PROSPECTIVA TECNOLÓGICA

AAPRESID

Los Organismos Vegetales Genéticamente Modificados (OVGMs) y el ambiente

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Temario

Los Organismos Vegetales Genéticamente Modificados (OVGMs) y el ambiente

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El presente trabajo corresponde a una búsqueda bibliográfica de diferentes revistas científicas especializadas en áreas temáticas de interés agropecuario y biológico. Cada título está vinculado al artículo original, se incluyó el resumen y se hizo una pequeña descripción del mismo.

En la entrega de este mes se preparó un número especial que refiere a "**Los Organismos Vegetales Genéticamente Modificados (OVGMs) y el ambiente**". El informe se divide en seis partes. La primera enfoca (con una serie de artículos, informes y páginas web) un análisis de los OVGMs en el Mundo y en Argentina, donde se muestra el crecimiento de la adopción agrobiotecnológica y las consecuencias de ese crecimiento. La segunda analiza el IMPACTO AMBIENTAL DE LOS OVGMs, sus aspectos generales y la evaluación de los riesgos que ellos ofrecen a los ecosistemas. La tercera presenta y compara los SISTEMAS REGULATORIOS de diferentes países, y también ofrece ANÁLISIS DE LA OPINION PUBLICA relacionada con la adopción y uso de productos derivados de estas tecnologías. La cuarta analiza el IMPACTO DE LOS OVGMs SOBRE LA BIODIVERSIDAD. La quinta enfoca el IMPACTO DE LOS OVGMs con RESISTENCIAS A HERBICIDAS E INSECTOS, con particular énfasis en el flujo de transgenes de cultivos modificados genéticamente hacia especies relativas. La sexta y última parte presenta una prospectiva de la adopción de OVGMs.

I. LOS OVGMs en el MUNDO y ARGENTINA.

Situación global de los cultivos transgénicos/GM comercializados: 2007

Clive James

ISAAA, Brief 37 (2007)

Como resultado de los beneficios sustanciales y constantes logrados durante los primeros doce años de comercialización desde 1996 hasta 2007, los agricultores continúan sembrando cultivos transgénicos año tras año. En 2007, y por el décimo segundo año consecutivo, el área global de cultivos transgénicos continuó creciendo. Notablemente, el crecimiento continuó a una tasa de crecimiento sostenida de dos dígitos de 12%, o 12,3 millones de hectáreas (30 millones de acres) – el segundo mayor aumento en el área de cultivos transgénicos de los últimos cinco años – alcanzando las 114,3 millones de hectáreas (282,4 millones de acres). La primera docena de años de cultivos transgénicos le ha brindado beneficios económicos y ambientales considerables a los agricultores de los países industriales y en desarrollo, donde millones de pequeños productores han aprovechado los beneficios sociales y humanitarios que han contribuido a aliviar su pobreza. Para considerar el uso creciente y generalizado de cultivos con dos o tres características acumuladas, capaces de ofrecer múltiples beneficios en una única variedad, el aumento de la adopción se determina de una forma más precisa si se lo expresa en "hectáreas de características", en lugar de hectáreas solamente – algo así como medir un viaje aéreo en "millas-pasajero" en lugar de millas. El crecimiento medido en "hectáreas de características" entre 2006 (117,7 millones) y 2007 (143,7 millones) fue del 22%, o 26 millones de hectáreas, reflejando el crecimiento real entre 2006 y 2007, y que es aproximadamente el doble del crecimiento aparente del 12%, o 12,3 millones de hectáreas, cuando se mide la adopción de forma conservadora en hectáreas.

Keywords: OVGMs, cultivos transgénicos, adopción tecnológica.

El presente artículo es un resumen ejecutivo del Servicio de Adquisición de Aplicaciones Agrobiotecnológicas. En el mismo se presentan datos actualizados de la evolución de la adopción de cultivos transgénicos a nivel mundial, destacando los países, las superficies, los cultivos y los caracteres incorporados. En el mismo se destaca que Argentina continúa ocupando el segundo lugar en el mundo, luego de Estados Unidos, en superificie cultivada con OVGMs, siendo los cultivos aprobados la soja, el maíz y el algodón, todos con resistencia a herbicidas e insectos.

GM Crops-A World View

Elsa Youngsteadt and Erik Stokstad

Science 320: 466-467 (2008)

In 2007, farmers grew more than 114 million hectares of GM crops—mainly soy, maize, cotton, and canola. Here we show who grows them, who imports them, and who avoids them, and highlight the top eight countries that together produce more than 99% of the world's biotech plants.

Keywords: OVGMs, cultivos transgénicos, adopción tecnológica.

En el mismo sentido que el artículo anterior, el presente resume la adopción de cultivos transgénicos a nivel mundial.

AGBIOS

http://www.agbios.com/main.php

AGBIOS is dedicated to providing public policy, regulatory, and risk assessment expertise for products of biotechnology.
AGBIOS has worked with government departments and agencies on issues of policy and regulation pertaining to genetically modified and other novel foods, crops, and forest tree species. The Company also provides experience and expertise to commercial enterprises seeking regulatory approval of biotechnology products, and to other public and private sector groups seeking clarification of issues associated with the development and utilization of biotechnology processes and products.
Our website offers access to a database of safety information on all genetically modified plant products that have received regulatory approval, information on the implementation of biosafety systems, including case studies for food and environmental safety assessments, and a searchable library of biosafety-related citations in key topic areas.

Keywords: OVGMs, base de datos, eventos transgénicos, cultivos transgénicos

El presente sitio web contiene una base de datos con todos los cultivos transgénicos desarrollados y en evaluación, con toda la información técnica de las construcciones génicas introducidas, las fuentes de los genes, los ensayos de impacto ambiental y alimentario realizados.
VISITA RECOMENDADA.

CONABIA: Seguridad Agropecuaria

http://www.sagpya.mecon.gov.ar/new/0-0/programas/conabia/bioseguridad_agropecuaria2.php

Keywords: OVGMs, adopción, evaluación de riesgo ambiental

La CONABIA es la Comisión Nacional Asesora en Biotecnología Agropecuaria, una División de la Secretaría de Agricultura de la Nación que entiende en la evaluación del impacto ambiental de los eventos transgénicos que se pretenden introducir en el mercado. En el vínculo superior permite el acceso a la página web oficial de la Oficina de biotecnología con toda la información relevante se seguridad agropecuaria y los eventos transgénicos aprobados en Argentina para la comercialización. En el vínculo siguiente se pueden observar los eventos transgénicos que fueron y están siendo evaluados en los sucesivos años, diferentes cultivos, caracteres y empresas solicitantes:
http://www.sagpya.mecon.gov.ar/new/0-0/programas/conabia/liberaciones_ogm.php

Consecuencias económicas de la transformación agrícola

Eduardo Trigo
Ciencia Hoy 15 (87): 46-51 (2005)

El cambio tecnológico es clave para el desarrollo de la agricultura y la mejora de los ingresos de los agricultores. Su importancia radica en que la producción agropecuaria depende de un factor fijo, la tierra, y comercializa sus productos en mercados sobre cuyos precios los agricultores no pueden ejercer influencia. Por lo tanto, el ingreso de los productores depende directamente de la productividad de sus recursos. Estas restricciones incentivan la permanente incorporación de tecnología, única vía para lograr el sostenido incremento de los ingresos. Si en vez de considerar la situación de cada productor se mira a escala del país, la situación es similar, aunque con algunas variantes. En muy pocas circunstancias de mercado un país logra influir sobre los precios. Por ello, la búsqueda de alternativas para reducir los costos de producción y aumentar la productividad –otra vez, cambio tecnológico– resulta el camino obligado para aumentar los ingresos del sector. En el caso particular de la Argentina, que compite en

mercados fuertemente influenciados por los subsidios a la producción y exportación de los países de la OCDE (*Organización de Cooperación y Desarrollo Económico*), es especialmente necesario incorporar nuevas tecnologías para mantener presencia y competitividad

Keywords: innovación tecnológica, OVGMs, transformación agrícola, adopción tecnológica

En el presente artículo se describe la transformación agrícola argentina, la adopción de paquetes tecnológicos en materia de siembra directa y de incorporación de biotecnología, la evolución de rendimientos y de los costos de producción.

Diez Años de Cultivos Genéticamente Modificados en la Agricultura Argentina

Eduardo J. Trigo y Eugenio J. Cap

ArgenBio 2006

El primer cultivo genéticamente modificado (GM) incorporado a la agricultura argentina fue la soja tolerante al herbicida glifosato, la cual fue aprobada en 1996. De esa fecha en adelante se han realizado cerca de 900 pruebas de campo en distintos cultivos y características y aprobado para comercialización nueve eventos adicionales en maíz y algodón (tolerancia a herbicidas y resistencia a insectos). De ahí en adelante se desarrolló un rápido proceso de difusión de este tipo de tecnologías que, en la última campaña agrícola, llegaron a representar más del 90% del área cultivada con soja, cerca del 70% del área de maíz y alrededor del 60% en el caso del algodón. En este proceso la Argentina se ha transformado en el segundo productor mundial de este tipo de cultivos, detrás de los Estados Unidos de Norteamérica, con más de 17 millones de hectáreas plantadas con cultivos GM.

Keywords: OVGMs, cultivos transgénicos, adopción tecnológica, evolución agropecuaria.

El presente informe contiene un extenso análisis sobre la introducción de biotecnología en el agro argentino. Enfatiza el impacto económico de la liberación de OVGMs en la agricultura, analiza cada cultivo transgénico introducido (soja, maíz y algodón) y los beneficios que los mismos aportaron al país.
LECTURA RECOMENDADA.

II. IMPACTO AMBIENTAL DE LOS OVGMs. Aspectos Generales y Evaluación de Riesgos.

The release of genetically modified crops into the Environment. Part II. Overview of ecological risk assessment

Anthony J. Conner, Travis R. Glare and Jan-Peter Nap

The Plant Journal (2003) 33, 19–46

Despite numerous future promises, there is a multitude of concerns about the impact of GM crops on the environment. Key issues in the environmental assessment of GM crops are putative invasiveness, vertical or horizontal gene flow, other ecological impacts, effects on biodiversity and the impact of presence of GM material in other products. These are all highly interdisciplinary and complex issues. A crucial component for a proper assessment is defining the appropriate baseline for comparison and decision. For GM crops, the best and most appropriately defined reference point is the impact of plants developed by traditional breeding. The latter is an integral and accepted part of agriculture. In many instances, the

putative impacts identified for GM crops are very similar to the impacts of new cultivars derived from traditional breeding. When assessing GM crops relative to existing cultivars, the increased knowledge base underpinning the development of GM crops will provide greater confidence in the assurances plant science can give on the risks of releasing such crops.

Keywords: agbiotecnología, biodiversidad, impacto ecológico, impacto ambiental, transferencia génica, fitomejoramiento.

Se trata de un excelente, detallado y extenso artículo de revisión en el que se analiza la liberación de eventos transgénicos de cultivos agrícolas en el medio ambiente y su impacto sobre aspectos ambientales, tales como la invasión, el flujo génico, la biodiversidad, etc. Es un artículo que resume la amplitud de los temas que se discuten en el presente informe de Prospectiva.
LECTURA RECOMENDADA.

Risk assessment of GM plants: avoiding gridlock?

Mike J. Wilkinson, Jeremy Sweet and Guy M. Poppy
TRENDS in Plant Science Vol.8 No.5: 208-212 (2003)

Cultivation of genetically modified crops is presently based largely on four crops containing few transgenes and grown in four countries. This will soon change and pose new challenges for risk assessment. A more structured approach that is as generic as possible is advocated to study consequences of gene flow. Hazards should be precisely defined and prioritized, with emphasis on quantifying elements of exposure. This requires coordinated effort between large, multidisciplinary research teams.

Keywords: GMOs, impacto ambiental, flujo génico.

El artículo de opinión plantea los estudios requeridos del flujo génico de cultivos transgénicos a especies o cultivares no transgénicas, especialmente cuando en el futuro se encuentren liberados varios eventos y cultivos diferentes con la condición de modificados genéticamente.

Environmental risks of genetic engineering

E. Ann Clark
Euphytica (2006) 148: 47–60

Before release into commerce, genetically engineered organisms are first assessed for possible risks, including risks to the environment. The present paper first identifies the environmental risks recognized by regulators, and reviews the parameters considered predictive of risk. Recent field-scale studies suggest opportunities for improvement of the environmental risk assessment process. Risks unique to genetically engineered crops – if any – could pertain to the specific traits chosen for commercialization and to unintended trait expression caused by the process of transgene insertion itself. Both the standard against which to compare genetically engineered traits and the scale of exposure need to be considered when assessing environmental impact. Evidence of environmental risk in the recognized areas of weediness on agricultural land, invasiveness of unmanaged systems, and non-target impacts from *Bacillus thuringiensis* (Bt) maize is presented. Targeted, statistically sound, rigorously conducted, multi-trophic studies analogous to the Field Scale Evaluation trials recently completed in the UK are needed to clarify the many questions which remain unanswered.

Keywords: flujo génico, impacto ambiental, OVGM, cultivos transgenicos

Se trata de un excelente artículo de revisión en el que se analiza el riesgo derivado de la liberación de eventos transgénicos de cultivos agrícolas al medio ambiente, incluyendo la invasión y competencia de transgénicos, el flujo génico

y la biodiversidad. Se enfoca la predicción del riesgo para ser evaluado pre-liberación. Es un artículo que resume la amplitud de los temas que se discuten en el presente informe de Prospectiva.
LECTURA RECOMENDADA.

How Should Society Approach the Real and Potential Risks Posed by New Technologies?

Carl F. Cranor

Plant Physiology, 2003, Vol. 133, pp. 3–9

As the 21st century opens, two new technologies raise the promise of benefits for humankind—biotechnology and nanotechnology. Crop biotechnology promises new and improved foods, e.g. vitamin A-enhanced rice (*Oryza sativa*), more food at lower cost from highly productive plants, plants that will grow under adverse—highly saline or drought—conditions, plants that will reduce reliance on potentially poisonous pesticides, or even plants that will produce pharmaceuticals. Human biotechnology promises cures for genetic diseases in somatic cells, diagnoses of diseases before they manifest themselves into deadly or irreversible conditions, e.g. breast cancer, perhaps even the prevention of inheritable genetic conditions that could be corrected by genetic engineering of the germ cells.

