TECHNICAL BOOKLET JANUARY 2010

Botrytis Management

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1.0 Introduction

This module aims to review and consolidate current information on best practice management of botrytis bunch rot, hereafter referred to as 'botrytis'. The module presents a general strategy for managing botrytis which will be the same for any vineyard in any region. Regions will vary, however, in the selection of botrytis management tactics, based on the factors contributing to botrytis risk and the intensity and type of viticultural practices, as dictated by climate and grape price. The tactics presented in the module have a distinct bias towards high input, cool climate regions because botrytis occurs relatively frequently in these vineyards. Nevertheless, tactics that would be impractical to apply in low input vineyards, in terms of cost, are highlighted clearly with the dot point symbol ©.

This module will provide

- A basic understanding of how botrytis bunch rot develops in grapes
- A description of the key stages in the pathogen lifecycle where disease management should be directed. These key stages are called 'critical control points'. Pathogen, vine and environmental factors that increase botrytis risk at each critical control point will be highlighted.
- A description of management measures that can be applied at each critical control point.
- A general but systematic process for identifying site-specific botrytis risk factors and evaluation of disease management according to crop stage or time of year.

The presentation is structured around three main themes:

1. How does botrytis develop?

2. Critical control points: what's in the tool box?

3. Integrated botrytis management

The presentation concludes with take home messages that summarise conditions for high botrytis risk, the process for integrated botrytis management and what to do when all else fails.

The notes below provide more detail than what may actually be delivered. However, the speaker can place more emphasis on some points and gloss over other points, depending on regional needs. The outline of botrytis management according to crop stage [slides 42–48] reinforces the previous messages, but can be deleted if the presentation is running over time. Supplementary information on chemical crop protection is provided at the end of this document for reference purposes.

2.0 Description of slides

2.1 Title slide and outline of presentation

[slide 1 & 2]

Title slide & presentation outline

Botrytis bunch rot is often referred to simply as 'botrytis'. Managing botrytis well depends on knowing how the disease develops and the key stages in the pathogen lifecycle that we can short circuit. These key stages are called the **critical control points**. Each control point is associated with key pathogen, vine and/or environmental factors that increase the risk of disease development. We will examine these risk factors and describe the tools that are currently available to reduce botrytis risk at each control point. Some of the tools suggested will not be suitable for low input viticulture where the cost of control needs to be consistent with the price of grapes. These control measures will be indicated by the 'copyright' symbol and can be disregarded for regions where these measures do not apply.

Selecting which management tools are right for your vineyard requires a process known as **integrated botrytis management**. The process is very much like going to the doctor, in that the condition of the patient needs to be diagnosed before prescribing a course of action.

By the end of this presentation, you should have a good idea about how to monitor, analyse, plan and implement your botrytis management. Regardless of your location, you will take home some key messages about botrytis risk, the management process and what to do when all else fails.

2.2 Section 1. How does botrytis develop?

[slide 3]

Botrytis is caused by Botrytis cinerea - a fungus that infects many plant species and is found widely in the environment.

[slide 4]

There are a number of other fungi that can damage grape bunches. This picture shows a blue-green fungus called *Penicillium*, which often occurs with botrytis on Riesling grapes.

[slide 5]

Given that other fungi can grow on grapes, it is important to make sure that the mould seen on the bunch is botrytis. Botrytis can be confirmed by examining the bunch with a dissecting microscope. Clusters of grey or colourless spores at the ends of branched dark stalks confirm that the rot is caused by *Botrytis cinerea*. The spores are called conidia.

[slide 6]

The spores of botrytis land on plant tissue and must germinate and penetrate the tissue to cause an infection. However, the berry cuticle is a very effective barrier to infection and the fungus relies on wounds and natural openings to enter grape tissue. Wounds do not need to be visible to the naked eye and can include microfissures in the berry skin.

During infection, botrytis secretes enzymes to kill plant tissue in advance of its colonisation. The fungus absorbs nutrients from dead tissue, which is why it colonises tissue that is decaying or senescing. When grapes are ripening they go through a prolonged process of senescence. Botrytis hastens this process, which in nature leads to the release of the seeds for the next generation.

[slide 7]

Flowers are green, yet botrytis still finds a way to get in. As the cap falls, a strip of necrotic or dead tissue becomes exposed at the tip of the torus (or receptacle). The gap between the ovary and torus is a natural spore trap, and it is not known how long botrytis can reside here before infection takes place. Botrytis might also enter the flower through the stigma, although it is thought that this infection pathway is less common.

