

Importance of Metiram in the control of Pear brown spot in Italy

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Technical Management APES

Brown spot of pear (causal agent: the Deuteromycete *Stemphylium vesicarium* = STEMVE. Teleomorph, according to current taxonomy: *Pleospora alli*) is currently one of the most important fungal diseases on pear and, in several regions of Northern Italy, its economic importance is similar or even greater compared to scab. It has been observed in the Po valley in Italy since the late 1970s, causing brown spot on leaves and fruits of pear.

The disease symptoms appear from flowering until harvest. During the crop season, various infections normally occur, caused by release of conidia from turfs, where the pathogen overwinters. This causes the progressive increase of the disease over time. The first symptoms on leaves usually appear after flowering, between May and June. The fruits are susceptible to fungal attacks in each stage of their cycle. Actually earlier infections can affect the crop flowers when the spores of the fungus, conveyed by the air currents and in presence of favorable conditions of prolonged wetting, reach either the flower fertile parts or the residues of the petals and/or sepals, causing later the so-called “maculatura calicina” visible on fruits.

Pear cultivars vary widely in susceptibility to *S. vesicarium*, but almost all the most frequently planted and commercially accepted pear cultivars in Italy (e.g. Abate Fétel, Conference, Kaiser, Decana del Comizio, etc.) are susceptible to this disease. Maximum levels of disease incidence are generally attained just before fruit harvest and infected fruits are non-marketable. Low levels of disease (5-10%) in one year may be followed by up to 80-90% infected fruit in the next year. Therefore, in the affected areas of Italy (mainly Emilia-Romagna and Veneto), brown spot causes production losses of up to 90% in severe epidemics.

The spread of the disease in the Italian pear orchards has been probably favored by the reduction of the number of treatments against scab with PPPs containing phthalimides and dithiocarbamates, both having broad activity spectrum, and at the same time by the inclusion in the spray programs of products like those containing [REDACTED], all fungicides controlling scab but without biological activity towards brown spot.

The optimal disease management consists of a combination of agronomical measures during the whole year with chemical fungicides, which are a crucial component in controlling brown spot of pear.

In fact, several biological control agents (e.g. XXXXXXXXXX) have been evaluated in the last years for disease control on leaves and fruits, but their efficacy in disease control was generally low under field conditions. Also the resistance inducers achieve low levels of efficacy when used alone, especially in presence of high disease pressure.

On the other hand, agronomical methods may be an alternative to the application of chemical fungicides: in pear, for example, infected leaves and fruits should be removed at the end of the season to prevent the formation of fungal spores and aspersion irrigation should be avoided as well as good field drainage promoted during the vegetative period. In addition, the use of not susceptible pear cultivars and cultivation measures to improve the crop vigor can be useful.

However, the integration of agronomical methods with fungicides improves significantly the efficacy of disease control over the level provided by agronomical methods alone.

So, chemical control is in the end the most efficient method to control brown spot of pear. As generally curative fungicides cannot effectively control brown spot of pear, because once conidia germinate the inhibition of the germination process by curative fungicides occurs when the fungal toxin has already been released, disease control is mainly based on preventative sprays with fungicides applied at 7 to 14-day intervals. Thus, the application timing before infection is critical for optimal fungicidal efficacy and applications must start as soon as the environmental conditions are favorable to the disease development, from end of flowering to harvest. It is therefore very important to implement a control strategy that is adequate for a period of about 4 months, using all the available active substances with different mode of action (MoA), to achieve, in addition to the control of the fungus, an appropriate anti-resistance strategy preserving the activity of the various products over time (Brunelli *et al.*, 2016; Bugiani *et al.*, 2016; Scannavini *et al.*, 2016).

Most effective fungicides are dithiocarbamates (thiram, ziram, metiram), QoIs (kresoxim-metil, trifloxystrobin or pyraclostrobin) and captan (Brunelli *et al.* 1984, 1986, 1997); moreover, other fungicides are also well controlling *Stemphylium vesicarium*, such as carboxamides (fluxapyroxad, boscalid, penthiopyrad, etc.), fluazinam, tebuconazole and fludioxonil. An overview of the actives really effective against that pathogen, which will be likely available in Italy in the next years, is given in the following table:

Active ingredient	FRAC code - group	Resistance risk	Remarks
██████████	██████████	Medium to high	Limited number of applications
██████████	██████████	Low	Limited number of applications Possible future use restrictions
██████████	██████████	Low	Limited number of applications Possible future use restrictions
██████████	██████████	Low to medium	Limited number of applications
██████████	██████████	Medium to high	Limited number of applications
██████████	██████████	Medium to high	Limited number of applications
██████████	██████████	Medium to high	Limited number of applications

As it can be seen, ██████████ are not included in the table, since a widespread resistance of *Stemphylium vesicarium* to these compounds in open field was observed in Italy in the last years, so that practically they are no more sprayed, contrary to the registered dithiocarbamates, which are broad spectrum contact fungicides not showing until now variations over time in efficacy levels against pear brown spot. QoI resistance was described by Alberoni *et al.* (2010), who found the first resistant strains in 2006 and concluded that by then the fungicidal activity against the fungus at issue was already insufficient.

In the last years BASF collaborated with ██████████ in an extensive resistance monitoring (see pdf attachment below reported) considering not only ██████████ but also ██████████. Results show how both families are under serious threat of resistance spread and use of these actives in mix or in alternation with multisite products is highly recommended.



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██████████ are not mentioned too in the above table, because not used in practice, due to their very low efficacy against brown spot of pear and low selectivity towards the crop plants.

██████████ on the other hand, are facing regulatory issues, so that their reregistration is brought into question.

In conclusion, if we exclude the dithiocarbamates, in the next future only four modes of action will be likely available in the Italian market to effectively control *Stemphylium vesicarium*, including the group of the ██████████ which are in general compounds with a significant resistance risk; further, all these four modes of action will probably undergo limitations in the number of applications.

Finally, because of the above-mentioned resistance issues, ██████████ are now mostly available as co-formulations of fungicides having different modes of action (e.g. pyraclostrobin+boscalid); moreover, their number of applications is limited (following the FRAC's indications, for the QoI and SDHI groups it is recommended a maximum of 3 and 4 applications per year, respectively) and they should be exclusively applied preventatively. Only in this way these compounds may still be applied in brown spot control programs.

Resistance status of brown spot in pear in Italy and fungicide resistance management

High frequency of [REDACTED] and moderate frequency of [REDACTED] have been recently found in Italy concerning *S. vesicarium* (FRAC, 2018). Therefore we can say that in this country there is a reduced sensitivity of this pathogen to the actives belonging to both those fungicide groups.

The introduction of new active ingredients (see [REDACTED]) with very specific modes of action was followed by development of resistant strains of the pathogen: in fact, when such actives were applied alone on pear, this led to failure of disease control with concomitant crop losses.

This experience indicates that the role of some fungicides in brown spot control programs must be re-considered and highlights the need for measures to minimize the risk of resistance development.

Actually FRAC classifies *Stemphylium vesicarium* as a high resistance risk pathogen in general, at the same level than *Venturia inaequalis*. Currently we know that this disease is very aggressive and the development of resistant strains can be relatively easy. Nevertheless, the combined pathogen-fungicide risk (Brent and Hollomon, 1998) by using dithiocarbamates is low, because of their multisite mode of action.

Nowadays integrated management for the control of the disease is a must, based particularly on the following aspects linked to the product application:

- Make full use of fungicides with different modes of action: avoid over-reliance on a single fungicide group, use co-formulations or tank-mixes of different active ingredients and include multisite fungicides like metiram, captan, ...
- Avoid always eradicator applications.
- Adjust the spray interval to the evolution of the disease. Not overextend the interval.
- Target specific products to appropriate crop growth stages.

All these good practices are important to control the disease, because an adequate fungicides' use (type of product, spray interval, time of application, ...) is a key factor in brown spot control.

In Italy there are different products available against that disease, but multisite active ingredients are particularly important. In fact, in 2018 FRAC international (Fungicide Resistance Action Committee) published a document about the high Importance of multisite fungicides in managing pathogen resistance. The use of multisite fungicides in spray programs in crops with multiple treatments such as fruits, vegetables or potatoes is really important. Due to their mode of action, multisite fungicides are considered as a low resistance risk group. As a consequence, they can be used as mixing partners or in alternation with single-site fungicides and other medium to high resistance risk substances. Over the past decades, no cases of field resistance against multisite fungicides have been reported. (FRAC, 2018).