Keywords: OGMs, bioseguridad, evaluación de riesgos, cultivos transgénicos.

Toda tecnología es neutra en sí misma, pero su aplicación trae aparejado riesgos. Cuáles son los riesgos que la sociedad está dispuesta a aceptar por el uso de las nuevas bio y nanotecnologías es el tema discutido en el presente artículo. Se ejemplifica el tema con la revolución química luego de la Segunda Guerra Mundial, la responsabilidad del control institucional, los riesgos que ofrecen los OVGMs, la polución, etc.

Abandoning 'responsive' GM risk assessment

Mike J. Wilkinson

TRENDS in Biotechnology Vol.22 No.9: 438-439 (2004)

Concerns over the potential for GM crops to cause unwanted environmental change have spawned intense research activity. Studies have ranged in scope from small-scale laboratory experiments aiming to specify unwanted changes that could occur (hazard identification studies) through to large-scale initiatives designed to calculate the likelihood that a particular hazard will occur (exposure and risk assessment studies).

Keywords: riesgo ambiental, OVGMs, evaluación de riesgos

El artículo de opinión se refiere a los riesgos azarosos que pudieren aparecer como consecuencia de la adopción de una nueva tecnología (cultivos transgénicos) a nivel ambiental, y la ejemplifica con el daño del maíz Bt sobre la mariposa monarca. Enfatiza la "calidad" requerida de los análisis de riesgo.

Geneflow from GM plants – towards a more quantitative risk assessment

Guy M. Poppy

TRENDS in Biotechnology Vol.22 No.9: 436-438 (2004)

Assessing the risks associated with geneflow from GM crops to wild relatives is a significant scientific challenge. Most researchers have focused on assessing the frequency of gene flow, too often on a localized scale, and ignoring the hazards caused by geneflow. To quantify risk, multi-disciplinary research teams need to unite and scale up their studies.

Keywords: riesgo ambiental, OVGMs, impacto ambiental, evaluación de riesgo

En el presente artículo de opinión se plantea el riesgo de transferencia génica horizontal via polen de cultivos transgénicos a no transgénicos, ejemplificando esta probabilidad a partir de la colza GM.

A conceptual framework for the design of environmental post-market monitoring of genetically modified plants

Olivier SANVIDO, Franco WIDMER, Michael WINZELER and Franz BIGLER

Environ. Biosafety Res. 4 (2005) 13–27

Genetically modified plants (GMPs) may soon be cultivated commercially in several member countries of the European Union (EU). According to EU Directive 2001/18/EC, post-market monitoring (PMM) for commercial GMP cultivation must be implemented, in order to detect and prevent adverse effects on human health and the environment. However, no general PMM strategies for GMP cultivation have been established so far. We present a conceptual framework for the design of environmental PMM for GMP cultivation based on current EU legislation and common risk analysis procedures. We have established a comprehensive structure of the GMP approval process, consisting of pre-market risk assessment (PMRA) as well as PMM. Both programs can be distinguished conceptually due to principles inherent to risk analysis procedures. The design of PMM programs should take into account the knowledge gained during approval for commercialization of a specific GMP and the decisions made in the environmental risk assessments (ERAs). PMM is composed of case-specific monitoring (CSM) and general surveillance. CSM focuses on anticipated effects of a specific GMP. Selection of case-specific indicators for detection of ecological exposure and effects, as well as definition of effect sizes, are important for CSM. General surveillance is designed to detect unanticipated effects on general safeguard subjects, such as natural resources, which must not be adversely affected by human activities like GMP cultivation. We have identified clear conceptual differences between CSM and general surveillance, and propose to adopt separate frameworks when developing either of the two programs. Common to both programs is the need to put a value on possible ecological effects of GMP cultivation. The structure of PMM presented here will be of assistance to industry, researchers, and regulators, when assessing GMPs during commercialization.

Keywords: impacto ambiental, monitoreo ambiental, OVGMs, cultivos transgénicos, monitoreo post-mercado

El presente artículo discute la implementación un sistema de monitoreo post-mercado de OVGMs para evaluar riesgos ambientales derivados de la liberación al mercado de eventos y cultivos transgénicos.

Conceptualizing risk assessment methodology for genetically modified organisms

Ryan A. HILL

Environ. Biosafety Res. 4 (2005) 67–70

Risk assessment methodology for genetically modified organisms (GMOs) has evolved over the last several years. At a conceptual level, the methodology has been adapted from the existing paradigm for environmental risk assessment, which was developed for chemicals and other types of environmental stressors since at least the 1980s.

Keywords: OVGMs, evaluación de riesgos, impacto ambiental, bioseguridad.

En el presente texto se discuten los conceptos que permiten el diseño de una metodología para la evaluación de riesgos de OVGMs.

A comparative risk assessment of genetically engineered, mutagenic, and conventional wheat production systems

Robert K.D. Peterson & Leslie M. Shama

Transgenic Research (2005) 14:859–875

Wheat (*Triticum aestivum* L.) varieties produced using modern biotechnologies, such as genetic engineering and mutagenic techniques, have lagged behind other crop species, but are now being developed and, in the case of mutagenic wheat, commercially grown around the world. Because these wheat varieties have emerged recently, there is a unique opportunity to assess comparatively the potential environmental risks (human health, ecological, and livestock risks) associated with genetically engineered, mutagenic, and conventional wheat production systems. Replacement of traditional herbicides with glyphosate in a glyphosate-tolerant (genetically engineered) wheat system or imazamox in an imidazolinone-tolerant (mutagenic) wheat system may alter environmental risks associated with weed management. Additionally, because both systems rely on plants that express novel proteins, the proteins and plants themselves may impose risks. The purpose of our study was to examine comparatively the multiple aspects of risk associated with different wheat production systems in the US and Canada using the risk assessment paradigm. Specifically, we used tier 1 quantitative and qualitative risk assessment methods to compare specific environmental risks associated with the different wheat production systems. Both glyphosate and imazamox present lower human health and ecological risks than many other herbicides associated with conventional wheat production systems evaluated in this study. The differences in risks were most pronounced when comparing glyphosate and imazamox to herbicides currently with substantial market share. Current weight-of-evidence suggests that the transgenic CP4 EPSPS protein present in glyphosate-tolerant wheat poses negligible risk to humans, livestock, and wildlife. Risk for mutated AHAS protein in imidazolinone tolerant wheat most likely would be low, but there are not sufficient effect and exposure data to adequately characterize risk. Environmental risks for herbicides were more amenable to quantitative assessments than for the transgenic CP4 EPSPS protein and the mutated AHAS protein.

Keywords: biotecnología, OVGMs, cultivos transgénicos, herbicidas, trigo transgénico, toxicidad.

En el presente trabajo se analizan métodos de evaluación cualitativa y cuantitativa de riesgos ambientales específicos asociados a los sistemas de producción de trigos modificados genéticamente, mutagenizados y convencionales con resistencia a herbicidas (glifosato e imidazolinonas) en Estados Unidos y Canadá.

Life in earth: the impact of GM plants on soil ecology?

Andrew K. Lilley, Mark J. Bailey, Colin Cartwright, Sarah L. Turner and Penny R. Hirsch

TRENDS in Biotechnology 24 (1): 9-14 (2006)

The impact of changes incurred by agricultural biotechnology has led to concern regarding soil ecosystems and, rightly or wrongly, this has focused on the introduction of genetically modified (GM) crops. Soils are key resources, with essential roles in supporting ecosystems and maintaining environmental quality and productivity. The complexity of soils presents difficulties to their inclusion in the risk assessment process conducted for all GM plants. However, a combined approach, informed by both soil ecology and soil quality perspectives, that considers the impacts of GM crops in the context of conventional agricultural practices can provide a regulatory framework to ensure the protection of soils without being overly restrictive.

Keywords: ecología de suelos, impacto ambiental, OVGMs, evaluación de riesgos

En este artículo se propone una ciencia y criterios apropiados para la evaluación de riesgos y monitoreo post-liberación de plantas modificadas genéticamente requiere evaluaciones amplias y específicas de los sistemas del suelo, y que esas evaluaciones deben beneficiar la ecología del suelo (organismos y procesos del mismo) y la calidad del suelo (la capacidad de proveer las funciones definidas y sostenidas). Así se analiza el sistema suelo y la influencia de las plantas y la evaluación del impacto de los cultivos GM sobre los ecosistemas del suelo (actividad y diversidad).

Need for an "Integrated Safety Assessment" of GMOs, Linking Food Safety and Environmental Considerations

ALEXANDER G. HASLBERGER

J. Agric. Food Chem. 2006, 54, 3173-3180

Evidence for substantial environmental influences on health and food safety comes from work with environmental health indicators which show that agro-environmental practices have direct and indirect effects on human health, concluding that "the quality of the environment influences the quality and safety of foods". In the field of genetically modified organisms (GMOs), Codex principles have been established for the assessment of GM food safety and the Cartagena Protocol on Biosafety outlines international principles for an environmental assessment of living modified organisms. Both concepts also contain starting points for an assessment of health/food safety effects of GMOs in cases when the environment is involved in the chain of events that could lead to hazards. The environment can act as a route of unintentional entry of GMOs into the food supply, such as in the case of gene flow via pollen or seeds from GM cropss, but the environment can also be involved in changes of GMO-induced agricultural practices with relevance for health/food safety. Examples for this include potential regional changes of pesticide uses and reduction in pesticide poisonings resulting from the use of Bt crops or influences on immune responses via cross-reactivity. Clearly, modern methods of biotechnology in breeding are involved in the reasons behind the rapid reduction of local varieties in agrodiversity, which constitute an identified hazard for food safety and food security. The health/food safety assessment of GM foods in cases when the environment is involved needs to be informed by data from environmental assessment. Such data might be especially important for hazard identification and exposure assessment. International organizations working in these areas will very likely be needed to initiate and enable cooperation between those institutions responsible for the different assessments, as well as for exchange and analysis of information. An integrated assessment might help to focus and save capacities in highly technical areas such as molecular characterization or profiling, which are often necessary for both assessments. In the area of establishing international standards for traded foods, such as for the newly created Standards in Trade and Development Facility (STDF), an integrated assessment might help in the consideration of important environmental aspects involved in health and food safety. Furthermore, an established integrated view on GMOs may create greater consumer confidence in the technology.

Keywords: OVGMs, bioseguridad, seguridad alimentaria, seguridad ambiental, CODEX; protocolo de Cartagena, evaluación de riesgos

El objetivo del presente artículo es discutir cómo los productos de la biotecnología moderna, especialmente los OVGMs, pueden indirectamente afectar la salud humana y la seguridad alimentaria a través de su presencia intencional o no intencional en el ambiente, de los agroecosistemas a los ecosistemas naturales. Sobre la base de esta discusión, se propone una mejor integración de la evaluación de seguridad ambiental y alimentaria que genere información para decisiones regulatorias y políticas.

How does scientific risk assessment of GM crops fit within the wider risk analysis?

Katy L. Johnson, Alan F. Raybould, Malcolm D. Hudson and Guy M. Poppy

TRENDS in Plant Science Vol.12 No.1: 1-5 (2007)

The debate concerning genetically modified crops illustrates confusion between the role of scientists and that of wider society in regulatory decision making. We identify two fundamental misunderstandings, which, if rectified, would allow progress with confidence. First, scientific risk assessment needs to test well-defined hypotheses, not simply collect data. Second, risk assessments need to be placed in the wider context of risk analysis to enable the wider 'non-scientific' questions to be considered in regulatory decision making. Such integration and understanding is urgently required because the challenges to regulation will escalate as scientific progress advances.

Keywords: OVGMs, evaluación de riesgos, impacto ambiental, opinión pública

En el presente artículo se analiza cuál es el rol del ámbito científico en el debate sobre las evaluaciones de riesgo de los OGMs, cuál es la importancia de los datos científicos en esa evaluación y cuál es la contribución del sector en la toma de decisiones para el sistema regulatorio.

Planning Environmental Risk Assessment for Genetically Modified Crops: Problem Formulation for Stress-Tolerant Crops

Thomas E. Nickson

Plant Physiology, Vol. 147, pp. 494–502 (2008)

A scientifically sound environmental risk assessment is required for crops derived from modern biotechnology (also referred to as genetically modified [GM]) prior to unrestricted release into the environment. The scientific principles underlying the environmental risk assessments completed for herbicide-tolerant and insect-protected GM crops commercialized to date are now being applied to crops currently under development that are modified for improved tolerance to abiotic stresses. These principles, and the processes built upon them, have been shown to be sufficiently robust to provide the appropriate information for regulatory decision making and to ensure an adequate level of environmental protection. This article describes the initial steps in the environmental risk assessment process and illustrates an approach that could be taken for GM crops tolerant to an abiotic stress (e.g. water, salt, cold, and heat). The discussion below begins with an overview of the initial steps in an environmental risk assessment, known as problem formulation (US EPA, 1998). A general overview describing how problem formulation has been applied for the first GM crops is presented next. Finally, the approach is applied to a hypothetical drought-tolerant maize (*Zea mays*) product as an example of how problem formulation can guide the environmental risk assessment for a specific abiotic stress tolerant crop.

Keywords: OVGMs, maíz transgénico, esters abiótico, evaluación de riesgo

El presente artículo describe las etapas iniciales de los procesos de evaluación de riesgos ambientales de cultivos GM tolerantes a estrés abiótico, ejemplificándolo con un hipotético maíz tolerante a sequía. Destaca los aspectos conceptuales a contemplar a la hora de diseñar un sistema de evaluación de riesgos para el caso particular del ejemplo.