[slide 8]

Once infection has taken place, botrytis can keep growing and cause disease symptoms or it can stop growing and simply 'take a rest' until conditions become favourable for its growth. This so-called latent infection occurs in flowers or green, hard berries. After the fungus has entered the grape tissue, say via a cap scar, fungal growth is stopped by a high concentration of antifungal compounds. As berries soften and ripen, the concentration of these antifungal chemicals declines and the fungus can resume growth. Flowering is the first opportunity for latent infections, although latent infection can occur anytime during berry development.

[slide 9]

What makes botrytis grow fast once it enters flower or fruit tissue? A prerequisite for fast growth is a low concentration of the antifungal compounds found in soft, ripening berries, the cap scar region of the flower or decaying plant tissue.

The increasing sugar content of ripening berries is also correlated to a greater rate of botrytis infection and symptom expression.

[slide 10]

It has just been stated that botrytis only rots soft, ripening berries, but on rare occasions botrytis will cause a green fruit rot. This happened in 2007 in the Hunter Valley when there were extremely wet conditions and a high load of botrytis spores.

[slide 11]

Where are botrytis spores produced and how do they get to grapevine tissues?

Botrytis is common in the environment, but the most important sources of spores are those produced within the vine canopy or on the vineyard floor.

Sources of spores from the previous growing season include cane debris, bunch remnants, tendrils, leaf petioles and leaf blades. In the current growing season, spores come from infected, damaged leaves, floral parts such as caps and aborted berries and, of course, rotting berries with visible grey mould.

[slide 12]

Spore production is favoured by high humidity, which often occurs at night. When humidity falls and wind speed increases, often during the day, the spores are then released into air currents for dispersal. The concentration of spores in the air fluctuates over time, but airborne concentrations are often highest during berry ripening. Botrytis spores are almost always present in vineyards, although prolonged drought and high temperatures should reduce botrytis risk significantly.

Spores can also be dispersed by rain splash and, most importantly, by insect vectors such as light brown apple moth. Insects aid the movement of spores within and between grape bunches.

[slide 13]

Once a spore lands on grape tissue, what conditions lead to spore germination? The optimum temperature for spore germination is between 18 and 21°C, although some spores can still germinate at temperatures below 10°C or above 30°C. A film of free water is essential for spore germination. Surface moisture can be created by rain, dew, mist or fog. Indeed, high humidity may be all that is needed for condensation to occur within the crevices of some tissues such as flowers. Sugars and amino acids can also stimulate spore germination. Berries 'leak' more and more sugars as they ripen, creating a perfect environment for botrytis.

[slide 14]

Researchers from New Zealand and Australia sampled 20 berries at random from non-treated grape bunches collected at pre-bunch closure to determine the mean incidence of latent botrytis infection at 44 sites over six years. There was a significant but **very weak** relationship between botrytis severity at harvest and the incidence of latent infection. An incidence of latent infections greater than 15% tended to lead to a botrytis severity at harvest of greater than 3%. However, this graph shows that latent infection at pre-bunch closure cannot be used to predict botrytis severity accurately, unless other factors, such as weather, are taken into account.

[slide 15]

So what makes botrytis grow after latency? We know that not all latent infections lead to rotten berries. The factors that lead to the re-growth of botrytis are poorly understood, but seem to be correlated to high relative humidity, and, perhaps, high soil moisture, noting that research on soil moisture has only been done with grapevines in pots.

[slide 16]

Having established either a latent infection or a direct berry infection, botrytis can then spread from berry to berry. Botrytis can spread rapidly within compact grape bunches because the skin where berries touch is thinner and has more pores. Likewise, bunches that touch each other allow the fungus to move rapidly from one bunch to another. Botrytis can also spread between bunches by dispersal of airborne spores from mouldy bunches. The relative importance of this secondary spread of botrytis in most Australian vineyards is unknown.

[slide 17]

The ease of berry to berry spread in compact bunches can be visualised by imagining that a single rotten berry has developed from a latent infection. It then becomes obvious that botrytis can spread more quickly in the compact bunch than in the more open bunch.

