. Sulphur is less effective and can cause russet on the fruit of some varieties if used at the full dose. It can also be toxic to predatory mites, but less so at reduced dose. Thus use of sulphur may not be compatible with Integrated Crop Management if not managed carefully. Potassium hydrogen carbonate may also be used on apples for mildew control; it can act as an eradicant or suppress sporulation.

Field Performance

- Variations in sensitivity to some DMIs have been reported in apple powdery mildew, and now contribute to poor disease control. Poor spray coverage and extended spray intervals are also significant.

Apple Powdery Mildew (*Podosphaera leucotricha*)

Guidelines

Guidelines for management of powdery mildew to optimise disease control and fungicide use are well documented in the Apple Best Practice Guide and summarised below:

- Assess primary blossom and vegetative mildew in spring to gauge the success of the previous season's programme and the size of the problem for the new season.
- Monitor the progress of the mildew epidemic on the extension growth by assessing secondary mildew on the top five leaves of the extension growth.
- Use the information in conjunction with weather conditions and amount of shoot growth to adjust the fungicide programme by choice of product, spray interval and spray volume.
- Use fungicides with different modes of action where this is possible.
- For products containing Qols, do not use more than two consecutive applications and separate with a minimum of two applications from a different fungicide group. Where the fungicide programme is planned to use fewer than 12 applications in total, use a maximum of three applications of products containing Qols. Do not apply Qols as the final spray of the season.

Nectria Canker & Fruit Rot (*Neonectria ditissima*)



Canker is one of the most important diseases of apple and pear. The fungus attacks trees in the orchard, causing cankers and die-back of young shoots, resulting in loss of fruiting wood and increasing pruning costs. Apple canker can be particularly damaging in young orchards where, in some years, up to 10% of trees can be lost annually during establishment. *Neonectria* also causes a fruit rot (eye rot) that can result in losses of 10% or more in stored fruit. Nectria rot, which is often at the fruit stalk end, is difficult to spot on the grading line, but becomes obvious during marketing leading to rejection of fruit consignments. Losses in store can be particularly high in the variety Bramley's Seedling, which is stored for almost 12 months of the year. The fungus produces two spore types, conidia in the spring and summer and ascospores in the autumn and winter. These infect shoots and branches on the tree through wounds, either natural such as leaf scars or artificial such as pruning wounds. Thus inoculum and points of entry on the tree are available all year round and the only limiting factor is rain, which is essential for spore production, spread, germination and infection. Autumn leaf fall is usually the main infection period and wet autumns are often followed by a high incidence of shoot dieback due to canker the following spring and summer.

Nectria Canker & Fruit Rot (*Neonectria ditissima*)

Currently canker is controlled by a combination of cultural methods to remove canker lesions and the use of protectant fungicides. Effective fungicides are currently limited. Generally copper fungicides are used at autumn leaf fall and before budburst to protect leaf scars and bud-scale scars. Tebuconazole (Folicur) has an EAMU for use post-harvest during leaf fall. However, products effective against *Neonectria* that can be used in the growing season are limited. When dithianon, dodine or captan are used to control scab, some reduction in canker may be expected. Boscalid + pyraclostrobin and cyprodinil + fludioxonil may also give some control of canker and fruit rot.

Field Performance

Control of canker is difficult as inoculum and points of entry on the tree are available all year round and the only limiting factor is rain, which is essential for spore production, spread, germination and infection. Current fungicide products available are only partially effective. There is no evidence of fungicide resistance or reduced sensitivity.

Guidelines

Guidelines for management of Nectria canker and fruit rot to optimise disease control and fungicide use are well documented in the Apple Best Practice guide and summarised below.

