INNOVATIONS
with a strong technological focus

Biofumigation requires fine chopping and rapid incorporation of the catch crop.

The search for solutions deriving from natural processes and preserving the competitiveness of production is at the heart of agro-ecology. This principle is particularly relevant with regards to crop protection. Detailed review

The choice of variety, the rotation and soil cultivation remain the main action levers to achieve self-regulation of the pressure exerted by some bioagressors within a cropped parcel. However, there are other solutions, involving both traditional and highly innovative agronomic measures. Biological control agents in crops (*insert*) and companion crops are emblematic examples of this approach.

From a perspective in the longer term, a study of the compounds emitted by plants and that are attractive to pests is offering interesting possibilities of biological regulation through genetics, trap plants and biocontrol through confusion.

« **Used to control nematodes,** biofumigation is also the subject of research in connection with some soil-borne diseases. »

Utilising the competitive effect

Commonly used in perennial crops, with multiple benefits (less erosion, bearing capacity of soil, etc.), companion plants are increasingly often associated with annual crops, such as oilseed rape, to control weeds.

Associating this crop with frost-sensitive covers (usually leguminous plants to capitalise on the nitrogen they provide, which is fixed by symbiosis) helps oilseed rape plants to compete with dicotyledonous species.

Terres Inovia's experiments show that leguminous-based companion covers do not compete, or only very little, with oilseed rape in the autumn. Without any weed control, the level of weed coverage at the beginning of winter is less extensive when the oilseed rape crop is associated with companion plants than when it is not. This competitive effect is proportionate to the biomass of the oilseed rape and companion cover at the beginning of winter. Early emergence is therefore even more advisable, with rapid growth of the companion cover.

However, the efficacy of this competitive mechanism with weeds is too partial to eradicate undesired flora. It must be considered as a weed management tool, as part of a reduced weed control programme, particularly in order to avoid hindering the development of leguminous plants. This strategy (reduced rate of dicotyledon herbicide and competitive effect of companion covers) is most effective in many situations. In cases of very significant weed presence and/or of weeds that emerge early (geraniums), this solution is unsuitable or must imperatively be combined with other means of action. Current work undertaken as part of an INRA/Terres Inovia thesis will supply more detailed information on the mechanisms at play when weeds compete with companion covers associated with oilseed rape, as well as on which species should be chosen to enhance this effect.

Companion covers for oilseed rape, here lentils and grass pea, help smother weeds, including when they emerge a few weeks after the cover.

Plant protecting plants

Used mainly to control nematodes, biofumigation, or biodisinfection (establishment of brassicas as catch crops, as they have a plant protection effect due to substances released as they degrade in the soil) is also the subject of research in connection with some soil-borne diseases.

Against Rhizoctonia, which is an issue in some rotations (potatoes, maize and sugar beet), it is essential to elaborate a protection strategy at cropping system level. The CASDAR SysPID project "*Réduire l'impact des maladies telluriques dans les systèmes de cultures pour une protection intégrée et durable des grandes cultures*" (Reducing the impact of telluric diseases in the different cropping systems for an integrated and sustainable protection of arable crops) has helped to gain a better understanding of the epidemiologic processes of *R. solani* AG3 (potato) and *R. solani* AG2-2 (sugar beet), in order to analyse the effects of biofumigation (*in situ* production of a fumigant by plants such as Indian mustard) on epidemics, and to give guidelines to help elaborate an integrated protection plan.

Experiments established on several sites have shown that used singly, fumigation is only partially effective. However, used as a complement to other control techniques such as rotation, it can deliver yield gains and probably, in the longer term, help preserve the safety quality of the soil through various crop rotations.

The study of attractive substances between plant and pest may lead in the long run to the implementation of new control methods.

Chemistry, a basic component of ecology

To offer new control methods, we need to understand the process or processes involved in the colonisation of the host plant by a pest, and in particular, we need to identify the chemical signals involved. Those methods are based on the modification of the relationship between the pest and the plant: modifying a plant's emission of attractive substances through varietal selection, creating dedicated non-harvested trap areas, or mixing a small dose of insecticide to a substance that attracts target pests.

ARVALIS - Institut du végétal, UMR PISC in Versailles and UMR Agroécologie in Dijon have been working together for several years on the subject of chemical ecology. The aim is to identify the kairomones involved in the relationships of two pest/host plant pairs: bean weevil and faba bean, and European corn borer and maize. The first tests carried out in fields show that it is possible to artificially produce the host plant message and attract the females of the target pest species. Now this must lead to the creation of tools that will harness this discovery and develop it into a new control technique.

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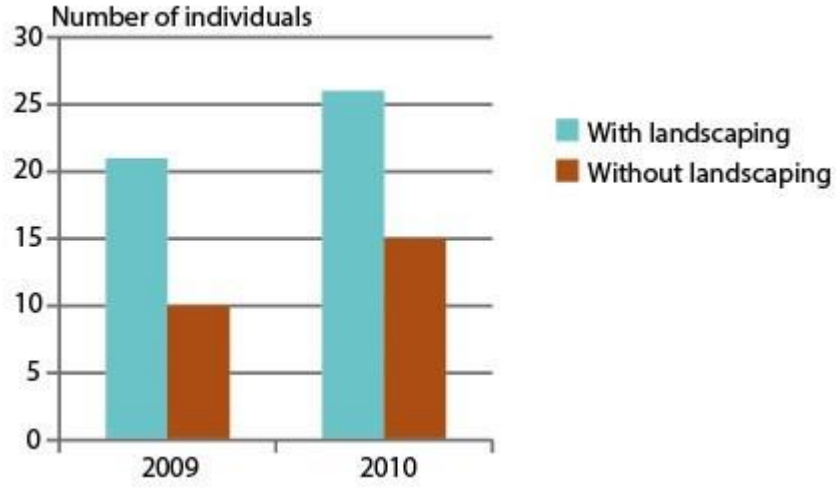

Figure 1: Characteristics of ground beetle communities in parcels (Rhône-Alpes, central eastern France). Similar results were obtained by measuring the number of species.

The allies of pest control

In order to ensure the presence of entomophagous arthropods, which are able to eradicate, or regulate, pest populations in cropped parcels, biological control through conservation aims to encourage those biological control agents by modifying their environment: appropriate agricultural practices, creation or preservation of uncropped areas.

Through a large scale monitoring process, the CASDAR project entitled "*Les entomophages en grandes cultures: diversité, service-rendu et potentialités des habitats* " (entomophagous fauna in arable crops: diversity, benefits and habitat potential) showed the benefits of uncropped spaces in order to entice numerous and various types of ground beetles into adjacent parcels *(figure 1)*. Biological control agents do go through all or part of their life cycle in those areas. Cropping practices, such as soil cultivation or plant protection treatments have an impact to varying degrees depending on their timing (larvae are more sensitive than adults) and the region in question. Likewise, the presence of forests near agricultural areas and of certain plant species around the fields (mainly *Asteraceae* and *Apiacae*) seems to encourage syrphid flies. In the future, the aim will be to qualify and quantify the regulation potential, in order to build bioagressor control strategies that integrate biological control agents.