[slide 18]

This photo shows the consequences of bunch crowding in Riesling where a number of bunches are starting to show symptoms of bunch rot. Bunch crowding not only aids physical movement of the botrytis fungus, but it can also increase humidity when water pools in wells created by adjoining bunches.

[slide 19]

By now you should have a good feel of some of the factors that promote botrytis epidemics. Perhaps the greatest risk of all, however, is simply the harvest date. Botrytis epidemics vary in the time when symptoms first appear and also in the rate at which disease increases per day.

The epidemic shown in this graph clearly shows the consequences of delaying the harvest date. On the day of harvest (depicted by the first arrow), the botrytis epidemic was increasing by nearly 1% per day. Any further delay in harvest would have made a bad situation much worse.

[slide 20]

In summary, botrytis usually appears sometime between veraison and harvest and then increases in severity if the weather and vine conditions are favourable. The symptoms are either the result of a latent infection occurring weeks or months previously, or a recent direct infection of the berry. The severity of the symptoms is then exacerbated by berry to berry and/or bunch to bunch spread.

2.3 Section 2. Critical Control Points

[slide 21]

The next section of this presentation deals with the key stages in the pathogen life cycle where we can intervene to reduce botrytis risk. We will define the specific risk factors at each key stage and look into the tool box to see what control measures can be applied.

[slide 22]

There are four critical control points for managing botrytis. These are:

1. Reducing the spore load

2. Minimising flower and fruit infection

3. Limiting botrytis re-growth after latency, and

4. Limiting disease spread once disease symptoms appear

[slide 23]

The first control point is reducing the spore load. The factors that contribute to a high spore load include the severity of botrytis in the previous growing season and whether or not there is botrytis infection on leaves before flowering. Leaf infection is not usually a problem in itself, but infected leaves can contribute spores, especially if falling infected leaves get trapped in the bunch. So other factors contributing to spore load include the amount of decaying leaves and floral parts trapped in compact bunches, and, of course, relative humidity.

There is not much we can do to reduce spore load apart from keeping botrytis severity low every growing season. Accelerating the decomposition of vine debris has been proposed. In trials conducted in New Zealand, mulch reduced the sporulation of botrytis on vine debris and it also increased soil biological activity. The use of mulch can influence canopy development and bunch microclimate, so its application really depends on your viticultural objectives and cost.

More open bunches are likely to trap less trash and we shall cover bunch compactness later.

[slide 24]

The second control point is reducing flower infection.

We still rely on fungicides for preventing flower infection, although biological control agents are being developed. It is recommended that a protective fungicide be applied at 80% capfall, when most of the cap scars are exposed. There is limited evidence about the need for additional fungicide applications during extended flowering. However, monitoring capfall and the weather forecast can ensure that fungicides are applied before rain. It is very difficult to get good spray coverage of the inflorescence and this might be improved by lowering sprayer air speed.

[slide 25]

Measures to reduce fruit infection start at planting with your decision about what variety to plant, where to plant it, and row orientation. It is recommended that highly susceptible varieties are not planted in low lying or sheltered areas with poor air drainage or next to large bodies of water. Rows should also be orientated for good air flow down the rows.

[slide 26]

Wounding increases the risk of fruit infection significantly. Examples of wounding include loose pedicels and splitting, plus damage from wire lifting, insects, birds, powdery mildew, frost, hail and sunburn. Managing light brown apple moth and powdery mildew are key control points. The benefits of controlling light brown apple moth are greatest with the weather conditions are marginal for botrytis. Once the weather becomes highly favourable for botrytis, then botrytis may be severe, regardless of the level of insect control. Any measure that can prevent berry split and care taken during wire lifting will also contribute to botrytis control.

[slide 27]

Reducing excess vigour will influence the microclimate in the fruiting zone. Vine balance should be checked so that node number can be adjusted at pruning. There may be scope to change trellis type where excess vigour is a persistent problem, and, if replanting, consider low vigour rootstocks.

[slide 28]

Inappropriate use of fertiliser and irrigation can contribute to excessive vigour. Manage these inputs with the aid of nutritional analyses and moisture monitoring. Removal of water shoots, or desuckering, can reduce canopy density, along with canopy management that prevents excessive lateral growth. It may be feasible to plant competitive inter-row crops, but be make sure the cover crop is not too high during periods of high frost risk.