There are therefore clear benefits to recommend multisite fungicides in spray programs:

- Multisite fungicides have a low risk to develop resistance and are effective mixing/alternating partners for medium to high risk fungicides.
- Beyond protecting and prolonging the lifespan of highly effective medium/high resistance risk fungicides, multisite fungicides provide added efficacy levels and activity spectrum. As a consequence, they can support the single site modes of action to be even more efficient.
- Multisite fungicides are considered as a valuable tool to manage resistance by preventing or delaying its development regarding many pathogens in many crops.

Therefore, the use restriction of multisite fungicides in important crops could result in faster development of resistance to fungicides with single site mode of action. This could lead to epidemic disease development, serious crop losses and finally loss of highly effective fungicides for a sustainable disease management.

Situation in Italy about role of multisite fungicides in controlling brown spot in pear

Currently in Italy there are several products with different MoAs registered against *S. vesicarium*. In this context, it is important to remark those ones containing multisite active ingredients:

- [REDACTED]: it belongs to the chemical group of phthalimides and could have regulatory restrictions in the next future.
- [REDACTED]: inorganic fungicides with low efficacy in general against brown spot, also considering that recently the rate of copper per hectare authorized per year has been drastically reduced.
- [REDACTED]: they generally have still good efficacy. Nevertheless, they are under strong regulatory pressure: thiram is no more available in Italy starting from April 2019; phase out of [REDACTED] is also possible.

The segment of the chemicals with multisite activity has always played a key role in ensuring the general effectiveness of the spray programs and preserving the substances with single-site activity (especially strobilurins and SDHIs) from the occurrence of resistance, but now it is under high risk in Italy, as well as in all Europe: in fact, in the next years, this crucial tool for pear production could be no more available or very limited in its use.

Inside this segment, metiram is a key active in pear orchards in Italy due to its well-known efficacy against brown spot, which can be deduced from a recent Italian trial. In this trial carried out in the Emilia-Romagna region (province of Ravenna) in 2018 on the cultivar Abate Fetel, 5 treatments representative in the brown spot control were tested: [REDACTED] (2 kg/ha), [REDACTED] (1 kg/ha), metiram (2,6 kg/ha), [REDACTED] (2,7 kg/ha) and [REDACTED] (2 kg/ha). 14 applications were done during crop BBCH GS 63 to 77, starting from the 10th of April until the 17th of July. The trial results are summarized in the following figure:

Figure 1 - Comparison of different fungicides in controlling *Stemphylium vesicarium* in pear.

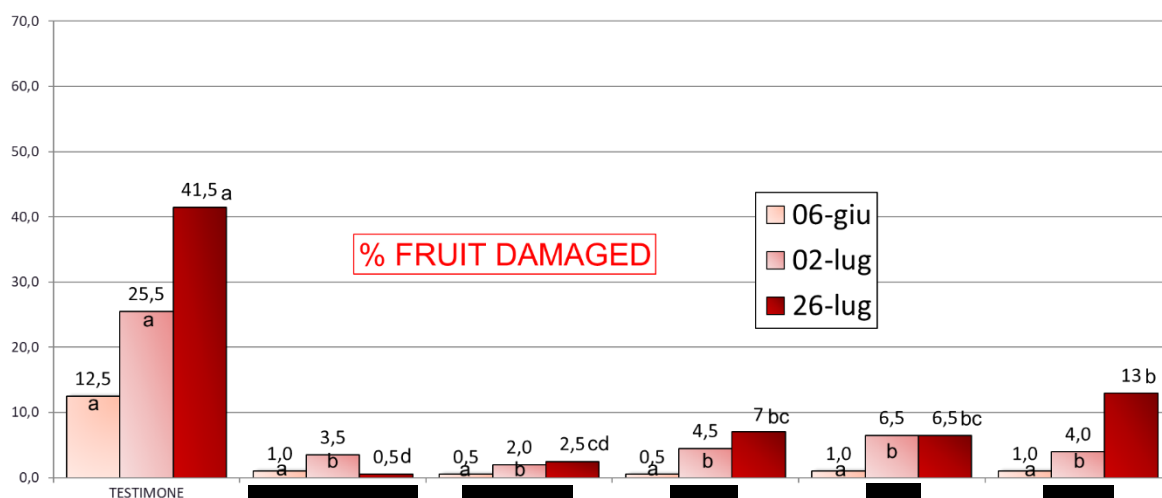


Figure 1 shows that, 7-9 days after last application, the biological activity of metiram is always good in a high disease level situation; further, metiram is equal or slightly better than the other multisite active ingredients and slightly inferior to [REDACTED] which in the future could either face important use limitations or even be out of the Italian market.

