Collaborative note
INRA, SPV, ARVALIS – Institut du végétal
2009
for cereals diseases resistance management

This note written by INRA, SPV and ARVALIS – Institut du végétal draws up the resistance situation and expresses recommendations. This 2009 note stresses the changes, and especially the emergence of a practical resistance to strobilurins in* Microdochium spp. *on wheat, mostly due to the G143A mutation in the cytochrome b gene.

SITUATION in 2008 AND RECOMMENDATIONS for 2009

SEPTORIA LEAF BLOTCH (*S. tritici*)
Resistance to QoIs (strobilurins, famoxadone) due to the mutation G143A affects all of the French regions producing cereals and for the first year, is also generalized in the South regions. In these conditions, the efficacy of all strobilurins is now compromised everywhere in France. Concerning triazoles (main class of DMIs), the current *S. tritici* strains show a low to moderate resistance to these compounds. Since 2002, in France, the strains moderately resistant to DMIs are dominant in all regions. Nevertheless, these strains are either lightly resistant or, for a part of them, fully sensitive to prochloraz, especially in regions near the Atlantic Ocean. Prochloraz, even if it belongs to the DMI class, exhibits excellent efficacy in associations, and counter-select a part the moderately resistant strains.

Recommendations: Though the efficacy of triazoles in the field is decreasing, the most efficient ones (mostly epoxiconazole and prothioconazole) are still interesting. Furthermore, the efficacy of triazoles can be reinforced by some multisite fungicides (chlorothalonil, mancozeb), boscalid or prochloraz. The use of boscalid, prothiconazole or prochloraz, also effective on eyespot, will be limited to one application per season.

POWDERY MILDEW (*B. graminis f. sp tritici* and *B. graminis f.sp hordei*)
We have observed a low disease pressure in 2008. Resistance to strobilurins is probably still deeply established in France, remaining however limited in the South. Even if resistance to SBIs (DMIs and "amines") is widespread in France, many of these molecules are still quite effective. Some strains strongly resistant to quinoxyfen have been detected in France these last few years and are mainly located in Champagne (North–East of France). Resistance to metrafenone has never been detected in the tested samples. Metrafenone, which has been recently registered, is effective on all resistant powdery mildew strains.

Recommendations: The QoIs family can no longer be considered as efficient on powdery mildew in most of the French regions. Cyprodinil is no longer effective enough to be used on powdery mildew. Quinoxyfen can no longer be used by itself on wheat powdery mildew when resistance occurs.

EYESPOT (*Oculimacula yallunadae* and *O. acuformis*.)
The main species is *Oculimacula yallundae* and the strains now encountered are often resistant to most DMIs, and especially to prochloraz. All strains of *Oculimacula spp*. are sensitive to prothioconazole. Some strains resistant to cyprodinil can still be detected in France at a low frequency within the two species of *Oculimacula spp*. They have, however, no impact in practice. Boscalid and metrafenone represent two new alternative modes of action available to control eyespot.

Recommendations: Prochloraz remains useful when it is associated with another active ingredient efficient on eyespot. Associations of products with different action modes of action are more effective. However, it is recommended to alternate the use of different types of products, either active on foot or leaves, over years to limit the risk of resistance. As prochloraz, boscalid and prothioconazole are also efficient against septoria leaf blotch, limit their use at one application per season, including foliar diseases.

HELMINTHOSPORIUM ON WHEAT (*H. tritici-repentis*)
In Northern Europe, some strains of *Helminthosporium tritici-repentis* exhibit mutations in the cytochrome b gene (the QoIs' target), either in position 129 (low level of resistance), or in position 143 (high level of resistance). These two mutations can be found both at the same time in a population. Efficacy of strobilurins can then be severely affected if the frequency of strains highly resistant is important. In France, these two mutations were observed but no efficacy losses were reported for strobilurins indicating that these mutations do not seem to be very frequent.

Recommendations: Use strobilurins in association with a triazole efficient on wheat *Helminthosporium* (in particular prothioconazole, tebuconazole, propiconazole) if high risk of disease.

