Crops

Strategy for avoiding the water stress period
Using earliness as a mean of adapting the growth cycle to water constraints

The strategy for avoiding the water stress period consists in moving yield-building stages forward, ahead of water restriction periods. In 2005, weather conditions were favourable for the study of this strategy in trials carried out by ARVALIS - Institut du végétal in centre-west France (Poitou-Charentes). They helped identify various strategies for developing maize cropping techniques adapted to lesser water availability due to irrigation restrictions at the end of the cycle.

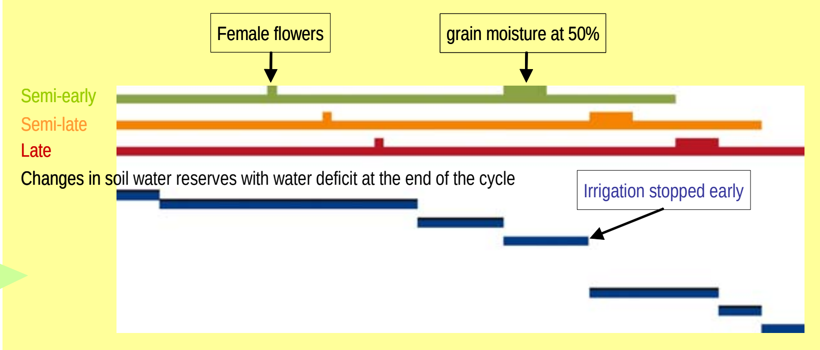
Changes in the economic situation as well as in regulations affecting the grain maize sector, have prompted ARVALIS - Institut du végétal to explore various solutions in order to adapt cropping techniques to those changes *(see Perspectives Agricoles n° 319 – January 2006 p. 24)*. The series of dry years with increasingly early irrigation restrictions imposed in several grain maize production areas, as well as the insufficient replenishment of water resources at the beginning of 2006, are adding to the need for an urgent implementation of strategies designed to limit yield losses and water consumption. The purpose of this article is to report on the first experimental results obtained in 2005 in the Vendée, Poitou and Charentes regions (centre-west), regarding the possible use of earlier varieties to counter the fact that irrigation is stopped very early in the final phase of the growth cycle, as well as the fact that ground water reserves are progressively running out. The different ways of adapting that are being studied, will have to be validated in other circumstances, but offer additional solutions to irrigating farmers who find themselves faced with increasing water constraints. The economic formula of the earlier sowing dates and variety strategy, called strategy for avoiding the water stress period, is partly based on the genetic progress noted in early and semi-early varieties, and on lower drying costs, which helps compensate to a certain extent for their slightly lower yields compared to the later varieties usually grown. This strategy completes the array of technical solutions being experimented by ARVALIS – Institut du végétal regarding water management, such as the irrigation management tool Irrinov®, which has been adapted for use in a wide range of crops and regions.

Identifying water deficit strategies for avoiding the water stress period

In cases of water deficit, the first objective is to avoid the period when water deficit is most likely, coinciding with the most sensitive period for the establishment of yield components. The second objective is to shorten the crop's water consumption period. The technical choices which help minimise yield loss vary depending on which one of the most common scenarios of water resources shortage is applicable. In the regions where irrigation stops early in the final phase of the cycle and where there is little rain in summer, the strategy relies on choosing earlier sowing dates and varieties, with a shorter plant growth cycle. This is designed to bring forward the flowering stage (i.e. the phase when the number of grain per square metre is determined, and when the grain starts forming) to a period less deficient in water *(figure 1)*. Having identified the most common weather and water resource conditions experienced in Poitou, Charentes and centre-west regions over the past few years, those were used as the basis for the development of parameters that were then studied in the 2005 trials.

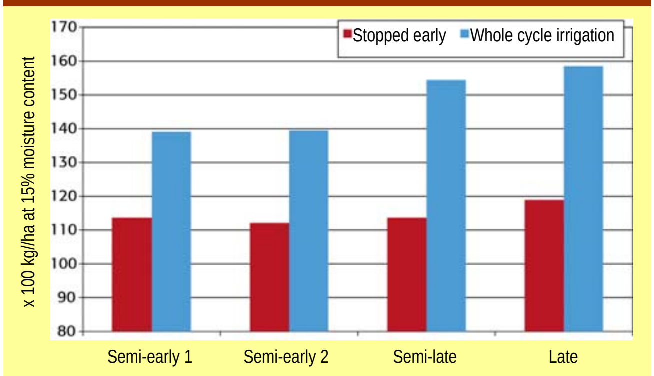
This type of measures for avoiding the water stress period against the risk of water restrictions is not as justified in other hotter regions with less limited water resources and a greater chance of rain at the end of the summer.