Canker

- Inspection of orchards for Nectria cankers during winter pruning and for shoot die back in spring/summer due to canker will give an indication of the problem in orchards. In addition assessment of *Nectria* rot incidence during fruit grading from store will also give an indication of canker incidence in the orchard.
- Effective control of canker requires an integrated approach.
- In winter, prune out cankers where possible or pare back cankers on scaffold branches to healthy tissue.
- If possible remove prunings from orchard and burn; otherwise macerate pruning debris.
- In summer prune out shoot dieback as soon as possible to reduce inoculum for fruit rot.
- In orchards with low canker incidence at autumn leaf fall, apply a spray of a copper fungicide at 10% leaf fall and repeat at 50% leaf fall.
- In orchards with moderate to high canker incidence apply a spray of tebuconazole at the start of leaf fall, a spray of a copper fungicide at 10% leaf fall, then a spray of tebuconazole at 50% leaf fall with a second copper spray at 90% leaf fall.

Nectria Canker & Fruit Rot (*Neonectria ditissima*)

Guidelines

Nectria Fruit rot

- Orchards at risk from Nectria rot can be identified in spring based on the incidence of cankered trees in the orchard (<5% = low risk, 5-25% = moderate risk, >25% = high risk) and the rot history from pack house records. The risk of Nectria rot in store can then be further assessed based on the rainfall between blossom and harvest.
- Apply sprays of captan or pyraclostrobin + boscalid (Bellis) or cyprodonil + fludioxonil (Switch) to orchards where a risk has been identified during blossom and at petal fall. These will give fruit some protection against Nectria rot and are essential in orchards with a high canker incidence if fruit is to be stored without significant losses beyond Christmas.
- The same treatments can be applied pre-harvest in late July and August.
- In orchards where a high canker risk has been identified, the best option may be to avoid chemical treatment and schedule the fruit for early marketing before Christmas to minimise losses.
- The Nectria risk of fruit from lower risk orchards is based on the amount of rainfall blossom-harvest. In seasons when rainfall is above average this fruit may also need to be scheduled for early marketing if sprays at blossom and petal fall were not applied.

Blossom Wilt (*Monilinia laxa* f.sp. *mali*)

Blossom wilt is an occasional disease of dessert and culinary apples, but where it occurs on very susceptible varieties such as James Grieve, Cox and Lord Derby it can cause significant losses. The disease is much more prevalent on cider apples where most commercially-grown varieties appear to be susceptible and control measures are more difficult to implement. Pear trees are rarely affected.

Field Performance

Currently there are no products specifically recommended for control of blossom wilt, but fungicide products such as fenbuconazole, pyraclostrobin + boscalid, pyrimethanil or cyprodonil + fludioxonil are known to give some control of the disease.

Guidelines

- In dessert and culinary apples routine treatments are not required every season but in cider apples routine treatments may be required each season where the disease has become established.
- Monitor orchards of susceptible varieties for symptoms. During winter check trees for cankers with grey pustules and after blossom look for wilting dying blossoms.
- Effective control requires an integrated approach.
- In dessert and culinary orchards cut out affected blossoms, cankers and spurs during early summer when they are easily visible.

Blossom Wilt (*Monilinia laxa* f.sp. *mali*)

Guidelines

- In the following one or two seasons after detection apply a spray of fenbuconazole (Indar) or pyraclostrobin + boscalid (Bellis) or cyprodonil + fludioxonil (Switch) or pyrimethanil (Scala) at first flower and repeat 7-10 days later.
- In cider orchards pruning out infected blossoms is not possible. Where the disease is present or on very susceptible varieties (e.g. Somerset Redstreak), apply a spray of fenbuconazole (Indar), pyraclostrobin + boscalid (Bellis), cyprodonil + fludioxonil (Switch) or pyrimethanil (Scala) at first flower and repeat 7-10 days later. Where the disease is present at high incidence a four spray programme, using different fungicide products, may be needed, starting at pink bud.

Phytophthora Collar or Crown Rot (*Phytophthora cactorum*)



Collar rot and crown rot are distinct diseases of apple trees caused by *Phytophthora* species, mainly *P. cactorum*. Collar rot is a disease of the scion portion of the tree and is sporadic in occurrence. Crown rot is a disease of the rootstock portion of the tree and is usually important on young trees during orchard establishment.

