Workshop report - Impact of GM crops on natural enemies

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During the first meeting of the IOBC/wprs working group entitled ‘Ecological impact of genetically modified organisms’ from November 26-29 in Prague, a workshop was hold that dealt with the possible impact of genetically modified plants on entomophagous arthropods. More than 30 participants from universities and governmental research institutions, private industry and regulatory agencies attended the workshop.

Due to the fact that most participants had a background in entomology, the focus of the discussion was on insect-resistant GM crops. In addition to commercialised Bt-transgenic crops (maize, cotton, potato), lectin-expressing plants were also discussed.

The possible effects of GM crops on entomophagous arthropods is a major concern, since these organisms play an important role in natural pest regulation and may affect the development of resistance towards the transgene product in the target pest. Thus, good levels of compatibility between GM-based strategies with biological control is necessary for a sustainable deployment of a GM crop (i.e. within an IPM framework).

The group agreed on the fact that research should focus on selected species or functional groups rather than doing full faunistic evaluations, since the latter often lack the statistical power to detect significant effects largely due to the limitations in sample size. It was suggested that all functional groups relevant to a particular crop should be assessed taking into account the information available for the trait (mode of action of the insecticidal protein, history of use, expression pattern,…) but only certain groups would need testing. Testing would be necessary for those groups where there was a potential risk identified, i.e. exposure could not be ruled out or hazard could be possible due to the mode of action of the trait.

The group discussed the criteria on how to select species to be tested in risk-assessment studies of GM crops that have been proposed by Dutton et al. (2003; BioControl 48: 611-636):

i) Economic/ecological importance in the crop
   It was agreed that species should be selected that play an important role in the agroecosystem. However, we were aware of the fact that we often lack the information on the importance of a specific entomophagous arthropod in respect to its role in regulating a herbivore population.

ii) Likelihood of exposure to the transgene product (toxin)
   Potential exposure was regarded as an important criterion for test species selection. To make a decision, information must be available on where and when a transgene product is expressed in the plant and on the feeding behaviour of both the herbivorous and entomophagous arthropods. Since a detailed crop characterization is necessary for the application for consent to cultivate a GM crop according to Directive 2001/18/EC, protein expression data are typically generated by the notifier.
   There was a strong feeling expressed by some members of the group, that, where appropriate, the risk assessment also may include trophic systems that are of importance...
for the agroecosystem, even though the transgene product may not be transported among certain species groups and/or trophic levels (e.g. aphids and their antagonists in Bt-maize events which do not express Bt-toxins in phloem sap). The basis for this is the fact that risk assessment should also evaluate potential ‘unintended adverse effects’ of the genetic modification, if they occurred, and ensure a sustainable use of the GM technology in IPM systems.

iii) A diversity of species should be considered
The participants agreed that, in general, the species selected should be selected from different taxonomic or functional groups. However, there might be reasons to test more species from a certain taxonomic order (see next criteria).

iv) Knowledge on the toxic specificity of the insecticidal protein
When selecting the test species, one should take into account the known specificity of the transgene product. For example, plant lectins in general are known to have a broader range of activity when compared to Bt-toxins. Therefore more species have to be tested for a broad spectrum toxin (e.g. lectin) than a more specific toxin (e.g. Bt-toxin). Also, in cases where the GM plant expresses a Bt-toxin with a known specificity on a particular insect order, more attention should be given to assessment of the non-target species from this particular order (e.g. predatory Coleoptera in the case of Bt-potato expressing the Cry3A toxin).

v) Amenability and availability of the species
While we agreed that this is not a purely scientific criterion, it should not be neglected. Amenability and availability should not be the driving force for the selection of a particular test organisms. However, to use well-understood and easy to rear species will for example increase the reproducibility of the tests in different labs.

Compromises have to be taken. For example in the case of soil organisms, most predatory arthropods in the soil are difficult to rear and therefore difficult or impossible to test. Therefore, soil studies might have to focus more on soil functions rather than on individual species or their interactions. This could, for example, be done in mesocosm studies.

The second phase of the workshop dealt with the question on when and why are field evaluations required in risk-assessment studies. Three areas were identified:

i) Assessment of ‘unintended effects’
Where potential ‘unintended effects’ of the genetic modification occurred, they should also be considered in the risk assessment, rather than the novel protein only. To study effects that result for example from interactions between the transgene product and secondary plant compounds, it would be important to grow the GM crop in a realistic environment (temperature, photoperiod, planting density, exposure to normal biotic and abiotic stress factors). Crop characterization that is conducted prior to registration of a new GM crop includes plant composition analysis. This knowledge might enable us to detect whether or not any ‘unintended effects’ of the genetic modification have occurred, to provide key elements for consideration in the risk assessment, or, where applicable, for case-specific monitoring of certain ‘unintended effects’ (e.g. plant metabolites with known ecological function in defence, attraction of pollinators etc.).

ii) Detection of long term effects
Pre-release risk assessment studies might reveal effects that need to be further evaluated in a case specific monitoring to detect possible long-term effects.

iii) Compatibility of a GM crop with other IPM measures
The group considered that compatibility of a GM crop with IPM practices is important for sustainable pest control. However, studies on the compatibility are more likely a post-release (after commercialization) type of work.
Questions that were only raised, but that need further discussion include:

- What are the requirements for pre-release risk-assessment (EU directive, EPA guidelines)? What could/should be done post-release?

- We agreed that a clear structure for a risk-assessment is required. However, there was no agreement on whether it should follow a clear tiered system approach, like the pesticide testing. Furthermore, decision points (trigger values) have to be identified and agreed.

- There was a strong opinion that risk-assessment of GM crops should be put into perspective, i.e. in the larger context of agricultural production, in particular with conventional pest control practices such as the use of insecticides or existing IPM systems. But the question remained on when this should happen in the course of the risk assessment. The conventional practice should be considered in a needs analysis, prior to the production/release of a GM crop. Conventional practice should also be considered later in the decision making process, when deciding whether to field release a GM crop or not.

- A discussion is needed on why possible ‘unintended effects’ are assessed for GM crops but not for all conventionally bred varieties with similar traits. It was argued that unintended effects affecting human/animal nutrition or ecological services (pollinators, natural enemies) should be checked for in both conventional and GM crops.