Positioning of reference yield building stages for three different cycle lengths in relation with water availability *(fig. 1)*



The diagram shows that the grain of the semi-early variety has almost reached the end of the growth stage, whereas the end of irrigation coincides with the period when the 1000 seed weight is determined in the late variety.

Yield of the 4 varieties, depending on the irrigation programme (Average results on 2 sites of the 2005 Esquive network, Poitou-Charentes) (fig. 2)



Removable greenhouses of Le Magneraud experimental station. Before drawing conclusions on the advantages of various alternative strategies, we must confirm the reference data acquired in 2005 with different weather and irrigation restriction patterns

Establishing yield components before early restrictions impose the end of irrigation in the final phase of the cycle

The first stage of the study focussed on assessing the impact of earliness-based strategies on the plant cycle of various categories of earliness, in several regions.

In semi-late and late maize areas, the strategy for avoiding the water stress period using semi-early varieties makes a difference measured in days. Choosing varieties at the tail end of the semi-early C1 group, or at the beginning of the semi-early C2 group, helps bring the date of grain moisture content at 50% stage forward by 5 to 10 days, depending on the sowing date and the region concerned, compared with the currently most commonly grown varieties.

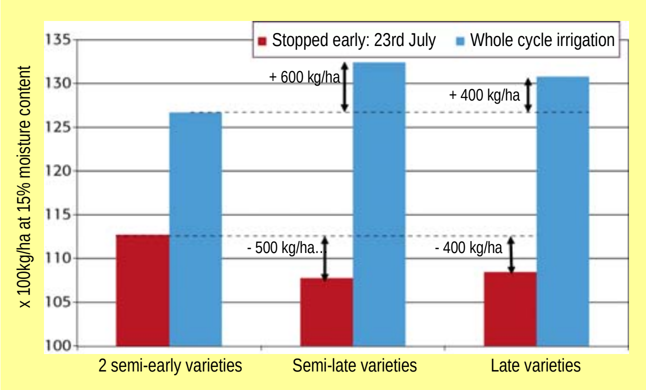
So, for a semi-early variety sown between 1st and 5th April in the Aunis and Plaine de Niort areas (centre-west), the end of the phase most sensitive to water shortages (i.e. the grain moisture content at 50%) is reached, one year in two, on 17th August. The forward shift of the cycle also results in a difference in moisture content at harvest time, with the possibility of an earlier harvest and lower drying costs. The cycle timing shift experiments based on the comparison of earlier varieties, as part of the strategy for avoiding the water stress period trials carried out in 2005 in the Vendée and Poitou–Charentes regions as well as the trials of a Technical and Economic Interest Network (RITE), confirm this type of date difference. The timing shift objective was easily achieved in 2005, as shown by the average dates noted for each stage on a few sites with unlimited irrigation. In fact, crops sown in the first ten days of April reached the 50% moisture content stage around 12th August for semi-early varieties, i.e. 7 to 9 days before semi-late and late varieties. By 15th September, the difference in moisture content between semi-early and semi-late varieties, sown at the very beginning of April, reached 8%, and 12% in the case of late varieties, which represented 7 and 10 days respectively of a timing shift in stages.

The RITE trials in the southwest, which included several earliness categories, also show, even with very low moisture contents at harvest reducing the difference in grain moisture content, between 4 and 8 points of a difference between semi early varieties and late and very late varieties respectively.

Conditions in 2005 were ideal to study the avoidance of the water stress period

The second phase of the work on the technical and economic value of the avoidance of the water stress period, focused on setting up special trials combining earliness and water resources patterns representative of cases where irrigation is stopped early, which are common in the Poitou-Charentes and Vendée regions.

Net yield after drying, depending on the irrigation programme (2005 Esquive network, Poitou-Charentes) (fig. 3)



Important points and practical recommendations

The results of the "avoidance of the water stress period" trials carried out in centre-west France in 2005 highlight the following:

- the economic advantage offered by semi-early varieties, close to or even slightly greater than that of late varieties in cases where irrigation is stopped from the end of July onwards,
- the possibility of avoiding the need for the last water application with semi-early varieties,
- drying cost savings which partially compensate for the loss of potential yield due to earliness,
- the possibility of an earlier harvest, which also offers an advantage in terms of intercropping season management and of the establishment of an autumn crop in better conditions.

At the moment, the field of validity of those results is limited to the following situations:

Centre-west,
- soils with average water reserves which help alleviate the impact of an acute lack of rain,
- small to moderate irrigation restrictions in June and July and risk of major restrictions from the beginning of August,
- yield increase potential of around 1.1 to 1.3 t/ha with no restrictions at the end of the cycle and with a minimum of 3 to 3.5 mm/day depending on soil depth,
- varieties with confirmed regular high performance in the post-registration trials carried out by ARVALIS - Institut du végétal.