Collar rot trunk lesions can be controlled if spotted early. Lesions can be cut out and painted. Aliette (fosetyl-Al) applied as a paste to the cut out area was effective in controlling collar rot, but this product is no longer available and an alternative has not been identified. Pear trees are not affected by crown rot and collar rot.

Protectant drenches applied to the bases of young trees during orchard establishment can prevent crown rot, but no products are currently approved for this use.

Copper oxychloride has an EAMU (0584/2014) for the control of collar rot. The product must be applied as a dilute solution to the tree trunk by paint brush or spray with latest time of application by bud burst. This treatment has only limited efficacy for control of collar rot. Metalaxyl-M + mancozeb has no approval (on or off-label) for control of *P. cactorum*.

Phytophthora Collar or Crown Rot (*Phytophthora cactorum*)

Field Performance

Currently there are no products available for control of collar rot or crown rot apart from copper oxychloride which has EAMU for use to control collar rot and crown rot. However, experience indicates this has only limited efficacy.

Guidelines

- Guidelines for management and control of collar rot and crown rot can be found in the Apple Best Practice Guide.
- Control of crown rot by copper oxychloride remains partially effective.

Botrytis Fruit Rot (*Botrytis cinerea*)



On pears *Botrytis* gains entry through wounds at harvest and accounts for 60 to 80% of rotting in pear stores. By contrast, in apples, *Botrytis* is only of minor importance in the UK as a wound rot in store, but can cause significant losses in some seasons, especially in Cox, as a calyx-end rot resulting from infection of the calyx during flowering which remains latent and subsequently develops in store.

Pre-harvest applications of fungicides on pears (e.g. thiram, boscalid +pyraclostrobin, cyprodinil + fludioxonil, fludioxonil) are only partially effective. Best control is achieved by a post-harvest drench with iprodione (pears only under EAMU 1761/08). Cases of dicarboximide resistance in *B. cinerea* have been found in surveys of pear fruit rots, but iprodione remains largely effective.

For apples, sprays applied at flowering time to control other diseases which are also active against *Botrytis* are ineffective in controlling the calyx rot.

Note that as Extensions of Authorisations for minor use conditions are not given on the product label, it is essential that anyone who needs to use a pesticide product in accordance with an Extension of Authorisation for Minor Use has a copy of the EAMU and reads the text before commencing any application. Post-harvest drenches may not be acceptable to all end users, so growers should check with their buyers before treating fruit.

Botrytis Fruit Rot (*Botrytis cinerea*)

Field Performance

- In pears, dicarboximide resistance is rare and rot control with the post-harvest drench is still adequate.
- Pre-harvest fungicide treatments are only partially effective in controlling Botrytis rot.
- In apples, fungicides active against Botrytis applied at flowering time to control other diseases have proved ineffective in controlling the calyx rot.

Guidelines

- Minimise damage to fruit, especially pears, at harvest. On pears, where Botrytis is the main problem, consider use of iprodione as a pre-storage drench.
- Guidelines on minimising losses due to Botrytis rot in apples can be found in the Apple Best Practice Guide.

Brown rot (*Monilinia fructigena*)



Brown rot is an important disease of apple fruits causing significant losses in store and in the orchard. All varieties are susceptible.

Field Performance

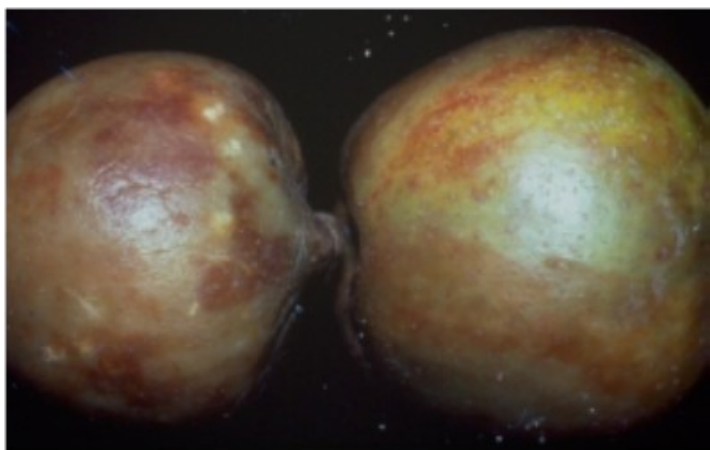
Pre-harvest fungicide sprays with captan or cyprodonil + fludioxonil (Switch) or pyraclostrobin + boscalid (Bellis) are only partially effective as the fungus invades fruit through damage such as insect holes.