[slide 29]

In New Zealand, removal of leaves in the bunch zone of Sauvignon Blanc with a high leaf layer number has been shown to reduce botrytis severity to the same degree as a full season program of fungicides. However, some viticulturists consider leaf removal as a measure of last resort: 70% fruit exposure might be sufficient for botrytis control and this can be achieved without leaf removal. If leaf removal is being considered, then be aware that the timing and extent of removal can influence grape juice composition. For example, over exposure of white grapes can lead to undesirable levels of phenolics and sudden exposure of shaded fruit can lead to sunburn.

[slide 30]

When there is little scope to manipulate the vine canopy, then there must be a greater reliance on protective fungicides. After flowering, a critical spray time is pre-bunch closure, as discussed in the next slide. A protective fungicide can also be applied at veraison, but only at high risk sites and before berries become increasingly susceptible to botrytis. While there are limits on late-season fungicide use, a fungicide (eg. iprodione) can sometimes be applied pre-harvest, but only if botrytis risk is high and severity is still low (to manage fungicide resistance).

Additional notes on fungicide selection and use:

Choosing which fungicide to use at each crop stage is not simply a matter of selecting the most cost-effective product. The issue of fungicide residues in wine means that there are limits on how late in the season a particular product can be applied. Ask your winery for specific recommendations or consult the 'dog book', which is the nick name for the guidebook on *'Agrochemicals registered for use in Australian viticulture'*. This essential booklet can be downloaded from the website of the Australian Wine Research Institute (www.awri.com.au).

In short, spray programs must be designed to allow fungicide resistance management and to satisfy maximum residue limits and withholding periods. Selections should also be based on the need to manage other pests and diseases and whether or not a fungicide has low or no negative impacts on non-target organisms such as beneficial insect predators.

[slide 31]

Pre-bunch closure is a critical time to apply fungicide because it is the last chance to achieve good spray coverage inside the bunch where latent infections often emerge. Use your most effective botrytis fungicide before closure to improve botrytis control.

[slide 32]

The third critical control point in botrytis management is limiting the re-growth of botrytis after latent infection. The risk factors are high relative humidity and, possibly, high soil moisture.

[slide 33]

If excessive soil moisture adds to botrytis risk, then it can be prevented by adequate drainage, vineyard floor management and appropriate irrigation. Humidity in the fruit zone can be lowered by canopy management and preventing the pooling of water in wheel ruts.

[slide 34]

The final critical control point is limiting disease spread.

Reducing bunch compactness should reduce botrytis risk, although there is limited scope to achieve this in practice. Pruning system can influence bunch compactness to some degree. For example, minimal pruning has been compared to mechanical hedging and cane pruning in several regions of Australia. It was found that minimal pruning produced small, less compact bunches and that these bunches were dispersed through a more open outer canopy, which in turn reduced congestion in the bunch zone. However, this effect depended on bunch number per vine. If bunch number was lower than average, then bunches tended to be larger and more compact.

[slide 35]

In dry climates there may be scope to limit berry size by deficit irrigation. In cool climates or high-input viticulture, fruit set can be reduced when there is a tendency of a clone or variety to set many berries in a compact bunch. Removal of leaves adjacent and basal to the bunch during early berry development can cause flower and fruit abscission. Chemicals that mimic plant hormones can be used to thin flowers or to lengthen the rachis, but there have been some side effects such as reduced bud fertility. These chemicals are still being developed for consistent use in wine grapes.

[slide 36]

Unlike bunch compactness, bunch crowding can be managed through pruning and canopy management. The first step is managing yield potential by estimating bud fruitfulness to set pruning level. Bud number can be reduced to a target yield, but only if vine balance will be maintained. Yield potential can also be managed by shoot thinning before flowering, but keep in mind that the remaining shoots may grow more vigorously. If shoots are removed, then focus on areas of potential congestion, such as the crown, trellis posts and uneven node spacing.

If yield potential is still too high after fruit set, then bunch thinning can be implemented after fruit set by removing secondary or later ripening bunches on vertically positioned shoots. At veraison, bunches that can be removed include later ripening bunches, bunch shoulders, bunches around trellis posts and damaged bunches.

[slide 37]

The simplest method to limit disease spread is to monitor botrytis symptoms and harvest early if botrytis risk is high. Even though severity at harvest various enormously among seasons and regions, the increase in disease severity after symptom appearance shows distinct patterns that allow prediction of the future course of the epidemic. Researchers in New Zealand and Australia have developed a prototype model that uses weather data (from capfall onwards) and monitored botrytis (late season) to predict the disease progress curve and botrytis severity at harvest. The prediction is updated daily from the start of capfall. Once the model software is implemented in vineyards, it should aid decisions about in-season management and harvest date.

