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Impact of genetically modified plants on the South African flora

By

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Abstract

The rapid advances of plant biotechnology have led to the production of genetically enhanced plants with altered traits such as resistance to an herbicide or insect. The use of these plants has raised concerns that these crops might pose a risk to agricultural ecosystem. A risk assessment study has therefore been conducted using maize and cotton as examples for South Africa. The aspects that have been considered in this study include a possible transgene transfer from a genetically modified plant carrying a herbicide or insect resistance to wild-type plants, the formation of super-weeds and volunteer-weeds, and the movement of a transgene to cultivated plant species. Information for determining any risk by genetically modified plants was obtained through personal interviews and literature search in libraries and the Internet. As an outcome of the study genetically modified maize can be considered as relatively safe for South Africa whereas cotton with weedy relatives might be more problematic due to the chance of out-crossing, which might require risk limitation strategies reducing a possible gene flow.

SAMEVATTING

Die snelle vooruitgang van plantbiotegnologie het gelei tot die produksie van geneties-verbeterde plante met gewysigde eienskappe soos weerstandbiedendheid teen onkruiddoders en insekte. Die gebruik van geneties gemodifiseerde plante het kommer laat ontstaan dat hierdie gewasse 'n risiko inhou vir die landbou ekosisteem. 'n Risikobepalingstudie is geloods waar mielies en katoen as voorbeelde van Suid-Afrikaanse plante gebruik is. Die aspekte wat in hierdie studie bestudeer is, sluit moontlike transgeniese oordrag vanaf 'n geneties-gewysigde plant wat onkruid- of insekwerende weerstandbiedendheid het na wilde-tipe plante, en die ontstaan van super- en toevallige-onkruide, asook transgeniese oordrag na gekweekte plantspesies. Om die risiko in geneties-gewysigde plante vas te stel is inligting versamel deur persoonlike onderhoude en 'n literatuurstudie te doen in biblioteke en op die Internet. Die navorsingsresultate toon aan dat geneties-gewysigde mielies kan veilig geag word vir gebruik in Suid-Afrika, maar dat katoen en verwante onkruid families problematies mag wees as gevolg van die moontlikheid van uit-kruising. Dit mag die daarstelling van risiko-beperkingstrategieë noodsaak om geen oordrag te voorkom.

Research objectives

Using genetic transformation, researchers have produced transgenic plants with desirable traits such as resistance to an insect or herbicide. Even though it is widely used, many concerns are still being expressed regarding the potential risk associated with genetically modifying crops. The possibility of gene transfer from a genetically enhanced plant expressing a herbicide-resistant gene may, for example, ultimately increase the chance of plant invasion altering interactions in natural communities. It is therefore recommendable to determine the impact of such plants on the environment to ensure the safety of such genetically modified crops.

For this MSc thesis a risk assessment study has been conducted to identify and evaluate the possible risk genetically enhanced maize and cotton plants carrying a herbicide or pest resistance transgene might pose to the South African flora. In particular (1) the possibility of movement of a transgene to a wild population of plants by cross-pollination, (2) the creation of 'super weeds' and (3) the movement of a transgene to cultivated plant species were studied in more detail. The risk assessment study was therefore focused on three primary objectives. These were (1) to collect available data from the literature and Internet about the impact on the flora of genetically modified maize and cotton plants, (2) to evaluate a possible impact of such plants on the South African flora and (3) to provide a possible recommendation for planting of such genetically modified plants in South Africa.

Thesis composition

Chapter 1 of this thesis presents the need for an impact assessment and tries to define the concept 'Impact Assessment'. This chapter also identifies the purpose and outcome of an Impact Assessment and the various definitions of an environmental impact assessment. **Chapter 2** analyses the terminology of biotechnology and genetic modification by transgene insertion and outlines the difference between traditional breeding and genetic modification by plant engineering. It also describes the different techniques used in plant engineering, the current production areas, commercial availability and possible benefits of genetically modified crops. This chapter also explains the different traits of such crops like enhanced herbicide and insect resistance. **Chapter 3** focuses on genetically modified plants and its potential application for Africa. This chapter outlines the current research on genetically modified crops in Africa and also provides information about the benefits of such crops, such as maize and cotton, to developing countries like South Africa. **Chapter 4** focuses on the various risks associated with herbicide and pest-resistant genetically modified crops. This chapter explains the potential risk of spreading a transgene for herbicide resistance to other agricultural crops or weedy relatives. It further outlines the gene flow and the various factors reducing gene flow. This chapter also outlines the possible gene transfer from genetically modified plants to wild species important to South Africa. **Chapter 5** focuses on a survey conducted to collect information about genetically modified plants grown in South Africa including their current use and growth areas. This chapter further describes the results of the survey and the potential risk of genetically modified plants in South Africa, such as out-crossing transferring a resistance gene to cultivated crops and wild relatives of maize and cotton. In **Chapter 6** the **Discussion and conclusion** the possible risk of genetically modified maize and cotton plants for the South African flora is discussed based on the information gained during the study. Furthermore, the possible shortcomings of the South African GMO Act and possible risk limitation strategies are discussed.

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Abbreviations and symbols

Bt	*Bacillus thuringiensis*
DNA	Deoxyribonucleic acid
EIA	Environmental impact assessment
EPA	Environmental protection agency
EPSPS	5-enolpyruvylshikimate-3-phosphate synthase
F1	First filial generation
G	Gossypium
GM	Genetically modified plants
GMO's	Genetically modified organisms
Ha	Hectare
IA	Impact assessment
IRM	Insect resistant management
RR	Round Up Ready
T-DNA	Transfer DNA
Ti	Tumor-inducing
Vir	Virulence
Z	Zea
%	Percentage

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