Co-existence of genetically modified crops with conventional and organic farming

Joachim SCHIEMANN

Environ. Biosafety Res. 2 (2003) 213–217

What has the co-existence of GM and non-GM crops to do with environmental biosafety? A clear distinction has to be made between the economic aspects of co-existence and the environmental and health aspects of GMOs. Nevertheless, since both the co-existence and the biosafety areas are often based on the same scientific knowledge (*e.g*. regarding gene flow) and EBR is interested in the socio-economic impact of GMO use as well, EBR is open for reflections on co-existence of GM and non-GM crops.
The cultivation of authorized GM crops will have an impact on agricultural production. It raises the question of how to manage the adventitious mixing of GM and non-GM crops as well as the possible economic consequences, at least in Europe. Farmers should be able to cultivate the crops they choose, be it GM, conventional or organic crops. The ability of the agricultural sector to maintain different production systems is fundamental for providing a high degree of consumer choice.

Keywords: cultivos transgénicos, OVGMs, impacto ambiental

En el presente artículo editorial se plantea una agricultura con coexistencia de cultivos transgénicos y orgánicos. Se discute la experiencia europea basada especialmente en dos cultivos: maíz y colza, se analizan implicancias biológicas, ambientales y económicas, y se proponen nuevas investigaciones tendientes al monitoreo y evaluación de flujos de genes de los cultivos GM a los no GM.

Databases on biotechnology and biosafety of GMOs

Giuliano DEGRASSI, Nevena ALEXANDROVA and Decio RIPANDELLI

Environ. Biosafety Res. 3 (2003) 145–160

Due to the involvement of scientific, industrial, commercial and public sectors of society, the complexity of the issues concerning the safety of genetically modified organisms (GMOs) for the environment, agriculture, and human and animal health calls for a wide coverage of information. Accordingly, development of the field of biotechnology, along with concerns related to the fate of released GMOs, has led to a rapid development of tools for disseminating such information. As a result, there is a growing number of databases aimed at collecting and storing information related to GMOs. Most of the sites deal with information on environmental releases, field trials, transgenes and related sequences, regulations and legislation, risk assessment documents, and literature. Databases are mainly established and managed by scientific, national or international authorities, and are addressed towards scientists, government officials, policy makers, consumers, farmers, environmental groups and civil society representatives. This complexity can lead to an overlapping of information. The purpose of the present review is to analyse the relevant databases currently available on the web, providing comments on their vastly different information and on the structure of the sites pertaining to different users. A preliminary overview on the development of these sites during the last decade, at both the national and international level, is also provided.

Keywords: bioseguridad, biotecnología, bases de datos, difusión de la información, impacto ambiental, OVGMs, patentes, evaluación de riesgos.

El propósito del presente artículo de revisión es analizar las bases de datos sobre OVGMs disponibles más relevantes, nacionales e internacionales, desde la información que se brinda de cada evento transgénico en evaluación o ya liberado para comercializar. Así, se identificaron categorías de información sobre aspectos regulatorios, ambientales, comerciales, de seguridad alimentaria, de secuencias de genes y de literatura científica. Por otro lado, se detectó la falta de bases de datos de patentes que completen la información que ayude a la toma de decisiones en aspectos regulatorios.

LECTURA RECOMENDADA

Effects of transgenic plants on soil microorganisms

Biao Liu, Qing Zeng, Fengming Yan, Haigen Xu & Chongren Xu

Plant and Soil (2005) 271: 1–13

The rapid development of agricultural biotechnology and release of new transgenic plants for agriculture has provided many economic benefits, but has also raised concern over the potential impact of transgenic plants on the environment. Considerable research has now been conducted on the effects of transgenic plants on soil microorganisms. These effects include unintentional changes in the chemical compositions of root exudates, and the direct effects of transgenic proteins on nontarget species of soil microorganisms. Most studies to date suggest that transgenic plants that have been released cause minor changes in microbial community structures that are often transient in duration. However, due to our limited knowledge of the linkage between microbial community structure and function, more work needs to be done on a case-by-case basis to further evaluate the effects of transgenic plants on soil microorganisms and soil ecosystem functions. This review summarizes the results of a variety of experiments that have been conducted to specifically test the effects of transgenic plants on soil microorganisms, and particularly examines the types of methods that are being used to study microbial interactions with transgenic plants.

Keywords: OVGMs, microorganismos del suelo, rizosfera, ecología, exudados radiculares, impacto ambiental, plantas transgénicas

En el presente artículo de revisión se resumen estudios recientes que evaluaron los efectos de las plantas transgénicas sobre los microorganismos del suelo, con particular énfasis en las metodologías usadas para este propósito. En algunos casos hay efectos consistentes detectados de cultivos transgénicos sobre microorganismos del suelo, pero la significancia ecológica de estos datos es difícil de interpretar. En otros casos no hay efectos observables, pero se discute si los métodos usados son lo suficientemente sensibles para conducir a una detección de efectos. Se analizan los mecanismos por los que las plantas pueden afectar a estos microorganismos, se plantean casos de estudio concretos, y se realiza una evaluación de los métodos empleados en la temática.
LECTURA RECOMENDADA.

III. ASPECTOS REGULATORIOS Y OPINION PUBLICA.

The release of genetically modified crops into the environment. Part I. Overview of current status and regulations

Jan-Peter Nap1, Peter L. J. Metz2, Marga Escaler3 and Anthony J. Conner

The Plant Journal (2003) 33, 1–18

In the past 6 years, the global area of commercially grown, genetically modified (GM) crops has increased more than 30-fold to over 52 million hectares. The number of countries involved has more than doubled. Especially in developing countries, the GM crop area is anticipated to increase rapidly in the coming years. Despite this high adoption rate and future promises, there is a multitude of concerns about the impact of GM crops on the environment. Regulatory approaches in Europe and North America are essentially different. In the EU, it is based on the process of making GM crops; in the US, on the characteristics of the GM product. Many other countries are in the process of establishing regulation

based on either system or a mixture. Despite these differences, the information required for risk assessment tends to be similar. Each risk assessment considers the possibility, probability and consequence of harm on a case-by-case basis. For GM crops, the impact of non-use should be added to this evaluation. It is important that the regulation of risk should not turn into the risk of regulation. The best and most appropriate baseline for comparison when performing risk assessment on GM crops is the impact of plants developed by traditional breeding. The latter is an integral and accepted part of agriculture.

Keywords: agrobiotecnología, OVGMs, aspectos regulatorios, fitomejoramiento, principio precautorio, evaluación de riesgos

Si bien se trata de un artículo de revisión de 5 años, en el mismo se plantean conceptos de los aspectos regulatorios vigentes de Europa y Estados Unidos sobre la liberación de OVGMs, que consideran tanto los riesgos ambientales como los alimentarios. Se trata también el caso de Argentina en forma particular con sus instituciones responsables y se lo compara con los sistemas de otros países. Se presenta un listado de la información que se requiere para la evaluación de riesgos previo a una liberación de los eventos transgénicos y se discuten otros aspectos del tema de manera integrada.
LECTURA RECOMENDADA

Application of GMOs in the U.S.: EPA research & regulatory considerations related to soil systems

Phil Sayre & Ramon J. Seidler

Plant and Soil (2005) 275:77–91

During the last 20 years recombinant biotechnology has resulted in the development of organisms with unique genetic compositions, some of which are for intentional release to the environment. While concerns have been raised that such organisms may be capable of inducing transient unintended environmental effects, longer-term perturbations to soil processes and non-target species effects have yet to be demonstrated. In parallel with the growth of the commercial biotechnology industry has come a significant growth in regulatory review processes intended to evaluate the risks of these GMO products. Under the Toxic Substances Control Act (TSCA), certain new microbial products that undergo pre-manufacture review are examined for human and environmental risks using data and other information received in accordance with the U.S. Environmental Protection Agency's (EPA's) ''Points to Consider'' guidance document. In the risk assessment process, carried out under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act (FFDCA) authorities, EPA evaluates both microbial pesticide products and plants with pesticidal properties to determine if Federal safety standards are met. For all pesticide products, including genetically engineered pesticides, EPA receives testing of product composition and chemical properties, human health effects, environmental effects on non-target pests, and the fate of the pesticide in the environment. The EPA's Office of Research and Development supports risk assessment research related to such GMO products. This paper focuses on relevant EPA research and regulatory examples related to soil effects considerations for GMOs.

Keywords: Bacillus thuringiensis, Burkholderia cepacia, OVGMs, aspectos regulatorios, evaluación de riesgos, transgenes, cultivos transgénicos

El propósito de esta revisión es enfocar los aspectos relevantes de la investigación en evaluación de riesgos de la Agencia de Protección del Ambiente de los Estados Unidos sobre microorganismos y plantas modificadas genéticamente. Estos estudios sugieren cómo los cambios en un pequeño número de genes pueden afectar las consideraciones asociadas al suelo.

US regulatory system for genetically modified organism (GMO), rDNA or transgenic crop cultivars

Alan McHughen and Stuart Smyth

Plant Biotechnology Journal (2008) 6, pp. 2–12

This paper reviews the history of the federal regulatory oversight of plant agricultural biotechnology in the USA, focusing on the scientific and political forces moulding the continually evolving regulatory structure in place today. Unlike most other jurisdictions, the USA decided to adapt pre-existing legislation to encompass products of biotechnology. In so doing, it established an overarching committee (Office of Science and Technology Policy) to study and distribute various regulatory responsibilities amongst relevant agencies: the Food and Drug Administration, Environmental Protection Agency and US Department of Agriculture. This paper reviews the history and procedures of each agency in the execution of its regulatory duties and investigates the advantages and disadvantages of the US regulatory strategy.

Keywords: agrobiotecnología, ingeniería genética, OVGMs, rDNA, aspectos regulatorios, Estados Unidos, evaluación de riesgos.

En el presente artículo de revisión se analiza el sistema regulatorio de los Estados Unidos en relación a la evaluación de riesgos y liberación al mercado de eventos y cultivos transgénicos, donde están involucradas la Agencia de Protección del Ambiente (EPA), la Administración de Alimentos y Drogas (FDA) y el Departamento de Agricultura (USDA).

Environmental protection: applying the precautionary principle and proactive regulation to biotechnology

Robert H. Richmond

Trends in Biotechnology Vol.26 No.8: 460-467 (2008)

Biotechnology is a broad field encompassing diverse disciplines from agriculture to zoology. Advances in research are occurring at a rapid pace, and applications that have broad implications socially, economically, ecologically and politically are emerging. Along with notable benefits, environmental consequences that affect core quality-of-life issues for present and future generations are materializing. The precautionary principle should be applied to biotechnology research, activities and products, and a strengthened, enforceable and proactive regulatory framework is needed. The environmental impacts of agriculture, aquaculture, genetically modified organisms (GMOs) and even pharmaceuticals are raising public concerns and demonstrate the need for guidance from a variety of social, economic and scientific disciplines to insure the benefits of biotechnology are enjoyed without unacceptable and irreversible environmental costs.

Keywords: OVGMs, impacto ambiental, evaluación de riesgos, principio precautorio, aspectos regulatorios

En el presente artículo de revisión se analiza la aplicación del principio precautorio en la evaluación de riesgos durante la regulación de OGMs, como base de la protección ambiental. Así, inicialmente se discuten los alcances del mencionado principio, se analiza la relación de los patógenos y el ambiente, las aplicaciones biotecnológicas y las industrias y la propia biotecnología como herramienta de protección ambiental. Finalmente se contemplan aspectos legislativos y regulatorios.

Regulating coexistence of GM and non-GM crops without jeopardizing economic incentives

Matty Demont and Yann Devos

Trends in Biotechnology Vol.26 No.7: 353-358 (2008)

The ongoing debate about the coexistence of genetically modified (GM) and non-GM crops in the European Union (EU) mainly focuses on preventive measures needed to keep the adventitious presence of GM material in non- GM products below established tolerance thresholds, as well as on issues covering questions of liability and the duty to redress the incurred economic harm once adventitious mixing in non-GM products has occurred. By contrast, the interplay between the economic incentives and costs of coexistence has attracted little attention. The current overemphasis on the technical aspects and cost of coexistence over its economic incentives might lead EU policy-makers to adopt too stringent and rigid regulations on coexistence. Therefore, we argue for flexible coexistence regulations that explicitly take into account the economic incentives for coexistence. Our arguments provide a timely and important framework for EU policy-makers, who are currently struggling to implement coherent coexistence regulations in all member states.

Keywords: aspectos regulatorios, cultivos transgénicos, OVGMs, impacto ambiental

En el presente artículo de opinión se analiza la coexistencia de cultivos transgénicos y no transgénicos en Europa desde la necesidad de contar con sistemas regulatorios sólidos en la evaluación de riesgos sobre bases científicas. Se enfoca la situación actual de coexistencia y se destaca la importancia de la implementación de políticas "justas" en relación a dicha coexistencia.

The GM public debate: context and communication strategies

Rosie Hails and Julian Kinderlerer

NATURE REVIEWS GENETICS 4 (10): 819-825 (2003)

Science communication is developing a new approach that promotes dialogue between scientists and the public. A recent example is the debate on the possible introduction of genetically modified crops into the United Kingdom. As this exercise in public engagement draws to a close, we consider the context in which this debate has taken place, and the challenges of developing such interactions between science and society.

Keywords: opinión pública, debate, OVGMs, comunicación científica

En el presente artículo se destaca la importancia de cómo llega la ciencia al público en general, cómo debe transmitirse el mensaje y qué rol le cabe a la opinión pública en un determinado tema. Aquí se plantea el tema de los OGMs.

GM crops: science, politics and communication

Charles J. Arntzen, Andy Coghlan, Brian Johnson, Jim Peacock and Michael Rodemeyer

NATURE REVIEWS GENETICS 4 (10): 839-843 (2003)

As the public debate in Europe about genetically modified (GM) crops heats up and the trade row between the United States and the European Union over GM food escalates, what better time to examine the issues with an international group of experts (BOX 1). Their views are diverse, but they all agree that we need more impartial communication, less propaganda and an effective regulatory regime that is based on a careful case-by-case consideration of GM technology. It seems that GM crops are here to stay, so let us hope that these requirements are met and that the developing nations that perhaps have the most to gain from this technology can start to reap its benefits.

Keywords: opinión pública, debate, OVGMs, comunicación científica

En el mismo sentido que el artículo anterior, se discute la estrategia de comunicación de los hallazgos científicos que tienen una aplicación directa con la vida cotidiana de las sociedades, de manera que no se genere una discusión improductiva que englobe los productos de esa tecnología como buena o mala en forma dicotómica, sino que ofrezca la gama de oportunidades que ocurren en el contexto real.