[slide 38]

In climates where rain falls later in autumn rather than earlier, then an early harvest can help to escape these rains and severe botrytis. In cool climates with intensive management, crop load can be reduced in order to advance harvest so that berry sugar reaches a higher level earlier. However, manipulation of crop load for an earlier harvest may not necessarily reduce the risk of botrytis. Indeed, botrytis severity can be higher, not lower, if rainfall occurs when the berry sugar content is high. There are complex interactions between berry sugar, weather and botrytis development that make it difficult to make general recommendations around crop load and harvest date.

[slide 39]

In summary, most management measures in the tool box are about manipulating the bunch zone microclimate for reduced humidity and rapid drying of wet bunches. We have seen the many ways that this can be achieved for the same end result. Moreover, open canopies can improve spray coverage and reduce reliance on fungicides. Fungicides, however, can provide significant additional control when timed well. The pre-bunch closure spray is often a critical spray time, and in some seasons, the flowering spray may be critical. Severe restriction on late season fungicide use makes canopy management all the more important. Remember that wounding and bunch crowding increase botrytis risk. Adoption of future tools for determining botrytis risk will depend on monitoring for botrytis and weather so that we know when to implement multiple control measures, including an early harvest.

2.4 Section 3. Integrated botrytis management

[slide 40]

Previously, a number of control measures were presented for attacking botrytis at key stages in its lifecycle. It’s all very well to understand the theory and potential control options, but how does one select the right tools for integrated botrytis management? What now follows is a systematic process that will help you select appropriate control measures from the management tool box.

[slide 41]

Integrated management involves four steps:

It's about evaluating your botrytis management,

it's about using a systematic process to identify risk factors,

it's about setting targets for acceptable control and making cost effective selections from the tool box, and finally,

it's about working through a tailored list of management activities for each crop stage.

This process sounds daunting, but many of you will already be doing this, because it is also the process for producing your desired quality of grapes to a target yield.

[slide 42]

Let's now examine activities and actions we might take according to the time of year or crop stage.

In winter, think about how bad botrytis was at harvest and whether or not you had issues with excessive crop vigour. What other factors contributed to your botrytis problem? This information will then guide the areas to focus on for botrytis management in the forthcoming season. When planning botrytis management, know what level of botrytis incurs a price penalty. Is your winery willing to take remedial action or is there zero tolerance for botrytis? What's you budget like? Can you improve the drainage in the lower half of block B? Have you used reliable measures to set the pruning level and communicated this well to your staff?

[slide 43]

After bud burst, check the results of your pruning when the inflorescences become visible. Is shoot thinning needed to manage yield potential and/or shoot congestion? Remove water shoots and monitor the level of leaf damage, which if infected by botrytis can provide a source of spores for flowers and fruit. Check vines for excessive vigour and don't forget to calibrate the sprayer and check coverage.

[slide 44]

At capfall, monitor the duration of flowering and capfall stages. If the flowering period is extended, then spray before it rains. If spraying at 80% capfall, then don't miss it! Consider lowering the sprayer airspeed for better coverage.

[slide 45]

After fruit set, bunch thin if yield potential needs to be managed. Note the amount of trash trapped in bunches and start monitoring for berry damage.

[slide 46]

Pre-bunch closure is your last change for good spray coverage inside the bunch. Use your best fungicide at this crop stage and if removing leaves, then do it before spraying. Continue to monitor for berry damage.

[slide 47]

At veraison, apply a fungicide if botrytis risk is high. Continue to monitor for berry damage. If bunch thinning, then aim to reduce bunch congestion.

[slide 48]

Assess botrytis severity before harvest using a valid, standard procedure. Mouldy bunches can be dropped to address winery specifications.

After harvest, it is important to obtain feedback from the winery so that you can record your assessment of botrytis severity against the actual outcome on wine making.

Try and identify the causes of botrytis 'hot spots'. This is also a good time to review site history. Did you have a one-off failure in your botrytis management or is botrytis a problem year after year? If the latter, consider removing problematic vines or alter the fruit zone microclimate (if possible) in botrytis 'hot spots'.