Brown rot (*Monilinia fructigena*)

Guidelines

- Effective control depends upon an integrated approach.
- In winter cut out cankers and remove mummified fruit to reduce inoculum.
- In the growing season ensure good control of scab and pests to minimise entry points for brown rot.
- In July / August estimate the % fruit with brown rot on about 20 trees per orchard.
- Orchards with <1% brown rot per tree are low risk.
- Where the incidence of orchard brown rot exceeds 1% per tree, schedule fruit for medium to short-term storage.
- At harvest selectively pick fruit so only sound fruit is stored. This will reduce the risk of introducing symptomless infected fruit into the bin.
- Pre-harvest fungicide sprays with captan or cyprodonil + fludioxonil (Switch), fludioxonil (Geoxe) or pyraclostrobin + boscalid (Bellis) are only partially effective as the fungus invades fruit through damage.

Phytophthora Fruit Rot (*Phytophthora syringae*)



Phytophthora fruit rot only became common in apples when the use of herbicide strips under trees was introduced in the 1970s. Low-hanging fruit become infected by the pathogen being splashed onto fruit from the soil during heavy rain. Phytophthora fruit rot can also occur on pears. The introduction of metalaxyl as a fruit drench in the 1980s was very effective and largely alleviated Phytophthora rot. However, strains of the pathogen less sensitive to metalaxyl were first found in surveys in the mid-1990s. There are no longer any approvals (either on or off-label) for post-harvest drenching of fruit with fungicides to control fungal rots.

Metalaxyl-M + mancozeb has an EAMU (2282/13) for application post-harvest to the orchard floor to reduce apple fruit rot (but not pear). Pre-harvest sprays of captan or boscalid + pyraclostrobin may also give some protection of fruit against Phytophthora rot.

Phytophthora Fruit Rot (*Phytophthora syringae*)

Field Performance

- There is no evidence that the presence of less sensitive strains of *P. syringae* has reduced the efficacy of metalaxyl-M.

Guidelines

- Guidelines for the management of Phytophthora fruit rot can be found in 'Rot risk assessment' in the Apple Best Practice Guide.
- The risk of Phytophthora rot pre-harvest for an orchard can be determined from the orchard rot history, the % bare ground, the proportion of the crop less than knee-height above the soil and hence at risk from soil splash, and the accumulated rainfall 15 days pre-harvest.
- The risk of rotting in store can be reduced by mulching the soil surface, selectively picking so only fruit above knee-height are stored and/or fungicide sprays (pyraclostrobin + boscalid (Bellis)) sprays at one month and 14 days pre-harvest.
- Metalaxyl-M + mancozeb as a spray to the orchard floor may also be used.
- Alternatively, the decision on action on Phytophthora risk can be made at harvest and fruit scheduled for early marketing to minimise losses where a risk has been determined.

Penicillium Rot (*Penicillium expansum*)



Penicillium rot is frequently found in stored apples and pears. Infection usually occurs in damaged fruit and is often secondary to other fruit-rotting fungi. There are no longer any approvals (either on or off-label) for post-harvest drenching of fruit with fungicides to control fungal rots.

Guidelines

- Pre-harvest fungicide treatment is generally ineffective against Penicillium as rot incidence is related to fruit damage but both cyprodonil + fludioxonil (Switch) and pyraclostrobin + boscalid (Bellis) are active against *P. expansum* and may give some control.
- Control or prevention of Penicillium rot is mainly dependent on good hygiene, particularly of bins, and of good supervision at harvest to minimise damage to fruit and to ensure only sound fruit is picked for storage.
- Correct nutrition of fruit, especially calcium, to ensure apples are suitable for long-term storage is also important.