The first encouraging results must be validated in 2006, which involves:

- confirmation through experimental data acquired with different weather and irrigation restriction patterns,
- analysing the advantages offered by the strategy in other regions,
- tests on a larger panel of hybrids from the various earliness categories, since there may be differences in behaviour amongst semi-early varieties or between late varieties.

What solutions are available to maize growers faced with irrigation restrictions in 2006?

- case scenarios in the Centre-West comparable to the 2005 trials: avoidance of the water stress period, by using earlier varieties with good production potential on most of the irrigated area, and sowing at the beginning of April, soil conditions permitting, seems to be a compromise both from an economic point of view and with regards to avoiding the last water application,
- in the other cases: experimental data is still insufficient to be able to generalise. However, this does not necessarily mean that there are no potential advantages to earlier varieties and sowing dates in cases with lower potential. This alternative warrants being tried on small areas.

The experiments carried out by ARVALIS - Institut du végétal at Le Magneraud research station, as well as in six fields on farmers' land in the Aunis area and Vendée region (centre-west), focused on the comparison of reference varieties in the semi-early, semi-late and late categories (varieties which performed well in the post-registration network), sown at the beginning of April in clayey-chalky soils and at the end of April in silty soils, in accordance with current seed rate recommendations, with two different irrigation programmes:
- one programme with unlimited irrigation, to assess the variation in productivity between different earliness categories when water is not a limiting factor,
- one programme in which irrigation is stopped early (last water application between 22nd and 30th July depending on the site, i.e. 15 to 20 days after female flowering of semi-early varieties), to test the advantages offered by earlier varieties when water is restricted at the end of the cycle.

Water deficit at the end of the cycle was exceptionally high for all sites, due to a virtually total lack of rain and of very hot conditions between 20th July and the end of August. In addition, the 20 mm of rain recorded between 20th and 22nd August, came too late, even for the latest varieties which were then at the 40% moisture content stage by then. The rainfall pattern over the whole year resulted in the harshest of conditions, and therefore was particularly suited to highlighting the impact of a strategy for avoiding the water stress period focussing on bringing the stages forward and shortening the plant cycle. *Figures 2 and 3* show respectively the difference in yields before and after drying, measured with two trials, from average and deep clayey chalky soils. All the varieties used with the "whole cycle irrigation" parameter were irrigated without restriction. With no restrictions on irrigation, the yields achieved were high. The difference in yield between semi-early, and semi-late and late varieties is usually on average 1.5 and 1.9 t/ha respectively (*figure 2*). But if we take into account the difference in grain moisture content on the day of harvest (identical harvest date for all varieties), the difference in yields after deducting drying costs gets smaller and comes down to between 400 and 600 kg/ha *(figure 3).*

Stopping irrigation early reduced the yield by 2.5 to 4 t/ha depending on earliness of the variety *(figure 2)*. This is a significant loss and confirms once again the fact that maize utilises water efficiently. Later varieties, which are not so far on when irrigation is stopped, were subjected to a greater level of water deficit, and during a period of higher sensitivity to lack of water. The variation between varieties in gross yields, before drying, is getting closer to the difference noted with the full irrigation programme. The economic yields of semi-early varieties rise by the equivalent of 400 to 500 kg/ha after deducting drying costs *(figure 3).*

The advantage of semi-early varieties over semi-late and late varieties, when irrigation is stopped early, was noted in all tests, and in particular in those with irrigation restrictions in July. *Figure 4* shows the results of the two tests which received under 120 mm between the 10 leaf stage and the end of July, whereas in full irrigation case scenarios, between 150 and 180 mm were applied over the same period.

Such data suggests that in case of strong restrictions at the end of the cycle (stopped early and dry month of August), the strategy for avoiding the water stress period can also offer benefits when irrigation is limited in June and July. The range of cases for which this strategy offers benefits is therefore wider than was initially thought. We must however still verify that this behaviour is confirmed in water shortage conditions less drastic at the end of the cycle than they were in 2005, before we can propose this strategy for a wider range of irrigation levels.