The complete final report can be seen in the here below file:



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As a conclusion, the multisite active ingredients still maintain a good level of fungicidal efficacy, combined with the advantage of avoiding resistance appearance, in this way preserving also the future efficacy of the single-site modes of action.

Finally, multisite fungicides such as metiram remain important both when used alone and also as effective mixture partners within anti-resistance strategies, which are of high importance with respect to *Stemphylium vesicarium*, as it is very important to preserve the effectiveness of the few remaining MoAs that can be applied to control this aggressive pathogen.

In the end, with the phase out of thiram, *i.e.*, the main multisite fungicide used in Italy to control STEMVE until now, together with a likely phase out of other currently registered actives, there will be a strong lack of multisite fungicides on the Italian market, in order to control that pathogen. Thus, a positive outcome concerning the reregistration process of metiram could allow farmers to still have a fundamental tool to use in pear orchards, considering that the European review of PPPs is unintentionally leading to a progressive reduction of the active substances that can be used towards *S. vesicarium*, in an overall context of progressive recrudescence of this disease in Italy.

Summary & conclusions

Multisite fungicides and specifically metiram are very important in the control of brown spot of pear because:

- ➔ Brown spot, together with scab, is the most dangerous and impactful disease for pear in Italy.
- ➔ Brown spot is very aggressive and entails a high risk of developing resistance to many currently registered fungicides.
- ➔ In Italy is therefore necessary a strategy of resistance management to control this disease.
- ➔ Fungicides are one of the main tools to control this disease and those with multisite mode of action are the key group in order to reduce the risk of resistance and prolong the efficacy of the other very specific modes of action in the future.
- ➔ In practice, in Italy the only effective multisite fungicides currently available against pear brown spot are captan and dithiocarbamates, which soon could suffer significant use restrictions or even be out of the market.
- ➔ Metiram is one of the few multisite fungicides registered in Italy for use against *Stemphylium vesicarium* on pear.
- ➔ Metiram is a very important tool for the Italian farmers to control in a sustainable way pear brown spot and maintain the profitability of the crop.

Bibliography

Alberoni, G., Cavallini, D., Collina, M. and Brunelli, A. (2010) Characterisation of the first *Stemphylium vesicarium* isolates resistant to strobilurines in Italian pear orchards. *European Journal of Plant Pathology* 126, 453-457.

Brunelli A., Fabbri M., Casagrandi F., Geminiani E., Troiano P.P. (2016) – Attività di recenti fungicidi inibitori del succinato deidrogenasi (SDHI) contro la maculatura bruna del pero. *Atti Giornate Fitopatologiche*, 2: 377-384.

Brunelli A, Di Marco G, Contarelli G, Ponti I (1984) Prove di lotta contro la maculatura bruna delle pere. *ATTI Giornate Fitopatologiche* 1:203–212.

Brunelli R, Rovesti R, Di Marco S, Ponti I. Attività di diversi fungicidi contro la maculatura bruna del pero. *Riv. Frutticoltura e Ortofloricoltura* 1986; 1:51–54.

Brunelli A, Gherardi I, Adani N. Ridotta sensibilità di *Stemphylium vesicarium*, agente della maculatura bruna del pero, ai fungicidi dicarbosimidici. *Informatore Fitopatologico* 1997; 9:44–48.

Bugiani R., Scannavini M., Miroseovich A., Ciriani A., Collina M. (2016) – Valutazione in semi-campo della persistenza dei principali fungicidi utilizzati nel contenimento della maculatura bruna del pero. *Atti Giornate Fitopatologiche*, 2: 361-367.

FRAC. 2018. Importance of multisite fungicides in managing pathogen resistance. Available in FRAC website.

FRAC. 2018. Minutes of the 2018 QoI meeting. Available in FRAC website.

FRAC. 2018. Minutes of the 2018 SDHI meeting. Available in FRAC website.

Scannavini M., Miroseovich A., Preti M., Bugiani R. (2016) - Valutazione in pieno campo della persistenza di alcuni fungicidi utilizzati nel contenimento della maculatura bruna del pero. *Atti Giornate Fitopatologiche*, 2: 369-376.