Gloeosporium rot (*Gloeosporium* spp.)



Gloeosporium and Colletotrichum can be important causes of rotting in stored Cox and other varieties and both have increased in incidence in recent years. They rarely cause a rot in the orchard.

The rots are caused by three species of fungi, mainly *G. album* (now *Neofabraea alba*) and *G. perennans* (now *Neofabraea malicortis*) and *Colletotrichum* spp. (formerly *G. fructigenum*).

Guidelines

- Control is based on an integrated approach combining cultural measures of inoculum removal in the orchard with chemical control where a risk has been identified.
- Only fruit of the correct mineral composition should be stored long-term.
- Orchards with a history of Gloeosporium or Colletotrichum rot should be sprayed pre-harvest with sprays of captan or cyprodonil + fludioxonil or pyraclostrobin + boscalid or thiram in July and August. Check product label for harvest interval.

Fungicide Groups for control of apple & pear pathogens

Fungicide Group (FRAC Code)	Active ingredient(s)	Product names (examples)	Apple/ Pear	Diseases controlled (or partially controlled) in absence of resistant strains		
				Mildew M	Scab S	Nectria canker N
Orchard Sprays						
Anilinopyrimidine (9)	pyrimethanil	Scala , EAMU on pears (0295/2011)	A	-	S	-
Anilinopyrimidine (9) + phenylpyrrole (12)	cyprodinil + fludioxonil	Switch	AP	(M)	(S)	(N)
DMI (3)	difenoconazole	Difference	AP	-	S	-
	penconazole	Topas	A	M	-	-
	myclobutanil	Systhane 20 EW	AP	M	S	-
	tebuconazole	EAMU: Folicur, applied post-harvest (2159/2008)	AP	-	-	N
	fenbuconazole	Indar 5 EW	AP	(M)	S	-
Dicarbonitrile (M9)	dithianon	Dithianon WG	AP	-	S	(N)
Dicarbonitrile (M9) + QoI (11)	dithianon + pyraclostrobin	Maccani	AP	(M)	S	(N)
Dithiocarbamate (M3)	mancozeb	Karamate Dry Flo	AP	-	S	-
	thiram*	Thianosan DG*	AP	-	S	-
Guanidine (U12)	dodine	Syllit 400 SC	AP	-	S	(N)
Hydroxypyrimidine (A2)	bupirimate	Nimrod	AP	M	-	-
Inorganic copper (M1)	copper oxychloride	Cuprokylt	AP	-	(S)	N
	Bordeaux mixture**	Bordeaux Mixture**	AP	-	(S)	N
Inorganic sulphur (M2)	sulphur	Headland Sulphur	AP	M	S	-
Not classified (NC)	potassium hydrogen carbonate (potassium bicarbonate)	Commodity substance Karma	A	(M)	S	-
Phenylacetamide (U6)	cyflufenamid	Cosine	AP	M	-	-
Phenylamide (4) + dithiocarbamate (M3)	metalaxyl-M+ mancozeb	EAMU: Fubol Gold WG, applied to orchard floor (2281/2013)	A	-	-	-
Phenylpyrrole (12)	fludioxonil	Geoxe	AP	(M)	(S)	(N)
Phthalimide (M4)	captan	PP Captan 80 WG	AP	-	S	(N)
QoI (11)	kresoxim-methyl	Stroby WG	A	(M)	S	-
Succinate Dehydrogenase Inhibitor (7) + QoI (11)	boscalid + pyraclostrobin	Bellis	AP	M	S	(N)

