ARVALIS Institut du végétal

European Project

endure diversifying crop protection

SIXIÈME PROGRAMME CADRE

An example of results from Endure

Limiting diseases without recourse to fungicides?

A study conducted in eight European countries shows that a range of agricultural practices can reduce the need to use fungicides. The study also points out the agronomic and economic limits of these practices and the complexities involved in using them.

What is ENDURE?

ENDURE brings together more than 300 researchers in the fields of agronomy, biology, ecology, economics and the social sciences from 18 organisations in 10 European countries. They are committed to the ENDURE NoE (Network of Excellence) for four years (2007-2010), with the financial support of the European Commission's Sixth Framework Programme, priority 5: 'Food Quality and Security'.

The ENDURE network's objectives are to:

- Define research priorities on pesticide reduction at the European level.
- Pool knowledge, facilities and human resources according to the needs of the agricultural extension, industry and non-profit sectors.
- Become a source of reference satisfying farmers' needs and societal expectations.

Subvention from the EC: € 11.2m
Coordinator : INRA

ARVALIS is part of ENDURE project as member of ACTA, which federates French technical institutes and centers in agriculture

For more information, consult:
www.endure-network.eu

Various solutions exist that make it possible to improve the precision of agricultural practices and to minimise dependence on fungicides without increasing disease pressure. An ENDURE case study (see box) conducted in eight European wheat-producing countries, highlights the existing techniques and room for improvement on French farms. Despite the different disease situations across the countries under consideration (see table one), five important areas were identified:

- The use of genetic resources
- The use of thresholds and decision support systems (DSS)
- The use of certain cropping techniques
- Reducing nitrogen levels
- The optimisation and reduction of fungicide doses.

The use of resistant cultivars does not only reduce fungicide use, but can stabilise it too.

The use of resistant varieties is an important tool, allowing the number of treatments to be reduced. In the UK, two varieties resistant to brown and yellow rusts currently account for 28% of the wheat grown. In France, agronomical criteria and disease resistance in particular are now the principal factors in choosing a variety. However, the use of resistant cultivars does have its limits as even these varieties cannot resist all the diseases that affect wheat. In France, Sankara is resistant to septoria, but not to brown rust, leading to large differences in yield loss depending on the year to year variation in disease pressure. For example, in 2006 the average yield loss for Sankara in 24 trials was only 8.5 q/ha, but it climbed to 27.1 q/ha in 2007.

Average crop losses (and ranges) in q/ha for different fungal wheat diseases in eight European countries (based on data from ENDURE institutes and long-term trials). *(tab. 1)*										
Pays	Septoria leaf blotch	Brown rust	Yellow rust	Powdery mildew	Tan spot	Septoria glume blotch	Eyespot	Take-all	Sharp eyespot	Fusarium head blight
France	15 (3-50)	10 (0-40)	0 (0-60)	1 (0-15)	0.5 (0-20)	0 (0-5)	3 (0-25)	0-20	0 (0-5)	2 (0-20)
Hungary	Max 40	Max 40	-	Max 40		-	-	-		Max 40
Italy	11 % (4-23)	11 % (4-23)	-			-	-	-		28 % (8-60)
Germany	5 (0-27)	2 (0-10)		1 (0-8)	1 (0-14)		0	2 (0-14)		1 (0-7)
United-Kingdom	10 (0-30)	1 (0-40)	1 (0-40)	1 (0-8)	0 (0-2)	0.2 (0-50)	2 (0-20)	8 (0-50)	0 (0-1)	0.5 (0-10)
Nederland	5 (2-20)	1 (0-5)	1 (0-5)	1 (0-5)	2 (0-5)	1 (0-2)	1 (0-10)	1 (0-2)	1 (0-2)	2 (0-59)
Poland	4 (0-8)	10 (0-16)	1 (0-19)	2 (0-6)	2 (0-11)	9 (0-16)	5 (0-10)	12 (0-19)	1 (0-2)	1 (0-19)
Denmark	8 (3-25)	1 (0-8)	(1 (0-50)	2 (0-15)	2 (0-15)	0.5 (0-5)	1 (0-15)	5 (0-30)	0 (0-2)	0.5 (0-10)

The use of resistant cultivars can cut fungicide expenditure by €20/ha.