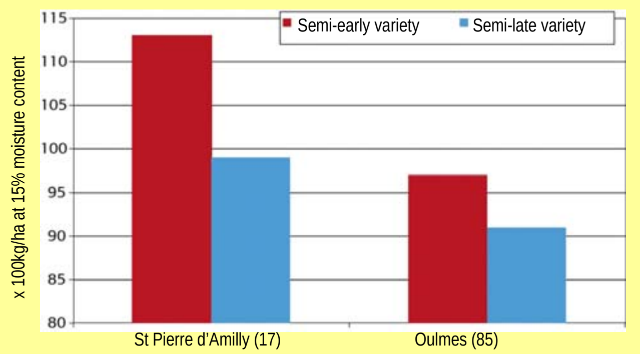
The strategy for avoiding the water stress period also helps save water

A priori, the use of earlier varieties could suggest that the need for water will be reduced, since the cycle is shorter and yields are lower. In 2005, water consumption was monitored in a trial carried out under the removable greenhouses of Le Magneraud experimental station. Regular soil moisture tests were combined with tensiometric measurements and recording of leaf area index stages and measurements for the semi-early and semi-late variety.

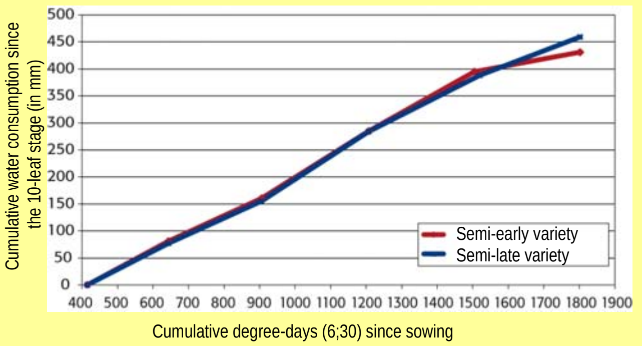
The level of water consumption is similar for both varieties up until the grain moisture at 50% stage of the semi-early variety, as shown in *figure 5.* Their capacity for extracting water from the soil has proved comparable. The 5 to 7 day shift in the 50% stage of the semi-late variety results in a level of consumption higher by 25 to 30 mm - i.e. the equivalent of one water application. This also means that the use of an earlier variety does not justify changing the irrigation programme. The rules proposed by the Irrinov® method for the semi-late or late variety, also apply to the semi-early variety.

Le Magneraud experimental station saw regular soil moisture tests combined with tensiometric measurements and recording of leaf area index stages and measurements.

Yields of two varieties with early end of irrigation (between 20th and 25th July) in two tests carried out with restricted irrigation in June and July (2005 Esquive network, Poitou-Charentes) *(fig. 4)*



Progression of the cumulative water consumption since the 10-leaf stage in the full irrigation programme of the experiment carried out at Le Magneraud research station in 2005: comparison of a semi-early variety and a semi-late variety *(fig. 5)*



Searching for the best yield-drying costs and crop density compromise

The economic benefits of earlier varieties (at least of one earliness category) were the subject of experiments in other regions in 2005. The addition of earlier varieties on the varietal lists of the post-registration variety assessment network helped assess, in 2005, the simultaneous impact of earliness on yield and drying costs. The differences in net yields (after deduction of the differences in drying expenses) are not always significant. The difference between earliness categories is no greater than the difference between less productive varieties belonging to the same earliness category.

Special trials, combining the impact of earliness categories and crop density, were designed to find answers to questions raised by many farmers regarding the advantages of increasing crop density for earlier varieties, in order to compensate for lower leaf areas.

The average of the results obtained in the 5 trials carried out in the southwest, in situations with very few restrictions on irrigation, confirm the information acquired in the full irrigation programmes of the 2005 experiment carried out in the Vendée, Poitou and Charentes regions.

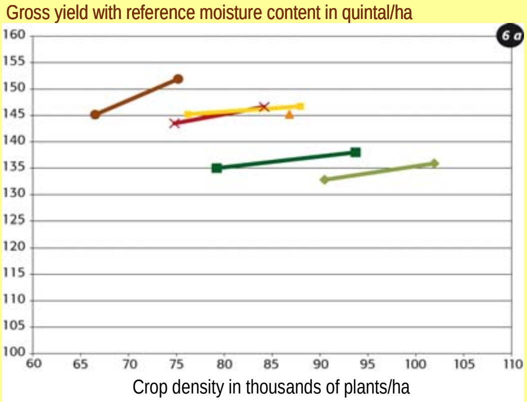
Figures 6 a, 6 b and 6 c show the impact of drying and seed costs on the respective benefits of the various earliness categories.

In cases with a good potential, the net yield, net of drying costs, *(figure 6 b)*, of late and semi-late varieties is on average 1 t/ha higher (variations of 500 kg to 2 t/ha depending on the trials) than in the case of the semi-early varieties with fairly low average moisture content (*figure* 7 shows grain moisture content varying between 20 and 27.5%), whereas it is close to 1.7 t/ha in terms of biological yield *(figure 6 a)*. The additional 10,000 to 15,000 plants/ha was well utilised in terms of gross yield *(figure 6 a)*, but not so well in terms of net yield *(figure 6 c)* (case scenario assuming that the average dose price is the same for all varieties).