* approval expires 31/8/15; ** approval expires 30/11/2015

Fungicide Groups for control of apple & pear pathogens

Fungicide Group (FRAC Code)	Active ingredient(s)	Product names (examples)	Apple/Pear	Diseases controlled (or partially controlled) in absence of resistant strains			
				<i>P. cactorum</i> / <i>P. syringae</i> Pc/Ps	<i>M. laxa</i> / <i>M. fructigena</i> MI/Mf	<i>Gloeosporium</i> spp. G	<i>Botrytis cinerea</i> B
Orchard Sprays							
Anilinopyrimidine (9)	pyrimethanil	Scala , also EAMU on pears (0295/2011)	A	-	(MI)	-	-
Anilinopyrimidine (9) + phenylpyrrole (12)	cyprodinil + fludioxonil	Switch	AP	-	(MI/Mf)	(G)	(B)
DMI (3)	difenoconazole	Difference	AP	-	-	-	-
	penconazole	Topas	A	-	-	-	-
	myclobutanil	Systhane 20 EW	AP	-	-	-	-
	tebuconazole	EAMU: Folicur, applied post-harvest (2159/2008)	AP	-	-	-	-
	fenbuconazole	Indar 5 EW	AP	-	(MI)	-	-
Dicarbonitrile (M9)	dithianon	Dithianon WG	AP	-	-	-	-
Dicarbonitrile (M9) + QoI (11)	dithianon + pyraclostrobin	Maccani	AP	-	-	-	-
Dithiocarbamate (M3)	mancozeb	Karamate Dry Flo	AP	-	-	-	-
	thiram	Thianosan DG*	AP	-	-	G	B
Guanidine (U12)	dodine	Syllit 400 SC	AP	-	-	-	-
Hydroxypyrimidine (A2)	bupirimate	Nimrod	AP	-	-	-	-
Inorganic copper (M1)	copper oxychloride	Cuprokylt	AP	-	-	-	-
	Bordeaux mixture	Bordeaux Mixture**	AP	-	-	-	-
Inorganic sulphur (M2)	sulphur	Headland Sulphur	AP	-	-	-	-
Not classified (NC)	potassium hydrogen carbonate (potassium bicarbonate)	Commodity substance Karma	A	-	-	-	-
Phenylacetamide (U6)	cyflufenamid	Cosine	AP	-	-	-	-
Phenylamide (4) + dithiocarbamate (M3)	metalaxyl-M+ mancozeb	EAMU: Fubol Gold WG, applied to orchard floor (2281/2013)	A	Ps	-	-	-
Phenylpyrrole (12)	fludioxonil	Geoxe	AP	-	(MI/Mf)	(G)	(B)
Phthalimide (M4)	captan	PP Captan 80 WG	AP	Ps	-	G	B
QoI (11)	kresoxim-methyl	Stroby WG	A	-	-	-	-
Succinate Dehydrogenase Inhibitor (7) + QoI (11)	boscalid + pyraclostrobin	Bellis	AP	-	(MI/Mf)	(G)	(B)

* approval expires 31/8/15; ** approval expires 30/11/2015

Fungicide Groups for control of apple & pear pathogens

Fungicide Group (FRAC Code)	Active ingredient (s)	Product names (examples)	Apple/Pear	Diseases controlled (or partially controlled) in absence of resistant strains			
				<i>P. cactorum</i> / <i>P. syringae</i> Pc/Ps	<i>M. laxa</i> / <i>M. fructigena</i> MI/Mf	<i>Gloeosporium</i> spp. G	<i>Botrytis cinerea</i> B
Post-harvest Drench							
Dicarboximide (2)	iprodione	EAMU: Rovral WG (1761/2008)	P	-	-	-	B
Paints/Pastes							
Inorganic copper (M1)	copper oxychloride	EAMU: Cuprokylt FL, applied as paint or coarse spray for control of collar rot (0584/2014), expires 30/11/2015	A	(Pc)	-	-	-

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The information on Plant Protection Products is correct at the time of publishing. Users must always ensure that Plant Protection Products are used correctly and in line with product authorisations and label directions.

This leaflet and further information on resistance are available from the FRAG-UK website
www.pesticides.gov.uk/rags.asp?id=644

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