Science policy and society: the British debate over GM agriculture

George Gaskell

Current Opinion in Biotechnology 2004, 15:241–245

The outcome of 'GM Nation?' — a public debate on genetic modification and the commercial growing of GM crops in Britain — was published in 2003. The objective of this public consultation was 'to promote an innovative, effective and deliberative programme of debate, against the background of the possible commercial production of GM crops in the UK . . . [and] provide meaningful information to Government about the nature and spectrum of the public's views, particularly at the grass roots level, to inform decision making'. Complementing an independent evaluation of GM Nation?, this article puts the debate into context, comments on the legitimacy of this, and similar exercises in public consultation, and develops some ideas on the future of public consultation on technological innovation.

Keywords: opinión pública, debate, OVGMs, comunicación científica

En el artículo se presentan los resultados de una consulta realizada en Gran Bretaña a la población sobre aspectos relacionados con los cultivos GM y la biotecnología, lo que generó un fuerte debate público sobre el tema.

GMOs worldwide: science and its public perception

BOKU – University of Natural Resources and Applied Life Sciences, Vienna

Abstracts ICA – NASULGC GMO WORKSHOP (2005), 37 pp.

Keywords: opinión pública, debate, OVGMs, comunicación científica

Se trata de un documento que reúne una serie de resúmenes y opiniones de expertos provenientes de diferentes universidades sobre la percepción pública de los OVGMs y la evaluación de riesgos y del impacto ambiental y alimentario.

Genetically modified crops: success, safety assessment, and public concern

Om V. Singh - Shivani Ghai - Debarati Paul - Rakesh K. Jain

Appl Microbiol Biotechnol (2006) 71: 598–607

With the emergence of transgenic technologies, new ways to improve the agronomic performance of crops for food, feed, and processing applications have been devised. In addition, ability to express foreign genes using transgenic technologies has opened up options for producing large quantities of commercially important industrial or pharmaceutical products in plants. Despite this high adoption rate and future promises, there is a multitude of concerns about the impact of genetically modified (GM) crops on the environment. Potential contamination of the environment and food chains has prompted detailed consideration of how such crops and the molecules that they produce can be effectively isolated and contained. One of the reasonable steps after creating a transgenic plant is to evaluate its potential benefits

and risks to the environment and these should be compared to those generated by traditional agricultural practices. The precautionary approach in risk management of GM plants may make it necessary to monitor significant wild and weed populations that might be affected by transgene escape. Effective risk assessment and monitoring mechanisms are the basic prerequisites of any legal framework to adequately address the risks and watch out for new risks. Several agencies in different countries monitor the release of GM organisms or frame guidelines for the appropriate application of recombinant organisms in agro-industries so as to assure the safe use of recombinant organisms and to achieve sound overall development. We feel that it is important to establish an internationally harmonized framework for the safe handling of recombinant DNA organisms within a few years.

Keywords: opinión pública, debate, OVGMs, impacto ambiental

La presente revisión discute las técnicas utilizadas para la creación, selección y detección de cultivos GM y el seguimiento de transgenes luego de la liberación en el ambiente. También enfoca los beneficios y limitaciones de los cultivos GM sobre sus aplicaciones debido a aspectos regulatorios y opinión pública.

How well is Environmental Biosafety Research supporting the scientific debate on the biosafety of genetically modified organisms (GMOs)?

Wendy CRAIG, Remigiusz LEWANDOWSKI, Giuliano DEGRASSI and Decio RIPANDELLI

Environ. Biosafety Res. 6 (2007) 161–165

One of the most direct routes to informing scientific debates is through the timely publication of relevant research results. By making a comparison of the number and type of articles published by Environmental Biosafety Research (EBR) with those from other journals active in the arena of GMO biosafety, it is possible to shed light on the answer to the question posed in the title. To do this, we have used a unique open access online tool, the Biosafety Bibliographic Database (BBD) that has been provided by ICGEB since 1990. As of June 2007, the BBD contained 6694 records pertaining to scientific publications (full references and abstracts), and appearing in international and national scientific periodicals and books. Based on the records in the BBD, biosafety research activity over the past 16–17 years can be summarized by analyzing basic statistics. The BBD should prove to be a useful starting point for diverse bibliometric studies of publications in this area.

Keywords: opinión pública, debate, OVGMs, comunicación científica

Se describe una base de datos bibliográfica sobre ciencia desarrollada en temas de bioseguridad de OVGMs, dependiente de la revista Investigación en Bioseguridad Ambiental.

Genetically modified crops for the bioeconomy: meeting public and regulatory expectations

Saharah Moon Chapotin - Jeffrey D. Wolt

Transgenic Res (2007) 16:675–688

As the United States moves toward a plant-based bioeconomy, a large research and development effort is focused on creating new feedstocks to meet biomass demand for biofuels, bioenergy, and specialized bioproducts, such as industrial compounds and biomaterial precursors. Most bioeconomy projections assume the widespread deployment of novel feedstocks developed through the use of modern molecular breeding techniques, but rarely consider the challenges involved with the use of genetically modified crops, which can include hurdles due to regulatory approvals, market adoption, and public acceptance. In this paper we consider the implications of various transgenic crops and traits under development for the bioeconomy that highlight these challenges. We believe that an awareness of the issues in crop and trait selection will allow developers to design crops with maximum stakeholder appeal and with the greatest

potential for widespread adoption, while avoiding applications unlikely to meet regulatory approval or gain market and public acceptance.

Keywords: ingeniería genética, biocombustibles, bioproductos, aspectos regulatorios, OVGMs, bioeconomía, opinión pública.

En el presente artículo de revisión se discute una economía productiva basada en la biología (bioeconomía). Esta considera la producción de alimentos, de energía, de compuestos industriales y de precursores biomateriales a partir de organismos vivos (plantas transgénicas). Los aspectos regulatorios, de adopción tecnológica y de aceptación pública son tratados especialmente.

IV. IMPACTO SOBRE LA BIODIVERSIDAD.

Transgenic organsims – Time for conceptual diversification?

Kaare M Nielsen

Nature Biotechnology 21 (3): 227-228 (2003)

Recent advances in genetic engineering have made it possible to effect previously unattainable genetic changes in most organisms subjected to breeding?. The altered organisms into which hereditary (that is, genetic) material from another organism has been introduced are referred as transgenic or genetically modified organisms (GMOs). Wide use of these process-based terms has resulted in little appreciation for the sources, extent, and novelty of the genetic modifications made in GMOs. Not surprisingly, undiscriminate scientific, public, and regulatory scrutiny based on misleading conceptual assumptions have developed into negative perceptions of GMOs, particularly among European citizens. I hypothesize that the failure to establish, from the onset, explicit terminology to categorize the various applications of gene technology in breeding have contributed to this skeptiscim and to rejection of the technology by many consumers.

Keywords:biodiversidad, OVGMs, impacto ambiental, evaluación de riesgos

El autor propone clarificar la terminología utilizada sobre la modificación genética de organismos para facilitar la comprensión de los consumidores de productos derivados de las biotecnologías y del público en general.

The limited value of measuring gene flow via errant pollen from GM plants

Alan MCHUGHEN

Environ. Biosafety Res. 5 (2006) 1–2

Since the advent over 30 years ago of recombinant DNA technologies giving rise to genetically engineered organisms (often called GMOs), gene escape from such transgenic organisms has been a consistent and legitimate concern. Initially, the fear of GM microbes escaping and wreaking ecological havoc on the biosphere generated both well funded scientific analyses of the actual threat, and fueled science fiction tracts of rampant monster microbes consuming every living thing on Earth. In recent years the focus—at least in the scientific community—has shifted to GM plants, particularly the incidence of escape of genes from GM crops.

Keywords: flujo génico, OVGMs, impacto ambiental

Uno de los aspectos más estudiados durante la evaluación de nuevos eventos transgénicos es la posibilidad del movimiento del polen de la planta GM hacia

otras plantas, impactando sobre la biodiversidad y modificando las frecuencias génicas de las poblaciones. La presente nota editorial discute este tema en particular.

Detection of potential transgenic plant DNA recipients among soil bacteria

Jean-Michel MONIER, Dominique BERNILLON, Elizabeth KAY, Aurélie FAUGIER, Oleksandra RYBALKA, Yves DESSAUX, Pascal SIMONET and Timothy M. VOGEL

Environ. Biosafety Res. 6 (2007) 71–83

The likelihood of gene transfer from transgenic plants to bacteria is dependent on gene number and the presence of homologous sequences. The large number of transgene copies in transplastomic (transgenes contained in the chloroplast genome) plant cells as well as the prokaryotic origin of the transgene, may thus significantly increase the likelihood of gene transfer to bacteria that colonize plant tissues. In order to assess the probability of such transfer, the length of homologous DNA sequences required between the transgene and the genome of the bacterial host was assessed. In addition, the probability that bacteria, which co-infect diseased plants, are transformable and have sequences similar to the flanking regions of the transgene was evaluated. Using *Acinetobacter baylyi* strain BD143 and transplastomic tobacco plants harboring the aadA gene (streptomycin and spectinomycin resistance), we found that sequences identical to the flanking regions containing as few as 55 nucleotides were sufficient for recombination to occur. Consequently, a collection of bacterial isolates able to colonize tobacco plant tissue infected by *Ralstonia solanacearum* strain K60 was obtained, screened for DNA sequence similarity with the chloroplastic genes accD and rbcL flanking the transgene, and tested for their ability to uptake extracellular DNA (broad host-range pBBR1MCS plasmids) by natural or electro-transformation. Results showed that among the 288 bacterial isolates tested, 8% presented DNA sequence similarity with one or both chloroplastic regions flanking the transgene. Two isolates, identified as *Pseudomonas sp*. and *Acinetobacter sp*., were able to integrate exogenous plasmid DNA by electro-transformation and natural transformation, respectively. Our data suggest that transplastomic plant DNA recipients might be present in soil bacterial communities.

Keywords: OVGMs, plantas transplantómicas, transgenes, recombinación, bacteria, Acinetobacter, Ralstonia, suelo, trasnsferencia génica horizontal

El presente trabajo se propuso estudiar, identificar y aislar candidatos bacterianos potenciales del suelo para la transferencia génica horizontal de transgenes de plantas basados en la presencia y longitud de secuencias de ADN similares a las regiones flanqueantes de los transgenes.

Fate of transgenic plant DNA in the environment

Alessandra PONTIROLI, Pascal SIMONET, Asa FROSTEGARD, Timothy M. VOGEL and Jean-Michel MONIER

Environ. Biosafety Res. 6 (2007) 15–35

This review addresses the possible ecological effects of transgenic plants on micro-organisms in the field, hence, in the phytosphere and in the soil matrix. The important steps involved in the interaction between plant DNA and bacteria and the factors that influence the horizontal gene transfer (HGT) process will be discussed. HGT is a process in which two partners are involved, even if indirectly. In the first section, aspects concerning bacteria, such as their physico-chemical, biological and genetic characteristics, are described. Parameters affecting transgenic DNA fate in the environment are described in the second section. Subsequently, terrestrial habitats are evaluated in terms of their capacity to favor horizontal gene transfer. Finally, we focused on several studies in order to evaluate possible perturbations of soil bacterial community composition due to cultivation of transgenic plants in the field.

*Keywords: **OVGMs**, bacteria, transgenes, impacto ambiental, destino del AND, microorganismos, transferencia horizontal de genes*

El presente artículo de revisión enfoca la transferencia horizontal de genes a partir de plantas transgénicas, analiza los riesgos ecológicos ligados a la liberación de OVGMs, el destino de los transgenes en la transferencia, los mecanismos de transferencia, los factores que la posibilitan, los impedimentos y la persistencia del ADN en el ambiente, entre otros aspectos.
LECTURA RECOMENDADA.

Transgene introgression from genetically modified crops to their wild relatives

C.Neal Stewart Jr, Matthew D.Halfhill and Suzanne I.Warwick
NATURE REVIEWS GENETICS 4 (10): 806-817 (2003)

Transgenes engineered into annual crops could be unintentionally introduced into the genomes of their free-living wild relatives. The fear is that these transgenes might persist in the environment and have negative ecological consequences. Are some crops or transgenic traits of more concern than others? Are there natural genetic barriers to minimize gene escape? Can the genetic transformation process be exploited to produce new barriers to gene flow? Questions abound, but luckily so do answers.

Keywords: transferencia horizontal de genes, impacto ambiental, flujo génico, introgresión transgénica

El presente es un artículo de revisión que enfoca la introgresión de transgenes de cultivos GM hacia especies relacionadas no GM. La introgresión depende de la modalidad y capacidad reproductiva de los cultivos GM, así clasifica las probabilidades de ocurrencia en cultivos de alto, moderado y bajo riesgo. Además, discute las tecnologías disponibles para disminuir el riesgo de transferencia génica entre diferentes especies.

Cost-efficacy in measuring farmland biodiversity – lessons from the Farm Scale Evaluations of genetically modified herbicide-tolerant crops

A. Qi, J.N. Perry, J.D. Pidgeon, L.A. Haylock & D.R. Brooks
Ann Appl Biol 152 (2008) 93–101

Measuring farmland biodiversity is time-consuming and costly. Operational data from the Farm Scale Evaluation of genetically modified crops project were collated to identify the financial and time costs of each of the 14 protocols used. A subset of 113 of the 266 experimental sites was used. The mean overall cost per site was £19 453 (£ of 2002). Laboratory time was almost 2.5 times that in the field. The most costly protocol was soil surface invertebrates because it required species level identification. The 'bees and butterflies' protocol at £418 per site was particularly cost-effective. The six vegetation protocols accounted for 65% and the six arthropod protocols accounted for 29% of the total costs. The recommended reduction from 12 to 3 transects would have saved £1356 per site, 6% of total budget. A minimalist approach using the single-season seedbank protocol would cost £3437 per site. The effect of geographical spread of sites on cost was small because of clustering of sites and the large number of protocols. Careful selection of ecological indicators can save considerable resources.