HELMINTHOSPORIUM ON BARLEY (*H. teres*)
In France, the resistance of *Helminthosporium teres* to QoIs fungicides is well established and seems to remain stable in 2008. This phenomenon is determined by the mutation located in position 129 which leads to low to moderate resistance. In 2008, in situation of resistance, field efficacy of all strobilurins was affected, especially for azoxystrobin and fluoxastrobin. Activity of pyraclostrobin and trifloxystrobin is less affected. A shift in sensitivity to DMI has also been observed for a long time and probably induced the decrease in efficacy of this class of SBI. Today, prothioconazole remains the most efficient product of this family on this disease.
Cyprodinil and boscalid represent two other modes of action that are not affected at the moment by resistance.

Recommendations: Always associate strobilurins with efficient fungicides that have other modes of action (in particular prothioconazole or cyprodinil). Diversify and alternate the modes of action while alternating: avoid using double applications of strobilurins or prothioconazole in the same year.

RUSTS (*P. recondite, P. striiformis, P. hordei*)
As far as we can know, brown and yellow rust are not concerned by field resistance, as well as for triazoles and strobilurins.

Recommendations: Take into account the potential action on rusts of active ingredients used in treatment programs. For the time being, associations of triazoles and strobilurins provide the best efficacy against these diseases.

Fusarium Head Blight (*M. majus, M. nivale, F. graminearum, F. culmorum, F. avenaceum, F. tricinctum, F. poae and F. langsethiae*)
In 2007 and 2008, heavy attacks of *Microdochium majus* and *M. nivale were observed*, reminding 1997 disease pressure. To understand the sometimes poor results with strobilurins, analyses were undertaken and *Microdochium spp.* strains resistant to strobilurins were detected in many regions in 2007 and 2008. The main mechanism of resistance is the alteration of cytochrome b at location 143 (mutation G143A) but some other mechanisms occur. According to the available data, frequency and levels of resistance are very high, especially in *M. majus*. Concerning benzimidazoles and thiophanates, analyses showed that more than 50% of *Microdochium spp.* strains were resistant, most of them cumulating resistance to strobilurins. The study also concerned sensitivity of *Fusarium* species. Less than 10% of *F. avenaceum* strains resist to benzimidazoles and thiophanates. On the other hand, all strains of *F. culmorum, F. graminearum* and *F. langsethiae* remained sensitive to this mode of action. At last, no shift in sensitivity to DMIs was recorded for these species of *Fusarium.*

Recommendations:
Field impact of strobilurin resistance in *Microdochium spp.* has not yet been evaluated in enough trials but a possible loss of efficiency can be expected within resistant populations. Among DMIs, prothioconazole is not concerned by the resistance phenomenon and is efficient on *Microdochium spp.* but not at the level that was observed with strobilurins after their registration. Fenpropimorph and prochloraz do have an efficacy against Fusarium Head Blight. Recommendations to control the various *Fusarium* species keep unchanged.

Mis en forme : Anglais (Royaume-Uni)

GENERAL RECOMMENDATIONS TO MANAGE CEREALS DISEASES RESISTANCE IN 2008

Based on this updated view of the situation, we renew our practical recommendations of prophylaxis to:
- Reduce parasitical risks,
- Limit the use of fungicides and thus the selective pressure on pathogen fungus,
- Manage situations of practical resistance

• Give preference to varieties tolerant to relevant diseases, and avoid using sensitive wheat or barley cultivars over wide areas.

• Prefer field practices that reduce the disease risk, in particular those that can limit primary inoculum (for example rotation, ploughing, sowing date…) or disease spreading (density, nitrogen).

• Treat only if necessary, according to the climate, cultivation conditions, models and observations.

• Design treatment times according to disease development, using reliable methods of observation and symptoms monitoring.

• Limit the amount of seasonal applications of active ingredients from the same chemical family (usually characterized by a positive cross resistance).

• Diversify modes of action by alternating or associating molecules in treatment programs, to minimize the risk of resistance development and/or to deal in practice with resistance for a given family.

• On cereals, some diseases are concerned by strobilurins resistance, and some are not. To limit the risk on unconcerned diseases, better use strobilurins only once a year.

• The most efficient DMI active ingredients can be used to treat cereals diseases in a resistance context. Furthermore, their performances will be improved if they are associated with some other modes of action, or even, in the case of mixtures, between complementary DMIs.