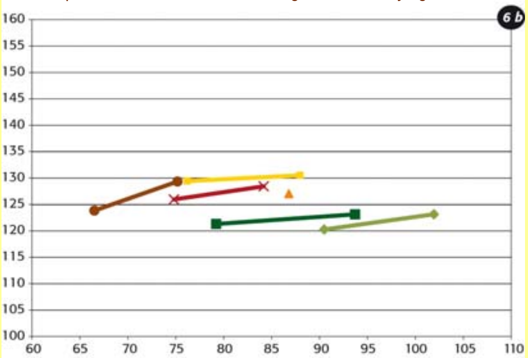
Comparison of biological and economic yields with two seed rates of reference varieties from various earliness categories, assuming average drying and seed prices.
Summary of 5 trials carried out in the southwest in 2005 (fig. 6)

RITE trials carried out by the ARVALIS-Institut du végétal teams in the southwest
Yields obtained in small fields

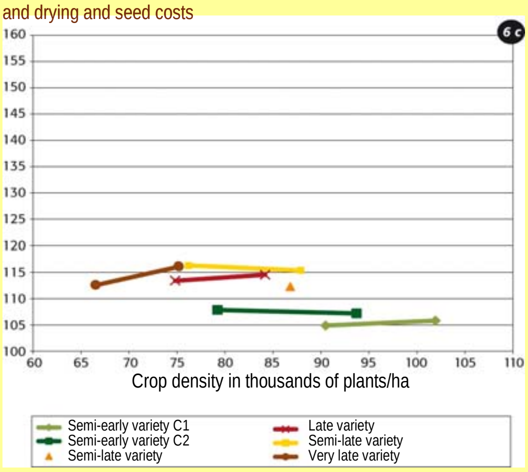
Gross yield with reference moisture content in quintal/ha



Yield in quintal/ha after deduction of weight loss and drying



Yield in quintal/ha after deduction of weight loss and drying and seed costs



Reference data to be confirmed with different weather patterns

2005 provided a great deal of information on the comparison between the different effects of important factors of the cropping techniques implemented to grow maize.

Where the crops were water deficient at the end of the cycle, which was often the case in some areas of the Poitou-Charentes and Vendée regions, the impact of irrigation and the good utilisation of water made by maize were once again confirmed, with differences in yield ranging from 2.5 to 4 t/ha depending on the irrigation programme used.

However, it also highlighted that in cases where it was impossible to satisfy properly the need for water at the end of the cycle of the varieties usually grown, earlier dent maize varieties, recently registered and with a good production potential (see N° *319 of "Perspectives Agricoles")* proved to offer undeniable advantages. Using an earlier variety, without changing the sowing date, helps bring critical phases forward by 5 to 10 days. The assessment of the impact on yield, net of drying costs (with the same harvest date for all varieties), shows that, in six trials, the use of earlier varieties in the Vendée, Poitou and Charentes regions results in a loss of 500 kg/ha when the water situation is favourable at the end of the cycle, but helps achieve an increase in the same range if water is severely restricted. The benefits of this strategy depend on the water and weather situation, as confirmed by trials carried out in the southwest, with differences in average net yields (after deducting the differences in drying costs and crop density) of around 1 t/ha between semi-early and late varieties.

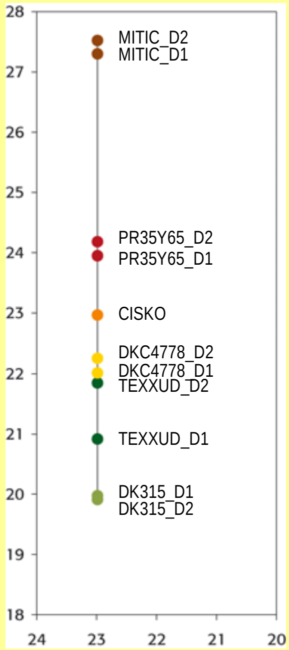
In 2005, the strategy for avoiding the water stress period had a positive outcome in terms of net yield (net of drying costs) and saved one irrigation application.

Before drawing conclusions regarding this alternative strategy, we must confirm the reference data acquired in 2005 with different weather and irrigation restriction patterns.

Indeed, the results obtained cannot be dissociated from the extreme water conditions experienced in 2005, from situations with no water restrictions to cases with no irrigation during the whole grain-filling phase. The results are encouraging and should lead to further experimental work, which will need to be completed with simulations using cropping models, in order to establish in which fields they are validated and what recommendations should be made.