Loss of resistance

The use of resistant varieties also has limits under certain agricultural practices. After a maize crop cultivated without tilling, choosing a resistant wheat cultivar does not provide complete protection against fusarium risk – there is about a 20% chance that a plot will be above the threshold of 1,250 µg/kg of DON (deoxynivalenol).

Finally, resistance does not necessarily remain stable over time. In France, Orvantis, which was rated as one of the best varieties for brown rust resistance when introduced in 2000, was rated as one of the best varieties only once in six trials in 2004. The evolution of resistance depends on the combination of specific resistance genes, partial resistances, the intensity with which the varieties are grown, and the agricultural practices used to cultivate them. Above all, the situation varies between diseases, depending strongly on the way the disease is spread and reproduces.

The number of field observations is falling, but they remain essential in reliable timing of applications.

Simulating disease dynamics

There is another tool useful for limiting and imporving timing of fungicide applications: DSS and treatment thresholds. Developed in several European countries, they are especially employed by advisers, who use them to draw up their recommendations. Thresholds can be based on field observations coupled with decision-making rules based on the expected losses caused by the diseases. However, there are a number of obstacles to using DSS, such as the reduction in field observations (which remain essential in reliable timing of applications) and the lack of economic incentives: these services often have to be paid for and pesticides continue to offer a good balance of efficacy and price.

Crop management offers other ways of reducing dependancy on fungicides. Here the effect of operations such as tilling have a proven affect on disease pressure: tilling makes it possible to plough-in the remnants of the crop, preventing a number of pathogens from developing during intercropping and from forming inoculum the following year. This is particularly the case for diseases such as eyespot and fusarium head blight.

Crop rotation also has an impact on disease pressure. By avoiding the monoculture of wheat and short rotations based on cereals, the accumulation of inoculum in the soil is limited. This is particularly effective in limiting stem and root diseases.

Reducing the spread of diseases

Sowing date also has an impact on the development of diseases. Early sowing, while allowing large areas to be cultivated, also favours septoria, rusts and eyespot *(figure 1)*.

Reducing sowing density is often beneficial in limiting disease. A smaller density of plants per square metre maintains a low humidity level and reduces the spread of fungal diseases. However, the rationale behind sowing density is primarily based on yield objective.

The best strategy against septoria and to minimise fungicide expenditure consists of later sowing, choosing a resistant variety and applying fungicides when thresholds have been passed.

Another tool is **the reduction of nitrogen inputs**. A number of studies have shown that high nitrogen levels in a plant increase that plant's susceptibility to fungal diseases such as powdery mildew, rusts and septoria. Applications of nitrogen contribute to the development of dense plant cover, where the microclimate is more humid. Also, they reduce the resistance of cell walls to penetration. The studies also show that split dressing of nitrogen fertilisers is favourable for limiting diseases.

Using reduced doses

Fungicide strategy trials conducted in the UK, Denmark and France all conclude that optimal fungicide expenditure (based on margins) corresponds to the use of reduced fungicide doses. This allows significant reductions in the total fungicide input (TFI), but must take into account the properties of the products used and the fungicide strategy, which is itself a product of the anticipated risk for each disease. In Denmark, for example, for a susceptible variety a two-application strategy (one during stem extension and another after heading) is the most effective. The best margin is obtained by using a half-standard dose of fungicide, equivalent to a TFI of 0.5. Increases in cereal prices clearly play a role in deciding the best fungicide strategy. In the case of a high wheat price (€20/q), strategies using three applications catch up with two-application strategies in economic terms *(figure 2)*. This means the TFI giving the best margin increases from 0.5 to 0.75. These conclusions corroborate the French results already presented by ARVALIS Institut du Vegetal.

Cultivars are not resistant to all wheat diseases.

David GOUACHE
d.gouache@arvalisinstitutduvegetal.fr

Lise N. JORGENSEN
Aarhus University, Danemark

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With : Marga JAHN, JKI, Germany ; Bill CLARK, Rothamsted, UK ; Daniele ANTICHI, SSUP, PISA, Italy ; Tomaz GÓRAL, IHAR, Poland ; Huub SCHEPERS, Wageningen University, Nederlands ; Philippe LUCAS, INRA, France ; Laszlo HORNOK, SZIE, Hungary