Keywords: biodiversidad; fauna; flora; OVGMs; impacto ambiental

En el presente trabajo se examinaron los costos directos de la investigación en escala de campo utilizando protocolos de medidas ecológicos de biodiversidad, en sitios con cultivos GM tolerantes a herbicidas.

Effects of biotechnology on biodiversity: herbicide-tolerant and insect-resistant GM crops

Klaus Ammann

TRENDS in Biotechnology Vol.23 No.8: 388-394 (2005)

Biodiversity is threatened by agriculture as a whole, and particularly also by traditional methods of agriculture. Knowledge-based agriculture, including GM crops, can reduce this threat in the future. The introduction of no-tillage practices, which are beneficial for soil fertility, has been encouraged by the rapid spread of herbicide tolerant soybeans in the USA. The replacement of pesticides through Bt crops is advantageous for the nontarget insect fauna in test-fields. The results of the British Farm Scale experiment are discussed. Biodiversity differences can mainly be referred to as differences in herbicide application management.

Keywords: biodiversidad, agrobiotecnología, impacto ambiental, resistencia a herbicidas, resistencia a insectos

Se trata de un artículo de opinión que compara la pérdida de biodiversidad bajo situaciones de agricultura convencional y de la agricultura moderna con biotecnología. Analiza los casos de cultivos resistentes a herbicidas e insectos en escala de campo. Concluye que la agrobiotecnología no ofrece un riesgo a la biodiversidad de los agroecosistemas.

V. IMPACTO DE LOS OVGMs CON RESISTENCIAS A HERBICIDAS E INSECTOS.

Herbicide-resistant genetically-modified crop: its risks with an emphasis on gene flow

YONG WOONG KWON and DO-SOON KIM

Weed Biology and Management 2001; 1: 42–52

Herbicide-resistant genetically-modified (GM) crops are the most widely cultivated worldwide, representing 78% of GM crops in 1999, followed by insect-resistant GM crops with *Bt* gene. Gene flow is the most touching risk arising from GM crops, and is categorized as three types: within species, between species and between GM crop and other organisms. This review shows that gene flow is a reality in the plant kingdom with evolutionary change. Herbicide resistance evolves naturally and spreads dynamically in weeds. One of the most concerning crop in relation to gene flow is *Brassica napus*, which has a high outcrossing rate and many relative species. In contrast, frequency of gene flow via outcrossing is relatively low in inbreeding cereal crops such as rice, wheat and barley, but published reports have shown that substantial gene flow is possible. Another possible and immediate risk is herbicide resistant GM crops becoming volunteer weeds. Dry direct-seeded rice is one of the most likely crops in this respect. Stacking different resistance genes in a crop would accelerate multiple resistance evolution in weeds. Multiple resistance to three major herbicides has already been observed in oilseed rape cultivation. More efforts must be made for long-term risk assessment on GM crops in the natural ecosystem. More studies on weed biology and ecology, particularly reproductive processes in weeds, are essential for better understanding of gene flow and systematic management strategy. We hope that this review motivates researchers to analyze data available now, to collect fundamental information on crops and weeds in agro-ecosystem, and to lead to better risk assessment and management.

Keywords: Brassica napus, colza, flujo génico, OVGMs, cultivos transgénicos, resistencia a herbicidas, evaluación de riesgo

El presente artículo de revisón enfoca los riesgos que genera la adopción de cultivos transgénicos en la agricultura, con particular énfasis en el flujo génico que transporta los genes de los cultivos GM hacia otras plantas emparentadas. Analiza las consecuencias de este movimiento polínico en cultivos resistentes a herbicidas e insectos, generando la probabilidad de aparición de plantas de cultivo como malezas guachas de otros. También analiza los mecanismos del flujo génico entre plantas de igual y de diferentes especies.
LECTURA RECOMENDADA.

Real-Time Polymerase Chain Reaction Quantification of the Transgenes for Roundup Ready Corn and Roundup Ready Soybean in Soil Simples

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J. Agric. Food Chem. 2005, 53, 1337-1342

A method for quantification of recombinant DNA for Roundup Ready (RR) corn and RR soybean in soil samples is described. Soil DNA from experimental field samples was extracted using a soil DNA extraction kit with a modified protocol. For the detection and quantification of recombinant DNA of RR corn and RR soybean, a molecular beacon and two pairs of specific primers were designed to differentially target recombinant DNA in these two genetically modified crops. Soil DNA extracts were spiked with RR corn or RR soybean DNA, and recombinant DNA was quantified using real-time PCR with a molecular beacon. As few as one copy of RR corn genome or one copy of RR soybean genome was detected in the soil DNA extract.

Keywords: ADN del suelo; detección de OVGMs; PCR en tiempo real; persistencia del ADN; suelo; plantas transgénicas, impacto ambiental

En el presente artículo se describe una metodología por PCR en tiempo real de detección de ADN existente en el suelo (persistencia del ADN) correspondiente a transgenes de maíz y soja resistentes a glifosato.

Impacto ambiental de los cultivos genéticamente modificados: El caso del maíz Bt.

PERMINGEAT Hugo - MARGARIT Ezequiel

Revista de Investigaciones de la Facultad de Ciencias Agrarias UNR, 7: 33-44 (2005)

Bt crops have been widely adopted by farmers in countries where its commercialization has been approved. However, although adoption of GM crops has increased dramatically in the last years, public opinion has not been in line with that increase. A profound debate about the environmental and health risks posed by GMOs started several years ago and is still ongoing between different sectors of the society. The present review discusses the scientific evidences related to the safety of the Bt crops available on the market.

Keyword: OVGMs, resistencia a insectos, maíz Bt, algodón Bt, impacto ambiental, evaluación de riesgos

En el presente artículo de revisión se analiza el impacto ambiental de la tecnología Bt, introducida en Argentina en maíces (diferentes eventos) y en algodón. Se discute temas como la dispersión génica, la expresión de la proteína Bt en plantas y su relación con el ambiente, y la incorporación y persistencia de la proteína Bt en el suelo.

LECTURA RECOMENDADA.

Six years after the commercial introduction of Bt maize in Spain: field evaluation, impact and future prospects

Matilde Eizaguirre, Ramon Albajes, Carmen López, Jordi Eras, Belén Lumbierres & Xavier Pons

Transgenic Research (2006) 15:1–12

We carried out a 6-year-field evaluation to assess potential hazards of growing Compa©, a transgenic Bt maize variety based on the transformation event CG 00256-176. Two categories of hazards were investigated: the potential of the target corn borer *Sesamia nonagrioides* to evolve resistance to Bt maize and effects on non-target organisms. In order to address the first hazard, dispersal capacity of the corn borer was measured and our results indicated that larvae move to plants other than those onto which the female oviposited – even to plants in adjacent rows – in remarkable numbers and they do so mostly at a mature age, suggesting that mixing Bt and non-Bt seeds in the same field would not be a very useful deployment strategy to delay/prevent resistance. In addition, adults move among fields to mate and males may do so for up to 400 m. Three different aspects of potential non-target effects were investigated: sub-lethal effects on the target *S. nonagrioides*, effects on non-target maize pests, and effects on maize-dwelling predators. Larvae collected in Bt fields at later growth stages, in which event 176 Bt maize expresses Bt toxin at sublethal concentrations, had longer diapause and post-diapause development than larvae collected in non-Bt fields, a feature that might lead to a certain isolation between populations in both type of fields and accelerate Bt resistance evolution. Transgenic maize did not have a negative impact on non-target pests in the field; more aphids and leafhoppers but similar numbers of cutworms and wireworms were counted in Bt versus non-Bt fields; in any case differences in damage or yield were recorded. We observed no difference in the numbers of the most relevant predators in fields containing transgenic or no transgenic maize.

Keywords: maíz Bt, OVGMs, Sesamia, plantas transgénicas, resistencia a insectos, impacto ambiental

El presente estudio resume experimentos tendientes a evaluar el riesgo ambiental del evento 176 de maíz Bt, luego de varios años de adopción en España. Se discuten las estrategias a aplicar para prevenir o demorar la resistencia en insectos blancos, los efectos sobre insectos blancos y no blancos, y los efectos sobre predadores.

Coexistence Between GM and Non-GM Maize Crops – Tested in 2004 at the Field Scale Level (Erprobungsanbau 2004)

W. E. Weber, T. Bringezu, I. Broer, J. Eder, and F. Holz

J. Agronomy & Crop Science 193, 79—92 (2007)

The objective of the study was to test the feasibility of coexistence between genetically modified (GM) and non- GM maize under real-life agronomical conditions. GM hybrid maize with the event MON810 (Bt maize) was drilled at 30 sites in fields surrounded by near isogenic conventional maize, although only 27 sites could be finally evaluated. Field sizes of Bt maize varied between 0.3 and 23 ha, and the flowering period of the Bt and conventional maize was synchronous. At some sites, different planting dates of GM and non-GM maize or an earlier ripening conventional maize were tested in additional strips to obtain altered flowering and thereby reduce cross-pollination. The overlapping of flowering periods was successfully avoided only at two sites where non-GM maize was planted 25 or 28 days later. During harvest, samples were taken from the conventional maize in strips at distances of 0–10, 20–30, and 50–60 m to the Bt maize fields to assess the GM DNA content as a function of distance. Sampled materials included chaffed plant material intended for silage (18 sites), grains (eight sites), or crushed husks and cobs (one site). Wind effects were taken into account by sampling in all four compass directions. Quantitative PCR was used to detect the event specific MON810 DNA sequence in sampled materials. The analysis was conducted by two certified independent diagnostic testing companies selected in a pre-

test. Taking averages over all compass directions and the two laboratories no samples collected beyond 10 m had levels of GM above the threshold of 0.9 %. In conclusion, the data indicate that coexistence of GM and conventional maize is possible under real-life large-scale agronomical conditions. Levels of GM DNA in harvested grain resulting from outcrossing can be managed to levels below 0.9 % by simply planting 20 m of conventional maize as a pollen barrier between adjacent fields.

Keywords: coexistencia de eventos transgénicos de maíz, transgenes, maíz transgénico, MON810, RT-PCR, impacto ambiental

En el presente trabajo se evaluó la transferencia de transgenes de maíces transgénicos Bt a convencionales cultivados en escala de campo en diferentes localidades, considerando diferentes distancias de separación entre ambos y cuantificando la presencia del transgen en los granos de los maíces convencionales cosechados. Se concluye que una barrera de 20 m de maíz convencional entre campos adyacentes es suficiente para disminuir el movimiento del polen con transgenes en un porcentaje menor al 0,9% de ADN transgénico.

Lack of repeatable differential expression patterns between MON810 and comparable commercial varieties of maize

Anna Coll - Anna Nadal - Montserrat Palaudelmas - Joaquima Messeguer - Enric Melé - Pere Puigdomenech - Maria Pla

Plant Mol Biol (2008) 68:105–117

The introduction of genetically modified organisms (GMO) in many countries follows strict regulations to assure that only products that have been safety tested in relation to human health and the environment are marketed. Thus, GMOs must be authorized before use. By complementing more targeted approaches, profiling methods can assess possible unintended effects of transformation. We used microarrays to compare the transcriptome profiles of widely commercialized maize MON810 varieties and their non-GM near-isogenic counterparts. The expression profiles of MON810 seedlings are more similar to those of their corresponding near-isogenic varieties than are the profiles of other lines produced by conventional breeding. However, differential expression of ~1.7 and ~0.1% of transcripts was identified in two variety pairs (AristisBt/Aristis and PR33P67/ PR33P66) that had similar cryIA(b) mRNA levels, demonstrating that commercial varieties of the same event have different similarity levels to their near-isogenic counterparts without the transgene (note that these two pairs also show phenotypic differences). In the tissues, developmental stage and varieties analyzed, we could not identify any gene differentially expressed in all variety-pairs. However, a small set of sequences were differentially expressed in various pairs. Their relation to the transgenesis was not proven, although this is likely to be modulated by the genetic background of each variety.

Keywords: OVGMs, MON810, maíz transgénico, maíz Bt, diversidad genética, perfil de expresión

El objetivo del presente estudio fue investigar diferencias de expresión génica posibles entre variedades comerciales GM del evento MON810 (un maíz Bt) y sus contrapartes isogénicas no GM, para dar luz a posibles efectos del transgen y de su modulación por el background genético de cada variedad GM. Así, se detectaron diferentes patrones de expresión de los genes seleccionados entre los maíces GM y no GM en algunas variedades consideradas en el estudio.

Bt protein rhizosecreted from transgenic maize does not accumulate in soil

Ezequiel Margarit, Martín I. Reggiardo y Hugo R. Permingeat

Electronic Journal of Biotechnology, 11 (2), fulltext 3 pp 1-10, 2008

The persistence of CryIAb protein rhizosecreted in soil is important in the assessment of its environmental risk. Here we report that CryIAb protein from transgenic maize does not accumulate at high levels in soils. Levels of CryIAb protein rhizosecreted by three maize transgenic events (BT11, MON810 and 176) were studied in hydroponic cultures and found only in the MON810 and BT11 events but not in event 176 or control plants. Under field conditions, the *cryIAb* gene and a basal level of CryIAb protein was detected in soils from plots cultivated with transgenic and nontransgenic maize, possibly from *Bacillus thuringiensis* present in the soils.

Keywords: gen cryIAb, proteína CryIAb, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental, hidroponia.

En el presente trabajo se confirma y cuantifica la rizosecresión de la proteína Bt en los eventos MON810 y Bt11 de maíz transgénico, y se cuantifica la proteína Bt en suelos cultivados con maíces GM y convencionales (isohíbridos no GM). Se concluye que no se detectan diferencias en suelos cultivados con ambos maíces, estando la proteína presente en los dos. Se sugiere que esta proteína proviene del Bacillus thuringiensis habitante natural del suelo.

Insecticidal toxin in root exudates from Bt corn

Deepak Saxena, Saul Flores, G. Stotzky

NATURE 402: 480 (1999)

Bt corn is corn (*Zea mays*) that has been genetically modified to express insecticidal toxins derived from the bacterium *Bacillus thuringiensis* to kill lepidopteran pests feeding on these plants. Here we show that *Bt* toxin is released into the rhizosphere soil in root exudates from *Bt* corn.