Comparison of grain moisture content at harvest time in the RITE trials carried out in southwestern France (fig. 7)

Average moisture content of varieties used in the network



Average moisture content of whole network (%)

D = type of density

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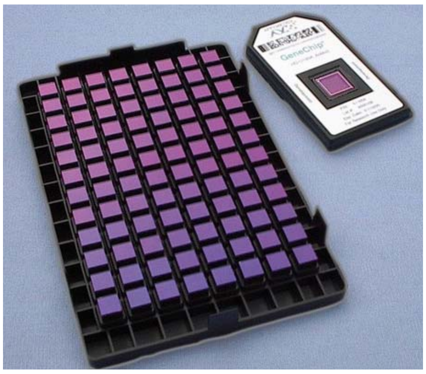
From Perspectives Agricoles n° 321 March 2006

DNA chips
Use of genomics to make plants reveal all

DNA chips are helping plant genomic research advance faster. The work undertaken on soft wheat led to the identification of genes giving information on the nitrogen status of the plant. Although this method is still only used in a laboratory environment, its actual application is not utopian and could offer many possible variations.



A robot lays several thousand DNA fragments over a few square centimetres: this is the DNA chip.
© *Courtesy of Affymetrix*

DNA chips are revolutionising our knowledge of the genetics of cultivated species. This technology, used for about ten years now in the field of medical research, is generating huge excitement within the scientific community. Applied to plants, it enables us to put a large quantity of genetic data onto a few square centimetres, in order to identify characteristics specific to a variety. Its principle is based on the sampling of plant tissue. Once ground and prepared, this sample is then applied to a nylon membrane or a glass slab.

The use of optical techniques and special software then helps read all the genes of a plant and measure their level of activity. It is a real open book: for instance, wheat contains 30,000 genes.

© *Courtesy of Affymetrix*

Identifying the function of a particular gene

"A DNA chip uses the information contained in the messenger RNA", explains Laurent Guerreiro, responsible for genomics at ARVALIS - Institut du végétal (figure 1).

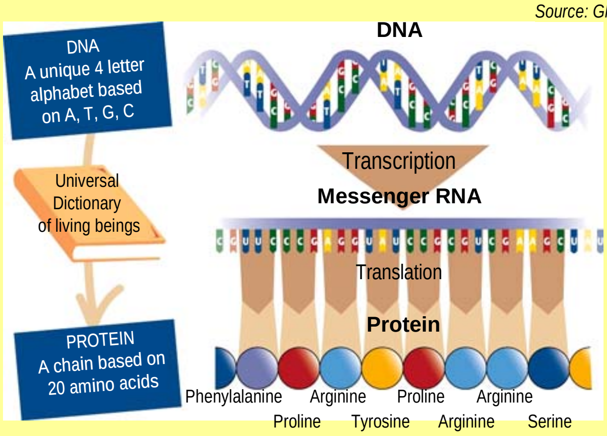
"One of its purposes is to convey genetic information from the nucleus to the cytoplasm, where it will be used. It shows how active the genes are. There is therefore a strong connection between a large quantity of messenger RNA and a visible symptom on the plant", he adds.

Consequently, once the potential function of this or that gene, or its level of activity have been identified, it is then possible to show, by comparison, whether under given circumstances the plant is suffering stress or not.

"DNA chips make plants reveal all: they give us information on the health of the plant, its nutrition, its well being…" sums up Laurent Guerreiro.

From gene to protein *(fig. 1)*

Source: GNIS



Similar to DNA from a molecular point of view, messenger RNA (mRNA) conveys genetic information between the DNA and the cells.

Genetic data is based on plant samples taken in the field.

Two extreme situations

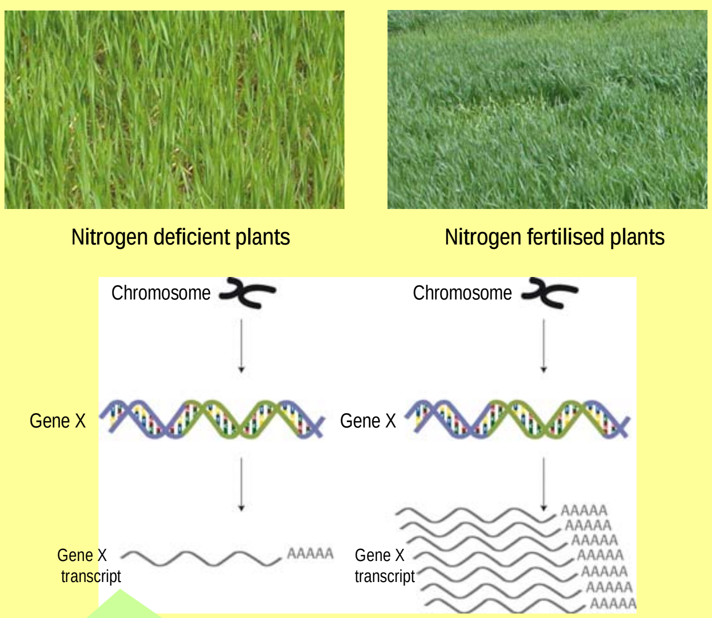
The initial concept is *almost* self-evident: environmental stress affects the way the plant functions. Logically, this effect is noticeable in the molecule long before signs of stress become visually apparent. The point of analysing the genetic data gathered was therefore to measure how the plant's genes reacted in given circumstances, in order to then diagnose the state of the plant.

