Fungicide resistance of *Sclerotinia sclerotiorum* in French oilseed rape crops

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ABSTRACT

Preventive chemical control against Sclerotinia stem rot at the beginning of flowering has led to the occurence of resistance of *Sclerotinia sclerotiorum* to benzimidazole fungicides (MBC). A large monitoring for MBC fungicides and alternative fungicides such as dicarboximide fungicides was carried over the last three years. MBC resistance of *S. sclerotiorum* is widespread in most oilseed rape cropping areas from the Centre to the north-eastern parts of France. Moreover, a few cases of *S. sclerotiorum* which would be less susceptible to dicarboximide fungicide were also detected.

Key words: *Sclerotinia sclerotiorum*, fungicide resistance, benzimidazoles, dicarboximides

INTRODUCTION

Sclerotinia stem rot is one of the major diseases of oilseed rape which can cause severe damage and important yield losses. For twenty five years, efficient chemical control has been achieved by a preventive and systematic treatment using benzimidazoles fungicides (MBC) at the beginning of flowering. Because of its effectiveness and its cheapness, carbendazim used to be sprayed but its wide use has led to fungi resistance (Souliac & al, 1995). To follow the practical resistance to fungicides, a monitoring has been performed every year.

MATERIALS AND METHODS

Over the last three years, samples of 10 to 20 sclerotia of *S. sclerotiorum* were collected in infected oilseed rape fields in different locations in France. From each sample, 10 strains of *S. sclerotiorum* were isolated on malt medium agar. Their fungicide sensitivity or resistance were characterized according the method described by Souliac & Leroux (1995). This method is based on colony radial growth of *S. sclerotiorum* on malt agar medium amended or not with carbendazim or iprodione. For each fungicide, two concentrations were tested with respectively 1 and 10 mg/l of carbendazim and 1 and 2 ml/l of iprodione. The mycelial growth was measured from the diameter of fungal colonies after three days of incubation at 20°C in the dark. Strains were considered as resistant when mycelium does not grow at the two concentrations. A the field level, the location was considered resistant as soon as one resistant strain was detected.

RESULTS

For the last three years, 200 to 300 samples per year were collected and characterized for bendimidazole and dicarboximide resistance (Table 1).

Table 1. Incidence of *S.sclerotiorum* resistant to carbendazim in France.

	Year		
	2000	2001	2002
Total number of analysis	270	213	329
Incidence of MBC resistance	70%	71%	57%

In 2000, 270 analyses were carried out and the incidence of locations where at least one isolate was resistant to carbendazim reached 70%. This resistance of *S. sclerotiorum* to carbendazim was mainly distributed in the Centre area and in the eastern parts of France (Fig 1).

In 2001, only 210 analyses were made and the incidence of 71% of locations with bendimidazole resistant isolates was the same as the previous year.

In 2002, the incidence of benzimidazole resistant locations was less than 60% unlike the 70% observed the two previous years. But this downward trend is due to sampling. Indeed the number of analyses was the most important one of the three years in the northern and western regions that are shown to be less resistant than in the eastern and central regions of France. Regarding the dicarboxymide fungicides, no resistant strain of *S. sclerotiorum* was isolated in 2000. Respectively three and one strains were detected in 2001 and 2002.

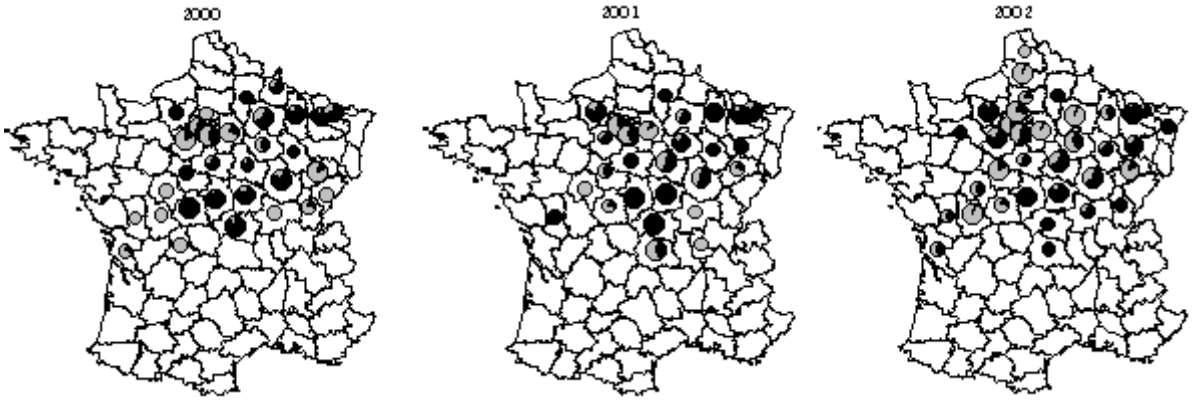

Fig 1 : Survey of resistance of S. sclerotiorum to carbendazim over the last three years. In black, occurrence of resistant isolates

DISCUSSION

The emergence of *S. sclerotiorum* resistance to carbendazim in oilseed rape was first reported in 1994 in Burgundy (Souliac & Leroux, 1995). Only four years later in 1998, two new resistant isolates were detected in the Paris area and in 1999 the phenomenon had spread with 20% of tested isolates resistant to carbendazim (Kaczmar & al, 2000). In practice, the benzimidazole resistance really surged in 2000 following severe attacks of sclerotinia stem rot in oilseed rape fields. In most cases, the chemical control with carbendazim failed. An analysis of cultural practices suggested that the development of resistance to carbendazim could be explained by short crop rotations such as oilseed rape every 2 or 3 years and at least 5 carbendazim sprays during the last ten years (Penaud & al, 2001).

In spite of a low level of sclerotinia stem rot in 2001 and 2002, the benzimodazole resistance has remained in the areas where it was previously detected suggesting that resistance of *S.sclerotiorum* to carbendazim should be stable like for other plant pathogenic fungi e.g. *Botrytis cinerea*.

The occurrence of *S.sclerotiorum* resistant to carbendazim has led us to develop resistance management strategies and several recommendations are made to farmers : i) give up a systematic treatment at the beginning of flowering and prefer the improvement of optimum timing to control the disease according to the climate conditions, ii) if a protection is needed, apply a single spray from the appearance of the first pods and iii) choose an efficient fungicide among different chemicals without cross-resistance to carbendazim. At the moment, three types of fungicides are registrated for sclerotinia use in France : 1) dicarboximide fungicides (iprodione, procymidone or vinchlozoline), which are very effective, 2) sterol biosynthesis inhibitors (tebuconazole, metconazole) which are less effective than the previous but interesting against other rapeseed diseases such as light leaf spot or powdery mildew and 3) recently a strobilurin (azoxystrobin). However, using effective fungicides only if necessary and alternating them could make it possible to manage practical resistance and maintain an

effective chemical control. At the same time, studies of biological control and of decision support system (Taverne & al, 2003) are in progress for a durable crop protection.

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