Keywords: gen cryIAb, proteína CryIAb, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental.

En el presente artículo se describe la exudación radicular de la proteína Bt en el maíz transgénico, y se menciona una adherencia de la misma a las partículas de arcilla del suelo que le hace mantener su actividad insecticida hasta por 234 dias (que fue el período estudiado).

Larvicidal Cry proteins from *Bacillus thuringiensis* are released in root exudates of transgenic *B. thuringiensis* corn, potato, and rice but not of *B. thuringiensis* canola, cotton, and tobacco

Deepak Saxena, C. Neal Stewart, Illimar Altosaar, Qingyao Shu, G. Stotzky

Plant Physiology and Biochemistry 42 (2004) 383–387

Larvicidal proteins encoded by *cry* genes from *Bacillus thuringiensis* were released in root exudates from transgenic *B. thuringiensis* corn, rice, and potato but not from *B. thuringiensis* canola, cotton, and tobacco. Nonsterile soil and sterile hydroponic solution in which *B. thuringiensis* corn, rice, or potato had been grown were immunologically positive for the presence of the Cry proteins; from *B. thuringiensis* corn and rice, the soil and solution were toxic to the larva of the tobacco hornworm (*Manduca sexta*), and from potato, to the larva of the Colorado potato beetle (*Leptinotarsa decemlineata*), representative lepidoptera and coleoptera, respectively. No toxin was detected immunologically or by larvicidal assay in soil or hydroponic solution in which *B. thuringiensis* canola, cotton, or tobacco, as well as all near-

isogenic non-*B. thuringiensis* plant counterparts or no plants, had been grown. All plant species had the cauliflower mosaic virus (CaMV) 35S promoter, except rice, which had the ubiquitin promoter from maize. The reasons for the differences between species in the exudation from roots of the toxins are not known. The released toxins persisted in soil as the result of their binding on surface-active particles (e.g. clay minerals, humic substances), which reduced their biodegradation. The release of the toxins in root exudates could enhance the control of target insect pests, constitute a hazard to nontarget organisms, and/or increase the selection of toxin-resistant target insects.

Keywords: gen cryIAb, proteína CryIAb, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental, Bacillus thuringiensis; hidroponia.

En este trabajo también se describe la exudación radicular de la proteína Bt en maíz, arroz y papa, pero no en colza, algodón y tabaco.

Insecticidal toxin from *Bacillus thuringiensis* is released from roots of transgenic Bt corn *in vitro* and *in situ*

D. Saxena, G. Stotzky

FEMS Microbiology Ecology 33 (2000) 35-39

The insecticidal toxin encoded by the cry1Ab gene from *Bacillus thuringiensis* was released in root exudates from transgenic Bt corn during 40 days of growth in soil amended to 0, 3, 6, 9, or 12% (v/v) with montmorillonite or kaolinite in a plant growth room and from plants grown to maturity in the field. The presence of the toxin in rhizosphere soil was determined by immunological and larvicidal assays. No toxin was detected in any soils from isogenic non-Bt corn or without plants. Persistence of the toxin was apparently the result of its binding on surface-active particles in the soils, which reduced the biodegradation of the toxin. The release of the toxin could enhance the control of insect pests or constitute a hazard to nontarget organisms, including the microbiota of soil, and increase the selection of toxin-resistant target insects.

Keywords: gen cryIAb, proteína CryIAb, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental, Bacillus thuringiensis.

Se trata de otro artículo que aporta evidencias de la exudación radicular de la proteína Bt producida por el maíz transgénico, destacando la importancia del tipo de arcilla que constituye el suelo y su relación con la persistencia de la toxina a la misma.

Biodegradation and insecticidal activity of the toxin from *Bacillus thuringiensis subsp. kurstaki* bound on complexes of montmorillonite-humic acids-Al hydroxypolymers

C. Crecchio, G. Stotzky

Soil Biology & Biochemistry 33 (2001) 573-581

The equilibrium adsorption and binding of the active toxin from Bacillus thuringiensis subsp. kurstaki on complexes of montmorillonite± humic acids±Al hydroxypolymers, as well as the biodegradation and the insecticidal activity of the bound toxin, were studied. Seventy percent of the total adsorption occurred within the ®rst hour, and maximal adsorption occurred in ,8 h. Adsorption of the toxin on a constant amount of the complexes increased as the amount of the toxin added increased, and equilibrium adsorption isotherms of the L-type were obtained. There was essentially no desorption of the toxin after extensive washing of the toxin±organomineral complexes with double distilled H2O and 1 M NaCl. The bound toxin was resistant to utilization by mixed microbial cultures from soil and to enzymatic degradation by Pronase E. Free and bound toxin were active against the larvae of Manduca sexta; the bound toxin retained the same activity after exposure to microbes or Pronase, whereas the toxicity of the free toxin decreased signi®cantly. The results of these studies indicate that the release of transgenic

plants and microorganisms expressing truncated genes that encode active insecticidal toxins from B. thuringiensis could result in the accumulation of these toxins in soil as a consequence of binding on surface-active soil particles. This persistence could pose a hazard to nontarget organisms, enhance the selection of toxin-resistant target species, and increase the control of target insect pests.

Keywords: gen cryIAb, proteína CryIAb, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental, Bacillus thuringiensis.

Un nuevo artículo que confirma la exudación radicular de la proteína Bt producida por el maíz transgénico, que analiza su unión a partículas del suelo y por ende su persistencia con actividad insecticida.

Bt toxin is not taken up from soil or hydroponic culture by corn, carrot, radish, or turnip

D Saxena & G. Stotzky

Plant and Soil 239: 165–172, 2002.

The culture of transgenic *Bt* corn (*Zea mays* L.) has resulted in concern about the uptake of the Cry1Ab protein toxin by crops subsequently grown in soils in which *Bt* corn has been grown. The toxin released to soil in root exudates of *Bt* corn, from the degradation of the biomass of *Bt* corn, or as purified toxin, was not taken up from soil, where the toxin is bound on surface-active particles (e.g. clays and humic substances), or from hydroponic culture, where the toxin is not bound on particles, by non-*Bt* corn, carrot (*Daucus carota* L.), radish (*Raphanus sativus* L.), and turnip (*Brassica rapa* L.). The persistence of the toxin in soil for 90 days after its addition in purified form or for 120–180 days after its release in exudates or from biomass, the longest times evaluated, confirmed that the toxin was bound on surface-active particles in soil, which protected the toxin from biodegradation. The greater toxicity of the toxin in soil amended with 9% montmorillonite or kaolinite than in soil amended with 3% of these clay minerals indicated that the binding and persistence of the toxin increased as the clay concentration was increased.

Keywords: Bacillus thuringiensis, maíz Bt, zanahoria, arcillas, proteína Cry1Ab, hidroponia, nabo, exudados radiculares, suelo, nabón

Luego de aportar evidencias de la rizosecresión de la proteína Bt del maíz, el presente artículo describe que otros cultivos no abosben la proteína liberada por el primero. El análisis de tejidos de nabo, nabón, zanahoria y maíz no GM reveló la ausencia de la proteína Bt cuando estas plantas sucedieron al maíz Bt en suelos artificiales y en hidroponía.

Persistence and biological activity in soil of the insecticidal proteins from *Bacillus thuringiensis*, especially from transgenic plants

G. Stotzky

Plant and Soil 266: 77–89, 2004.

Insecticidal proteins produced by various subspecies (*kurstaki, tenebrionis*, and *israelensis*) of *Bacillus thuringiensis* (*Bt*) bound rapidly and tightly on clays, both pure mined clay minerals and soil clays, on humic acids extracted from soil, and on complexes of clay and humic acids. Binding reduced susceptibility of the proteins to microbial degradation. However, bound proteins retained biological activity. Purified Cry1Ab protein and protein released from biomass of transgenic *Bt* corn and in root exudates of growing *Bt* corn (13 hybrids representing three transformation events) exhibited binding and persistence in soil. Insecticidal protein was also released in root exudates of *Bt* potato (Cry3A protein) and rice (Cry1Ab protein) but not in root exudates of *Bt* canola, cotton, and tobacco (Cry1Ac protein). Vertical movement of CrylAb protein, either purified or in root exudates or biomass of *Bt* corn, decreased as the concentration of the clay minerals, kaolinite or montmorillonite, in soil increased. Biomass of

transgenic *Bt* corn decomposed less in soil than biomass of near-isogenic non-*Bt* corn, possibly because biomass of *Bt* corn had a significantly higher content of lignin than biomass of non-*Bt* corn. Biomass of *Bt* canola, cotton, potato, rice, and tobacco also decomposed less than biomass of the respective near-isogenic non-*Bt* plants. However, the lignin content of these *Bt* plants, which was significantly less than that of *Bt* corn, was not significantly different from that of their near-isogenic non-*Bt* counterparts, although it was consistently higher. The Cry1Ab protein had no consistent effects on organisms (earthworms, nematodes, protozoa, bacteria, fungi) in soil or *in vitro*. The Cry1Ab protein was not taken up from soil by non-*Bt* corn, carrot, radish, or turnip grown in soil in which *Bt* corn had been grown or into which biomass of *Bt* corn had been incorporated.

Keywords: Bacillus thuringiensis, maíz Bt, arcillas, proteína Cry1Ab, hidroponia, exudados radiculares, suelo, lignina., algodón Bt

Se trata de un artículo de revisión que plantea, describe y analiza la rizosecresión de la proteína Bt del maíz, la adsorción a las arcillas y ácidos húmicos del suelo, y la persistencia de la misma y de la actividad biológica en el suelo.

No Differences in Decomposition Rates Observed between *Bacillus thuringiensis* and Non-*Bacillus thuringiensis* Corn Residue Incubated in the Field

R. Michael Lehman, Shannon L. Osborne, and Kurt A. Rosentrater

Agron. J. 100:163–168 (2008).

Recent speculation of slower residue decomposition for *Bacillus thuringiensis* (Bt) corn (*Zea mays* L.) hybrids compared with non-Bt corn hybrids has prompted investigative study. We evaluated the residue decomposition rates of Bt and non-Bt corn hybrids over a period of 22 mo under field conditions using the litter bag technique. The four corn hybrids used were (i) DKC60–16 (Bt+, Cry1Ab protein active against the leptidopteran European corn borer, event MON810), (ii) DKC60–12 (Bt+, Cry3Bb1 protein active against the coleopteran corn rootworm, event MON863), (iii) DKC60–14 (stacked Bt++, Cry1Ab and Cry3Bb1 proteins) and, (iv) DKC60–15 (Bt−, base genetics). The biochemical and physical properties of the corn residues were determined. No differences in the decomposition rates of the residue from the four corn hybrids were detected. Residue decomposition rate constants were approximately 0.25 d^{-1} for all four hybrids with predicted residue half-lives of about 200 d. No differences in compositional properties, including lignin content, were observed among the four hybrids. Physical compression testing of the chopped residue failed to detect significant differences in mechanical strength properties among the hybrids. This is the first report regarding decomposition of Bt corn residue under field conditions following ambiguous reports from laboratory studies on the relative susceptibility of Bt corn residue to decomposition.

Keywords: maíz Bt, descomposición del rastrojo, OVGMs

En el presente estudio se describen los resultados de experimentos en escala de campo sobre la descomposición de los residuos de maíces Bt (diferentes genes en función de los insectos a controlar) en comparación con maíces convencionales (isohíbridos no GM). Estos resultados indican que no exiten diferencias en la descomposición de los residuos ni en la composición química (incluyendo la lignina) de los mismos.

Effects of physical and chemical properties of soils on adsorption of the insecticidal protein (Cry1Ab) from *Bacillus thuringiensis* at Cry1Ab protein concentrations relevant for experimental field sites

Sibylle Pagel-Wieder, Jürgen Niemeyer, Walter R. Fischer, Frank Gessler

Soil Biology & Biochemistry 39 (2007) 3034–3042

The adsorption of the insecticidal Cry1Ab protein of *Bacillus thuringiensis* (Bt) on Na-montmorillonite (M-Na) and soil clay fractions was studied. The aim of this study was not to find the adsorption capacity of the soils from the experimental field site, where Bt corn (MON810) was cultivated, but rather to characterize the adsorption behavior of the Cry1Ab protein at concentrations typically found at experimental field sites. In kinetic experiments, the Cry1Ab protein adsorbed rapidly (o60 min) on M-Na. As the concentration of M-Na was varied and the added Cry1Ab protein concentration was kept constant (20 and 45 ng ml^{-1}), the adsorption per unit weight of Cry1Ab protein decreased with increasing concentrations of M-Na. Adsorption of Cry1Ab protein on M-Na decreased as the pH value of the suspension increased. All adsorption isotherms could be described mathematically by a linear regression with the parameter k, the distribution coefficient, being the slope of the regression line. Although their mineralogical composition was nearly identical, the soil clay fractions showed different k values. The different k values were correlated with the physical and chemical properties of the soil clay fractions, such as the organic carbon content, the specific external surface area, and the electrokinetic charge of the external surfaces of the clays, as well as with the external surface charge density. An increase in the amount of soil organic matter, as well as an increase in the electrokinetic external surface charge of the soil clays, decreased the distribution coefficient k. An increase of the specific external surface areas of the soil clays resulted in a higher distribution coefficient k. Less than 10% of adsorbed Cry1Ab protein was reversibly adsorbed on the soil clays and, thus, desorbed. The desorption efficiency of distilled water was higher than that of a solution of $CaCl_2$ (2.25 mmol) and of dissolved organic carbon (50 mgC l^{-1}).

Keywords: proteína Cry1Ab; Bacillus thuringiensis; Na-montmorillonita; arcillas; adsorción; persistencia

El objetivo del presente estudio fue caracterizar la adsorción de la proteína Bt en el suelo, en condiciones de campo, considerando la composición textural del suelo, el pH, los cationes del complejo de intercambio, entre otros factores.