[slide 49]

The final step of integrated botrytis management is simply integrating all your management measures with the aid of an action plan developed for specific crop stages. When botrytis risk is high, this pie chart illustrates that effective botrytis management is rarely achieved with a single management measure. At some sites, you may have to accept that a full season fungicide program can fail when the weather is very favourable for botrytis. When our botrytis management fails and disease is rampant, it is always tempting to spray something to make us feel better. However, this can be a very dangerous practice, because those members of the botrytis population that can resist the fungicide are likely to survive and multiply. The next spray of the same chemical group may be less effective as fungicide resistance develops.

'Prediction systems' are also added to this pie because we know that our spray programs work best when they are not needed. If botrytis risk can be quantified accurately, then there is scope to tailor management according to actual risk.

'Biosuppressants' are also added to this pie in the hope that effective biological control agents or methods to augment natural vineyard microflora contribute to botrytis management in due course.

2.5 Section 4. Take home messages/acknowledgements

[slide 50]

Understanding botrytis risk has been the dominant theme of this presentation. In a single sentence, it can be said that "Botrytis risk is highest in thin-skinned varieties with compact bunches in humid canopies carrying high crop loads".

This risk and the level of botrytis observed can be quantified so that appropriate measures can be implemented for cost-effective control. A systematic process is required to design integrated botrytis management. Remember to **Monitor**, **Analyse**, **Plan and Act** for:

- balanced vines and target grape yield and quality, that will allow
- strategic fungicide use and market access

Finally, learn to accept that very favourable weather for botrytis can undo your best efforts. The best you can do in these situations is to track disease progress and harvest early.

[slide 51]

As this presentation comes to an end, consider that the end is just the beginning. Sometime between 600 and 531 BC, Lao told us that "If you do not change direction, you may end up where you are heading". Where do you want to go? (Morning/afternoon tea!!)

[slide 52]

This acknowledgements slide can be displayed without dialogue at the conclusion of the presentation.

Key references

Key references on botrytis biology and management are cited in the following publication:

Evans K.J. (2008) Overview of R&D for managing botrytis bunch rot in Australia. In: Proceedings of the ASVO seminar 'Breaking the Mould: a Pest and Disease Update', K. DeGaris, M. Krstic, G. McCorkelle, S. McLoughlin (Eds), Australian Society of Viticulture and Oenology Inc., Adelaide, South Australia, pp. 4–15.

Acknowledgement to reviewers

I thank Mark Krstic, Bob Emmett, Jacky Edwards, Rob Beresford and Dion Mundy for reviewing this presentation and providing useful feedback.

Supplementary information

Maximum residue limits (MRLs) and withholding periods

- Each country sets a limit for the amount of fungicide residue in wine, which may be similar to or vastly different from Australian regulations
- When no MRL is set, detectable residues are not allowed, OR 'safe' amounts may be permitted
- The booklet '*Agrochemicals registered for use in Australian viticulture*' (available from www.awri.com.au) specifies restrictions on spray timings to ensure Australia meets the MRLs for any of Australia's major wine markets
- Products may be used closer to harvest than specified by the AWRI for a specific market, as long as the label withholding period is observed
- The **withholding period** is the minimum delay that should be observed between spraying the grapes and harvest

Fungicide resistance management strategy (FRMS) for botrytis

- Fungicide resistance is the ability of a pathogen population to survive a dose of fungicide that would normally control it
- Each fungicide belongs to an 'activity group' denoted by a number or number & letter code
- The FRMS guides the maximum number of applications per growing season of a particular 'activity group'

The **fungicide activity groups** for 2009/2010 are listed in Table 1. These groups are updated each year in the booklet entitled '*Agrochemicals registered for use in Australian viticulture*' (available from www.awri.com.au).

Table 1. Fungicide activity groups for 2009/2010

New code	Old code	Chemical type	Examples of active constituents
M5	Y	multisite activity	captan, chlorothalonil, hydrogen peroxide, peroxyacetic acid
1	A	benzimidazoles	carbendazim
2	B	dicarboximides	iprodione, procymidone
7	G	carboxamides	boscalid
9	I	anilinopyrimidine	pyrimethanil, cyprodinil
11	K	quinone outside inhibitor	azoxystrobin
12	L	phenylpyrroles	fludioxinil
17	J	hydroxyanilide	fenhexamid

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