"The first experiments on soft wheat focused on nitrogen fertilisation of soft wheat, a subject with which we are very familiar", explains Laurent Guerreiro. *"We placed soft wheat in two types of extreme conditions, i.e. excessive nitrogen and lack of nitrogen, before comparing the behaviour of the 30 000 genes in both cases."*

"Indeed, we found genes connected to the nitrogen satisfaction of the plant", Laurent Guerreiro is happy to report. *"The higher the nitrogen dosage becomes, the more those genes are active (figure 2). The lower the nitrogen input, the less active the genes are. We have shown that some genes react to the nitrogen dosage."*

"This approach is radically different from current methods, which interpret the nitrogen status from the nitrogen dosage. Here we use the reasoning followed by the plant."

Biotic or abiotic stress leads to molecular changes in the plant, including in the genes expression, before the phenotype becomes visually apparent. *(fig. 2)*



Biotic or abiotic stress leads to molecular changes in the plant, including in the genes expression, before the phenotype becomes visually apparent. (fig. 2)

Simpler techniques

If the concept works, ARVALIS – Institut du végétal would like to double-check the reliability of the tool. *"In 2006, 17 ARVALIS - Institut du végétal sites all over France are taking part in this work. Each scientist involved will soon have to give his/her verdict on this technique."*

"We have selected genes entirely connected to the needs of the plant. Regardless of variety, environment and development stage, they indicate the level of nitrogen satisfaction", continues Laurent Guerreiro. *"We are currently working on singling out one indicator gene and thus simplifying this method."*

But already, around thirty genes having been identified, less expensive and simpler techniques can now be used, such as the PCR technique (Polymerase Chain Reaction; DNA replication technique which helps highlight the presence of a gene or mRNA). The technique is sufficiently conclusive to be used in other research fields (*see insert*).

"And if we are able to identify a single reliable gene for all the varieties of a species, we will be able to devise field tests, using perhaps a strip type kit", imagines Laurent Guerreiro. It would just be a case of obtaining leaf juice to test it on a strip whose colour would indicate the nitrogen status of the plant, or its level of resistance to disease. Does this still belong to the realm of dreams? The question startles the scientist: *"You will no longer be saying that in five years time".*

DNA used in fungicide protection

In 2006, three ARVALIS – Institut du végétal trials are using DNA chips to help protect plants against leaf spot. The outcome is extremely important, as up to now, there are no reliable tools to assess the harm caused by a leaf spot attack. Genomics could help implement a targeted and more environmentally friendly treatment.

"It is easy to imagine basing our decision on whether a treatment is absolutely necessary or not, on the information given by the plant itself." The research logic is the same as for the first experiment: various plant samples are closely examined, some free from leaf spot, others increasingly diseased. DNA chips are helping search for a gene indicating whether the plant is under attack or not.

Other fields could benefit from such innovation: irrigation is one of them. By identifying genes indicating drought induced stress, it will be possible to select varieties most suited to coping with lack of water.

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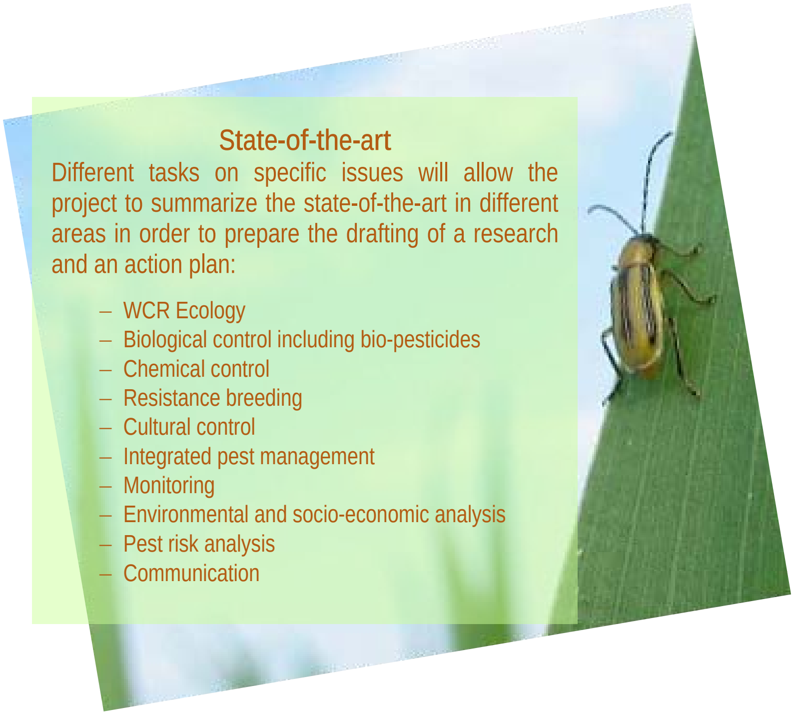
ARVALIS Institut du végétal