Fate and effects of insect-resistant Bt crops in soil ecosystems

Isik Icoz, Guenther Stotzky

Soil Biology & Biochemistry 40 (2008) 559–586

Recent applications of biotechnology, especially genetic engineering, have revolutionized crop improvement and increased the availability of valuable new traits. A current example is the use of the insecticidal Cry proteins from the bacterium, *Bacillus thuringiensis* (Bt), to improve crops, known as Bt crops, by reducing injury from various crop pests. The adoption of genetically modified (GM) crops has increased dramatically in the last 11 years. However, the introduction of GM plants into agricultural ecosystems has raised a number of questions, including the ecological impact of these plants on soil ecosystems. Crop residues are the primary source of carbon in soil, and root exudates govern which organisms reside in the rhizosphere. Therefore, any change to the quality of crop residues and rhizosphere inputs could modify the dynamics of the composition and activity of organisms in soil. Insect-resistant Bt crops have the potential to change the microbial dynamics, biodiversity, and essential ecosystem functions in soil, because they usually produce insecticidal Cry proteins through all parts of the plant. It is crucial that risk assessment studies on the commercial use of Bt crops consider the impacts on organisms in soil. In general, few or no toxic effects of Cry proteins on woodlice, collembolans, mites, earthworms, nematodes, protozoa, and the activity of various enzymes in soil have been reported. Although some effects, ranging from no effect to minor and significant effects, of Bt plants on microbial communities in soil have been reported, using both culturing and molecular techniques, they were mostly the result of differences in geography, temperature, plant variety, and soil type and, in general, were transient and not related to the presence of the Cry proteins. The respiration (i.e., CO_2 evolution) of soils cultivated with Bt maize or amended with biomass of Bt maize and other Bt crops was generally lower than from soils

cultivated with or amended with biomass of the respective non-Bt isolines, which may have been a result of differences in chemical composition (e.g., the content of starch, soluble N, proteins, carbohydrates, lignin) between Bt plants and their near-isogenic counterparts. Laboratory and field studies have shown differences in the persistence of the Cry proteins in soil, which appear to be the result primarily of differences in microbial activity, which, in turn, is dependent on soil type (e.g., pH, clay mineral composition, other physicochemical characteristics), season (e.g., temperature, water tension), crop species (e.g., chemical composition, C:N ratio, plant part), crop management practices (e.g., till vs. no-till), and other environmental factors that vary with location and climate zones. This review discusses the available data on the effects of Cry proteins on below-ground organisms, the fate of these proteins in soil, the techniques and indicators that are available to study these aspects, and future directions.

Keywords: Bacillus thuringiensis; cultivos Bt; agrobiotecnología; microorganismos del suelo; OVGMs; resistencia a insectos; suelo, agroecosistema.

El presente y extenso artículo de revisión resume los resultados de numerosos estudios conducidos para determinar los efectos de la proteína Bt derivada de cultivos GM sobre los ecosistemas del suelo (incluyendo microorganismos, procesos y funciones) y la persistencia y destino de las proteínas Bt en el mismo.

Cry1F Protein Not Detected in Soil After Three Years of Transgenic Bt Corn (1507 Corn) Use

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Environ. Entomol. 37(1): 255Ð262 (2008)

To evaluate the potential of *Bacillus thuringiensis* (*Bt*) Cry1F protein accumulation in soil, transgenic corn containing event DAS-01507-1 encoding the *cry1F* gene was grown in three field sites for 3 consecutive yr, and the corn plants were incorporated into the soil through postseason tillage or no tillage each year. Soil samples were collected from these fields, and the level of Cry1F protein in these samples was determined using an enzyme-linked immunosorbent assay (ELISA) with a synthetic invertebrate gut ßuid as an extraction buffer. The ELISA was validated in soil matrices over the concentration range of 18-180 ng/g dry weight, with a limit of detection of 4.5 ng/g dry weight. The assay was shown to have good accuracy and precision. No detectable Cry1F protein was found in any of the soil samples collected from the Cry1F corn fields. Soil also was bioassayed, and no biological activity was observed against *Heliothis virescens* neonates. These results indicate that the level of Cry1F protein accumulated in soil after 3-yr continuous planting of transgenic Cry1F corn is negligible.

Keywords: gen cryIF, proteína CryIF, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental.

En el presente estudio de analizó la persistencia de la proteína Bt del maíz Herculex (proteína Cry1F) en el suelo luego de tres años de cultivo de este material. Los resultados indican que pasado este período no se detecta la proteína tanto por métodos inmunológicos como biológicos (por bioensayos).

Microbial Populations and Enzyme Activities in Soil In Situ under Transgenic Corn Expressing Cry Proteins from *Bacillus thuringiensis*

I. Icoz, D. Saxena, D. A. Andow, C. Zwahlen, G. Stotzky

J. Environ. Qual. 37:647–662 (2008).

Transgenic *Bt* crops produce insecticidal Cry proteins that are released to soil in plant residues, root exudates, and pollen and that may affect soil microorganisms. As a continuation of studies in the laboratory and a plant-growth room, a field study was conducted at the Rosemount Experiment Station of

the University of Minnesota. Three *Bt* corn varieties that express the Cry1Ab protein, which is toxic to the European corn borer (*Ostrinia nubilalis* Hübner), and one *Bt* corn variety that expresses the Cry3Bb1 protein, which is toxic to the corn rootworm complex (*Diabrotica* spp.), and their near-isogenic non-*Bt* varieties were evaluated for their effects on microbial diversity by classical dilution plating and molecular (polymerase chain reaction-denaturing gradient gel electrophoresis) techniques and for the activities of some enzymes (arylsulfatases, acid and alkaline phosphatases, dehydrogenases, and proteases) involved in the degradation of plant biomass. After 4 consecutive years of corn cultivation (2003–2006), there were, in general, no consistent statistically significant differences in the numbers of different groups of microorganisms, the activities of the enzymes, and the pH between soils planted with *Bt* and non- *Bt* corn. Numbers and types of microorganisms and enzyme activities differed with season and with the varieties of corn, but these differences were not related to the presence of the Cry proteins in soil. The Cry1Ab protein of *Bt* corn (events Bt11 and MON810) was detected in most soils during the 4 yr, whereas the Cry3Bb1 protein was not detected in soils of *Bt* corn (event MON863) expressing the *cry3Bb1* gene.

Keywords: gen cryIAb, proteína cryIAb, gen cry3Bb1, proteína cry3Bb1, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental.

En el presente artículo se describen análisis de suelo cultivados con maíces Bt que portan distintos genes (control de lepidópteros y de coleópteros) y de las comunidades bacterianas que los habitan. Los resultados indican que en un período de estudio de cuatro años, no se detectan diferencias en las actividades microbianas del suelo, en tanto que sí se observan diferencias en la detección de la proteína Bt; esto es, se detecta la proteína que controla lepidópteros y no se observa presencia de la que controla coleópteros.

Decomposition of Bt and Non-Bt Corn Hybrid Residues in the Field

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Nutr Cycl Agroecosyst (2008) 80:211–222

Results of a previous laboratory study indicated that six transgenic crops expressing the Cry1Ab insecticidal protein from *Bacillus thuringiensis* (Bt) decomposed at a slower rate than their respective non-Bt isolines. Consequently, litter decomposition rates, nitrogen cycling, and carbon pools may change in agricultural systems as the result of the widespread use of Bt crops. In this study, we assessed the decomposition rates and chemical composition of commonly grown hybrids of Bt and non-Bt isolines of corn (*Zea mays* L.) in the field. Leaves, stalks, and cobs from two Bt corn hybrids (Pioneer 34N44 Bt and NC+ 4990 Bt) and their non-Bt isolines (Pioneer 34N43 and NC+ 4880) were analyzed for biomass fractions (soluble, hemicellulose, cellulose, and lignin) and total C and N content. Litterbags containing these residues were buried at a depth of 10 cm in a Holdrege silt loam (fine-silty, mixed, mesic Typic Argiustolls) soil and recovered 5, 11, 17, and 23 months after placement in the field. There were no differences in the rates of decomposition and mass of C remaining over time between the Bt and non-Bt corn residues. Plant parts differed in decomposition rates where leaves > stalks > cobs. There were differences in total C, total N, biomass fractions, and C:N ratios between initial Bt and non-Bt corn residues, and between companies (NC+ and Pioneer), however, these differences did not result in differences in their rates of decomposition or mass of C remaining over time. For each plant part, there were no differences in lignin content between the Bt and non-Bt residues. These data suggest that the Bt and non- Bt corn hybrids used in this study should not cause differences in carbon sequestration when their residues decompose under similar environmental conditions.

Keywords: descomposición de rastrojos, maíz Bt, biomasa, lignina, celulosa, hemicelulosa

Los objetivos del presente trabajo fueron determinar si los residuos de híbridos Bt y no Bt de maíz tienen diferentes tasas de descomposición, si las concentraciones de fracciones de biomasa, de C total y nitrógeno muestran diferencias, y si estas diferencias se relacionan con la tasa de descomposición.

Los resultados indicaron que no existen diferencias en la tasa de descomposición de maíces Bt y no Bt, contrariamente a lo publicado en alguna publicación anterior.

Earthworms of different functional groups affect the fate of the Bt-toxin Cry1Ab from transgenic maize in soil

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European Journal of Soil Biology 44 (2008) 283 – 289

The fate of the insecticidal Cry1Ab protein from crop residues (leaves and roots) of the transgenic maize variety MON810 was studied in the presence and absence of two earthworm species (*Lumbricus terrestris*, *Aporrectodea caliginosa*; separate incubations) in soil microcosms. The recombinant Cry1Ab protein was quantified using a highly sensitive ELISA. Control microcosms received corresponding non-transgenic plant material. All earthworms survived in the microcosms over a period of 5 weeks, irrespective of whether they received MON810 or non-transgenic plant material. Weight loss was observed for both earthworm species, independent of the plant material or transgenic modification. A strong decline of immunoreactive Cry1Ab in plant residues (mean initial concentration approx. 5000 ng g^{-1}) of MON810 was observed in all treatments, but in microcosms with earthworms this decline was significantly higher with less than 10% of the initial Cry1Ab concentration remaining after 5 weeks. Cry1Ab concentrations in casts were only 0.1% of those found in remaining plant material of the respective microcosms. No immunoreactive Cry1Ab proteins were found in earthworm tissues (threshold of detection: 0.58 ng g^{-1} fresh weight). No further decline was found for Cry1Ab concentrations in casts of *A. caliginosa* during a subsequent period of 3 months of incubation in bulk soil (<0.1 ng g^{-1}) after removal of the earthworms from the microcosms, while in casts of *L. terrestris* the concentration decreased from 0.4 to below 0.1 ng g^{-1}. In conclusion, this study demonstrates that earthworms enhance the decline of immunoreactive Cry1Ab proteins from maize residues.

Keywords: lombrices, maíz Bt, MON810, proteína Cry1Ab, suelo, ELISA

El presente estudio aporta evidencias que las lombrices contribuyen a la degradación de la proteína Bt presente en el suelo, incorporada a través de residuos de plantas GM. Por otro lado, mediante ensayos inmunoreactivos, no se detectó la proteína en los tejidos de los invertebrados.

Cry3Bb1 protein from *Bacillus thuringiensis* in root exudates and biomass of transgenic corn does not persist in soil

Isik Icoz - Guenther Stotzky

Transgenic Res (2008) 17:609–620

The Cry3Bb1 protein, insecticidal to the corn rootworm complex (*Diabrotica spp.*), of *Bacillus thuringiensis* (Bt) *subsp. kumamotoensis* was released in root exudates of transgenic Bt corn (event MON863) in sterile hydroponic culture (7.5 ± 1.12 ng/ml after 28 days of growth) and in nonsterile soil throughout growth of the plants (2.2 ± 0.62 ng/g after 63 days of growth). Kitchawan soil, which contains predominantly kaolinite (K) but not montmorillonite (M), was amended to 3 or 6% (vol./vol.) with K (3K and 6K soils) or M (3M and 6M soils) and with 1, 3, 5, or 10% (wt./wt.) of ground biomass of Bt corn expressing the Cry3Bb1 protein and incubated at 25 ± 2ºC at the –33-kPa water tension for 60 days. Soils were analyzed for the presence of the protein every 7 to 10 days with a western blot assay (ImmunoStrip) and verified by ELISA. Persistence of the protein varied with the type and amount of clay mineral and the pH of the soils and increased as the concentration of K was increased but decreased as the concentration of M was increased. Persistence decreased when the pH of the K-amended soils was increased from ca. 5 to ca. 7 with $CaCO_3$: the protein was not detected after 14 and 21 days in the pH-adjusted 3K and 6K soils, respectively, whereas it was detected after 40 days in the 3K and 6K soils not adjusted to pH 7. The protein was detected for only 21 days in the 3M soil and for 14 days in the 6M soil, which were not

adjusted in pH. These results indicate that the Cry3Bb1 protein does not persist or accumulate in soil and is degraded rapidly.

*Keywords: gen cry3Bb1, proteína Cry3Bb1, ELISA, OVGMs, PCR, maíz transgénico, maíz Bt, exudación radicular, suelo, impacto ambiental, hidroponía, a*rcillas, ph, persistencia

En el presente trabajo se confirma y cuantifica la rizosecresión de la proteína Bt en el evento MON863 de maíz transgénico en suelos con distinto contenido de arcillas. No obstante la detección de la proteína, se concluye que la misma no se acumula en el suelo y que es rápidamente degradada.

Toxins in transgenic crop byproducts may affect headwater stream ecosystems

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PNAS 104 (41): 16204–16208 (2007)

Corn (*Zea mays* L.) that has been genetically engineered to produce the Cry1Ab protein (Bt corn) is resistant to lepidopteran pests. Bt corn is widely planted in the midwestern United States, often adjacent to headwater streams. We show that corn byproducts, such as pollen and detritus, enter headwater streams and are subject to storage, consumption, and transport to downstream water bodies. Laboratory feeding trials showed that consumption of Bt corn byproducts reduced growth and increased mortality of nontarget stream insects. Stream insects are important prey for aquatic and riparian predators, and widespread planting of Bt crops has unexpected ecosystem-scale consequences.

Keywords: maíz Bt, maíz transgénico, ecosistemas acuáticos, impacto ambiental

En el presente artículo se describe un estudio sobre el efecto de la toxina Bt transportada desde los campos cultivados con maíz vía polen, residuos, etc., hacia los arroyos y ríos cercanos. Se analiza la biología de estos ecosistemas acuáticos luego de la introducción de la proteína insecticida.

VI. MIRANDO HACIA EL FUTURO.

Guidance on Principles of Best Practice in the Design of Genetically Modified Plants

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The objective of this guidance is to promote the philosophy of best practice in the genetic modification of plants. This document describes ways in which the construction of GM plants could be approached to simplify the assessment of risks to the environment and to reduce the scope for unidentified hazards as well as identified hazards.
The three main principles of best practice in the design of GM plants are to:
i. Avoid or minimise the inclusion of superfluous transgenes or sequences
ii. Avoid or minimise superfluous expression of the transgene
iii. Avoid or minimise the dispersal of transgenes in the environment
Considering these principles early in the development of a GM plant can help to deal better with risk and uncertainty in evaluating the safety of the plants. For example, by avoiding the inclusion of superfluous DNA sequences in the plant genome their impact does not have to be considered in risk assessments.

Likewise, avoiding expression oftransgenes in parts of the plant where the gene product is not needed will reduce the potential for known or unanticipated effects on non-target organisms.
The philosophy of best practice is meant to be challenging and thought provoking. Some of the ideas could be applied to new projects now whereas other ideas are more speculative but have significant potential. Because the technology moves on quickly, this document will be subject to periodic review.
It is acknowledged that most of the safety concerns expressed about GM crops apply equally well to crops produced by conventional plant breeding, which go largely unregulated. That said, the immediate challenge for the GM regulators is to apply the existing controls over GM crops in a measured and balanced way that is proportionate to risk. Where the risk is uncertain then steps should be taken to reduce that risk to the practicable minimum. ACRE's guidance on the principles of best practice is offered in this spirit.
It is also acknowledged that broader socio-economic and ethical definitions of best practice are important. ACRE has approached best practice from a scientific and technological perspective that is focused on safety. However, this document may provide a useful platform for others more qualified to take the social aspect of the debate forward.

Keywords: liberación de OVGMs, aspectos regulatorios, diseño de OGMs, impacto ambiental

Se trata de una guía elaborada por el Departamento del Ambiente, Alimentos y Asuntos Rurales de Gran Bretaña, que sugiere estrategias de diseño de OGMs que no afecten el ecosistema y minimicen los riesgos sobre el ambiente, y que faciliten los procesos regulatorios.

Hypothesis: Transgene establishment in wild relatives of wheat can be prevented by utilizing the Ph1 gene as a senso stricto chaperon to prevent homoeologous recombination

Sarit Weissmann, Moshe Feldman, Jonathan Gressel
Plant Science 175 (2008) 410–414

Durum and bread wheat need transgenic traits such as herbicide and disease resistance due to recent evolution of herbicide resistant grass weeds and an intractable new strain of stemrust. Transgenic wheat varieties have not been commercialized partly due to potential transgene movement to wild/weedy relatives, which occurs naturally to closely related *Aegilops* and other spp. Recombination does not occur in the F1 hybrid between wheat and its relatives due to the presence of the Ph1 gene on wheat chromosome arm 5BL, which acts as a chaperone, preventing promiscuous homoeologous pairing to similar, but not homologous chromosomes of the wild/weedy species. Thus recombination must occur during backcrossing after the wheat Ph1 gene has been eliminated. Based on these findings, we speculate that Ph1 could be used to prevent gene introgression into weedy relatives. We propose two methods to prevent such transgene establishment: (1) link the transgene in proximity to the wheat Ph1 gene and (2) insert the transgene in tandem with the lethal barnase on any chromosome arm other than 5BL, and insert barstar, which suppresses barnase on chromosome arm 5BL in proximity to Ph1. The presence of Ph1 in backcross plants containing 5BL will prevent the homoeologous establishment of barnase coupled to the desired transgene in the wild population. 5BL itself will be eliminated during repeated backcrossing to the wild parent, and progeny bearing the desired transgene in tandem with barnase but without the Ph1-barstar complex will die.

Keywords: trigo transgénico, impacto ambiental, flujo génico.

En el presente artículo se propone un método que previene el flujo de transgenes de cultivos poliploides como el trigo a sus especies emparentadas. El mismo se basa en ligar el transgen en proximidades del gen Ph1, que evita la recombinación entre especies relacionadas.

Evaluating genetic containment strategies for transgenic plants

David Lee and Ellen Natesan

TRENDS in Biotechnology Vol.24 No.3: 109-114 (2006)

One of the primary concerns about genetically engineered crop plants is that they will hybridize with wild relatives, permitting the transgene to escape into the environment. The likelihood that a transgene will spread in the environment depends on its potential fitness impact. The fitness conferred by various transgenes to crop and/or wild-type hybrids has been evaluated in several species. Different strategies have been developed for reducing the probability and impact of gene flow, including physical separation from wild relatives and genetic engineering. Mathematical models and empirical experimental evidence suggest that genetic approaches have the potential to effectively prevent transgenes from incorporating into wild relatives and becoming established in wild populations that are not reproductively isolated from genetically engineered crops.

Keywords: flujo génico, impacto ambiental, contención de tansgenes, evaluación de riesgo, OVGMs

En el presente artículo se revisan las estrategias desarrolladas para reducir la probabilidad y el impacto de la transferencia de genes de plantas modificadas genéticamente a otras plantas o especies, usando un modelo recientemente desarrollado.

Genetic use restriction technologies (GURTs): strategies to impede transgene movement

Melissa J. Hills, Linda Hall, Paul G. Arnison and Allen G. Good

TRENDS in Plant Science Vol.12 No.4: 177-183 (2007)

No clear consensus has emerged in the debate about the risks posed by transgenic crops and how to assess these risks accurately. In the meantime, interest is growing in strategies to impede transgene movement. This attention is being driven, in part, by expanding interest in using transgenic crops to produce pharmaceutical and industrial products. Potential strategies to impede transgene movement have been published in the scientific literature, and numerous patents have been submitted; however, the efficacy of such strategies has still to be evaluated in a field situation. In this review, we discuss some of the genetic strategies that could be used to restrict the spread of transgenes, although at present many of these technologies are still largely at a theoretical stage of development.

Keywords: flujo génico, impacto ambiental, contención de tansgenes, evaluación de riesgo, OVGMs

En el presente artículo de revisión se discuten las tecnologías desarrolladas para minimizar la transferencia o movimiento de genes de OVGMs a especies relacionadas, limitando el impacto ambiental de la transformación genética. Estas tecnologías, denominadas GURTs (tecnología que restringe el uso genético), consideran varias estrategias que se enfocan detalladamente en el artículo y se enfocan en el movimiento del polen y en la herencia materna de los transgenes, entre otras.

Novel roles for genetically modified plants in environmental protection

Tomas Macek, Pavel Kotrba, Ales Svatos, Martina Novakova, Katerina Demnerova and Martina Mackova

Trends in Biotechnology Vol.26 No.3: 146-152 (2008)

Transgenic plants of environmental benefit typically consist of plants that either reduce the input of agrochemicals into the environment or make the biological remediation of contaminated areas more

efficient. Examples include the construction of species that result in reduced pesticide use and of species that contain genes for either the degradation of organics or the increased accumulation of inorganics. Cutting-edge approaches, illustrated by our own work, focus on the applicability of genetically modified (GM) plants that produce insect pheromones or that are specifically tailored to the phytoremediation of cadmium or PCBs. This paper discusses the role that the next generation of GM plants might play in preventing and reducing chemical contamination and in converting contaminated sites into safe agricultural or recreational land.

Keywords: impacto ambiental, fitorremdiación, agroquímicos, cultivos transgénicos, OVGMs.

Fuera del riesgo ambiental que se discutió en los artículos anteriores, el presente artículo de revisión enfoca el uso de plantas transgénicas como herramienta de protección ambiental. Esta protección está definida desde la disminución de agroquímicos utilizados en los agroecosistemas al diseño de nuevos eventos tendientes a una fitorremediación de los mismos (captura de metales pesados, detoxificación de compuestos orgánicos, etc.).
LECTURA RECOMENDADA.

Crop ferality: Implications for novel trait confinement

M.V. Bagavathiannan, R.C. Van Acker

Agriculture, Ecosystems and Environment 127 (2008) 1–6

Ferality is observed in many crop species wherein individuals of the cultivated crop reproduce successfully and establish a self-perpetuating population in natural or semi-natural habitats. Feral populations can evolve to differ from their parent populations and lose traits associated with domestication including for example, a lack of seed dormancy. Hybridization between wild and cultivated forms of cropped species may facilitate ferality. If GM plants become feral, they can establish populations in natural and semi-natural environments and act as both a source and sink for novel traits. The presence of novel traits may facilitate the persistence of feral populations if the novel trait confers a selective advantage (e.g. drought tolerance, salinity tolerance, pest and disease resistance), but there is no evidence yet that transgenesis per se facilitates ferality. In some cases and in some jurisdictions, the introduction of GM crops will require assurances of effective segregation and novel trait confinement. The existence of feral crop populations can make novel trait confinement more difficult. Monitoring and management of feral populations will be required for effective novel trait confinement.

Keywords: cultivos silvestres, cultivos transgénicos, flujo génico, coexistencia, OVGMs

El objetivo de esta revisión es proveer un background de los cultivos silvestres, la naturaleza de las poblaciones salvajes o silvestres, el rol de los cultivos transgénicos en esa feracidad y los pormenores de los problemas asociados con la ocurrencia de cultivos dedomesticados con respecto al confinamiento de nuevos caracteres. Así, se discute el establecimiento de poblaciones ferales, los caracteres ferales, la feracidad y los cultivos transgénicos, el movimiento y el confinamiento de caracteres ferales de cultivos transgénicos.

CONSIDERACIONES FINALES

En base a la información volcada en el presente informe de prospectiva, resulta interesante destacar las siguientes reflexiones.

1) Las técnicas de cultivo *in vitro* de plantas, del ADN recombinante y de transformación genética de plantas fueron motivo de una fuerte inversión en esfuerzo, tiempo y dinero de muchísimos grupos de investigación a nivel mundial, y están desarrolladas; es decir, llegaron para quedarse y utilizarse.

2) Como toda tecnología, las mismas son neutras en sí; esto es, son sólo tecnologías (en este caso, biotecnologías). Depende de los usuarios el uso que se haga de ellas. El descubrimiento de la radioactividad, por ejemplo, posibilitó el gran desarrollo de la medicina y de la bioquímica durante la segunda mitad del siglo pasado, y al mismo tiempo condujo al desarrollo de la bomba atómica con las consecuencias que conocemos de destrucción en Nagasaki e Hiroshima.

3) Los usuarios de las biotecnologías son concientes que están rediseñando el genoma de las especies que se modifican, y que como toda actividad humana, esto implica asumir riesgos. Los objetivos están dirigidos a mejorar la productividad de las cosechas, mejorar la calidad de los alimentos, proteger el ambiente, utilizar las plantas como fábricas de numerosos compuestos, etc.. La misma tecnología posibilita, mediante su uso, disminuir sus riesgos intrínsecos.

4) Dentro de los riesgos ambientales de los cultivos transgénicos se destacan: i) la generación de nuevas malezas por flujo génico de plantas resistentes a herbicidas hacia especies relacionadas, ii) la aparición de resistencia en malezas controladas por determinados herbicidas como consecuencia de un aumento en la presión selectiva de esos principios activos, iii) la contaminación del suelo y de las napas como consecuencia del uso intensivo de los mismos herbicidas, iv) efectos de tecnologías como la "Bt" sobre insectos no blanco, alterando los ecosistemas, predatores e insectos benéficos, v) generación de resistencia en insectos blanco como consecuencia de un uso intensivo de estas tecnologías, y vi) efectos sobre la biodiversidad de los ecosistmas. En términos generales, no puede afirmarse que estos hechos hayan ocurrido como consecuencia del uso de cultivos transgénicos. Los países adoptantes de estas tecnologías han diseñado sistemas regulatorios dirigidos a realizar una evaluación de estos riesgos antes que el hecho se produzca.

5) Analizando el caso de Argentina:

   - Es importante destacar que el país decidió ser protagonista a nivel mundial respecto de la superficie agrícola destinada al cultivo de OVGMs: ocupa el segundo lugar en el mundo luego de los Estados Unidos, con casi 20 millones de hectáreas. Tiene un sistema regulatorio consistente en un organismo que evalúa el riesgo ambiental (la CONABIA), el riesgo alimentario (el SENASA) y el riesgo comercial (la Secretaría de Agricultura). Los detalles del mismo pueden encontrarse en http://www.sagpya.mecon.gov.ar/new/0-

0/programas/conabia/bioseguridad_agropecuaria2.php. En los artículos "Consecuencias económicas de la transformación agrícola" y "Diez años de cultivos genéticamente modificados en la agricultura argentina" incluidos en este informe pueden observarse los resultados de la adopción de estas agrobiotecnologías.

- Los cultivos aprobados para su comercialización en el país son:
  La soja con resistencia a glifosato (evento 40-3-2), los maíces con resistencia a glifosato (eventos GA21 y NK603), el maíz con tolerancia al glufosinato de amonio (evento T25), los maíces con resistencia a lepidópteros (eventos 176, MON810, Bt11 y TC1507), los maíces con resistencia a glifosato y lepidópteros (eventos con genes apilados: NK603-MON810 y TC1507-NK603), el algodón resistente a lepidópteros (evento MON531) y a glifosato (evento MON1445). Toda la información de las construcciones génicas introducidas y la evolución del OVGM durante el proceso regulatorio puede encontrarse en la página web http://www.agbios.com/dbase.php?action=ShowForm.

- El artículo "Bt protein rhizosecreted from transgenic maize does not acumúlate in soil" contiene información de impacto ambiental de los maíces correspondientes a los eventos 176, MON810 y Bt11 cultivados en Argentina. Tanto estos maíces como el algodón y la soja ya comercializada desde hace más de una década en el país no fueron sujetos de informes de riesgo ambiental como consecuencia de su adopción.

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