European Project

Sixth Framework Programme

Diabr-Act

ARVALIS – Institut du vegetal is coordinating Diabr-Act, an European project gathering 13 partners from 7 countries in Europe. This project is a two years specific support action supported by the EU's 6th framework programme of research and technological development.



State-of-the-art

Different tasks on specific issues will allow the project to summarize the state-of-the-art in different areas in order to prepare the drafting of a research and an action plan:

- WCR Ecology
- Biological control including bio-pesticides
- Chemical control
- Resistance breeding
- Cultural control
- Integrated pest management
- Monitoring
- Environmental and socio-economic analysis
- Pest risk analysis
- Communication

Diabr-Act, what is it about?

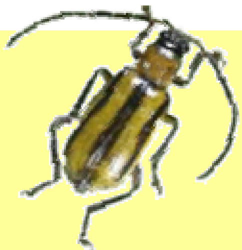
In the past few years the Western Corn Rootworm (WCR - Diabrotica virgifera virgifera) invaded central Europe more rapidly than expected in the past. Its rapid spread together with the establishment of continuous populations will evidently result in severe problems to European high intensity maize production areas throughout Europe.

Several research activities in the EU member states aimed at finding integrated strategies for reducing WCR populations below threshold levels in already infested areas and to avoid an introduction and spread in non-infested areas. There is an urgent need for harmonising and concentrating these activities both on a scientific and administrative level. Diabr-Act will propose to the European Commission a community-scale action and research plans in order to establish a harmonised and sustainable control strategy for continuously established and discontinuously emerging WCR populations.

Diabr-Act's propositions will of course take into account the aim of minimizing the impact of these measures on biodiversity and environment. Control strategies to be established should also be adapted to the situation of each country involved and should take into account the situation of the farmers and the economic chains build upon the maize crop (biological and integrated control, plant resistance traits, the adaptation of biotechnological approaches, cultural techniques).

DIABR-ACT will also evaluate short and long term costs/benefits of containment and eradication strategies at the micro or macroeconomic level.

13 partners from 7 countries in Europe



Project coordinator:

- ARVALIS – Institut du vegetal (France)

Scientific and technical coordinator:

- Georg-August-Universität Göttingen (Germany)

Other partners

- Università degli Studi di Padova (Italy)
- CAB International – CABI (Switzerland)
- Praktijkonderzoek Plant & Omgeving B.V. – PPO (The Nederlands)
- Szent Istvan Egyetem –SZIE (Hungary)
- Wageningen Universiteit (The Nederlands)
- Institut National de la Recherche Agronomique – INRA (France)
- Station de recherche Agroscope Changins-Wädenswil - ACW (Switzerland)
- Csongrád megyei Növény- és Talajvédelmi Szolgálat - LBC (Hungary)
- Federal Biological Research Centre for Agriculture and Forestry - BBA (Germany)
- Poljoprivredni fakultet u Osijeku - PFOS (Croatia)
- Association Générale des Producteurs de Maïs - AGPM (France)

The outputs of DIABR-ACT will benefit the European Union by the following main results:

- An increased awareness and understanding of the problems caused by this pest species encountered by plants breeders, farmers, and plant protection services
- A coordinated European Action Plan: harmonising and improving control and prevention of Western Corn Rootworm populations in Europe.
- A coordinated European research plan: identifying the priority research areas and minimising parallel research

An international symposium will be held in June 2008, in Göttingen to introduce and discuss the drafts of the research and action plans that Diabr-Act will propose to the European Commission.

ARVALIS' participation

Within Diabr-Act, ARVALIS is in charge of the general coordination of the project helped by the University of Göttingen for the scientific and technical part. ARVALIS is also in charge of drafting the action plan.

ARVALIS will also participate in different workshops aiming at summarizing the state-of-the-art in different areas.

Website of the project:
http://www.diabract.org/

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