

# Herbicide-Resistant Crops

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## Abstract

The term herbicide-resistant crops (HRC) (sometimes termed herbicide-tolerant crops) has come to mean crops that have been genetically altered by biotechnology to be resistant to herbicides to which they are normally susceptible. Until the advent of plant biotechnology, selective herbicides were designed to kill important weed species while causing limited injury to major crops. Nonspecific herbicides that kill almost all plant species were used only at times and places where crop injury was not a concern or with complicated application methods that avoided contact with the crop. There was little success in breeding crops for herbicide resistance especially to nonselective herbicides. Crops with genetics altered by biotechnology to impart herbicide resistance now offer the farmer valuable new tools for weed management. During the past few years, herbicide-resistant canola, cotton, maize, and soybeans have been widely adopted in North America and a few countries outside of North America. This technology has had many critics who have pointed out an array of environmental, toxicological, and societal risks.

## CURRENT IMPACT ON WEED MANAGEMENT

The largest segment of the transgenic crop market has been HRCs. Several HRCs are currently available in North America (Table 1). At this time, the most widely utilized HRCs are those that are resistant to two nonselective herbicides, glyphosate (e.g., Roundup®) or glufosinate (e.g., Basta®). Glyphosate-resistant crops in particular have been widely adopted in cotton, soybean, maize, and canola in North America. In 1999, 55 and 37% of the soybean and cotton acreage, respectively, in the United State was planted with glyphosate-resistant varieties. An even larger proportion of the soybean crop in Argentina was glyphosate resistant. The use of glyphosate-resistant maize grew from 950,000 acres in 1998 when it was introduced to 2.3 million acres in 1999. The rapid adoption of glyphosate-resistant crops in the United State (Fig. 1) indicates that farmers find this trait to be very valuable. Other HRCs, such as bromoxynil-resistant cotton (Fig. 1), have been useful in situations with special weed problems. At this time, HRCs are not available to European farmers because of public resistance to their use.

## RISKS AND BENEFITS

Generalities regarding risks and benefits of HRCs are difficult to make, as what is true for one HRC can be quite different for another, and even different for the same crop at another place or time. Furthermore, risks and benefits must

be considered within the context of current and predicted future farming practices. These products are relatively new, and there are relatively few data to support predicted risks and benefits. Nevertheless, an attempt will be made to point out likely potential benefits and risks of particular HRCs. Many of these risks are being considered by regulatory agencies in their regulation of HRCs.

### Benefits and Risks for the Farmer

A major benefit of the HRCs that are resistant to nonselective herbicides (glyphosate and glufosinate) is that the herbicide kills all or almost all weeds. Thus, in these crops, one herbicide can substitute for several selective herbicides that were needed to manage an array of weed species. Furthermore, glufosinate and glyphosate are used as foliar sprays after the weeds have appeared. Theoretically, the farmer can avoid prophylactic herbicide treatments and only rely on the nonselective herbicide after the weed problem appears. Some weed species, however, require relatively high rates of glyphosate for adequate control. In these cases, farmers are finding that the most efficacious weed management with glyphosate-resistant crops sometimes requires use of a selective herbicide with glyphosate.

Perhaps one of the most attractive features of being able to apply nonselective herbicides directly on the crop is that it greatly simplifies weed management, eliminating or reducing the need for tilling, for applying preemergence herbicides, and for decisions as to which selective postemergence herbicides should be used. Management simplicity favors

# Herbicide Resistant Weed Management In World Grain Crops

**Yeqiao Wang**



## **Herbicide Resistant Weed Management In World Grain Crops:**

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**Weed Science and Weed Management in Rice and Cereal-Based Cropping Systems, 2 Volumes** Aurora M. Baltazar, Surajit K. De Datta, 2023-03-29 The book presents discussions on the biology and ecology of major troublesome weeds infesting rice, wheat, corn, and soybean, focusing on different cropping patterns in both tropical and temperate cropping systems and science-based weed management practices involving chemical, non-chemical, biological, and integrated methods. Herbicides used with their most recent classification, identification of new target sites, mechanisms, and modes of action, and how and why weeds evolve resistance to herbicides. New concepts, new

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Encyclopedia of Plant and Crop Science (Print) Robert M. Goodman, 2004-02-27 Encyclopedia of Plant and Crop Science is the first ever single source reference work to inclusively cover classic and modern studies in plant biology in conjunction with research applications and innovations in crop science and agriculture From the fundamentals of plant growth and reproduction to developments in agronomy and agricultural science the encyclopedia's authoritative content nurtures communication between these academically distinct yet intrinsically related fields offering a spread of clear descriptive and concise entries to optimally serve scientists agriculturalists policy makers students and the general public ALSO AVAILABLE ONLINE This Taylor Francis encyclopedia is also available through online subscription offering a variety of extra benefits for both researchers students and librarians including Citation tracking and alerts Active reference linking Saved searches and marked lists HTML and PDF format options For more information visit Taylor and Francis Online or contact us to inquire about subscription options and print online combination packages US Tel 1 888 318 2367 E mail e reference taylorandfrancis com International Tel 44 0 20 7017 6062 E mail online sales tandf co uk Integrated weed management for sustainable agriculture Professor Emeritus Robert L. Zimdahl, 2017-12-14 Summarises latest research on IWM principles and methods Assesses current challenges facing herbicide use Detailed review of the range of cultural physical and biological methods of control available for IWM Wheat Brett F. Carver, 2009-06-23 Wheat Science and Trade is an up to date comprehensive reference work designed to expand the current body of knowledge on this staple crop incorporating new information made available by genetic advances improvements in the understanding of wheat's biology and changes in the wheat trade industry Covering phylogeny and ontogeny manipulation of the environment and optimal management genetic improvement and utilization and commercialization the book focuses on the most economically significant diseases and impacts **Are Superweeds an Outgrowth of USDA Biotech Policy?** United States. Congress. House. Committee on Oversight and

Government Reform. Subcommittee on Domestic Policy,2011

**Weed Management Handbook** Robert E. L.

Naylor,2008-04-15 Weed Management Handbook updates the 8th edition of Weed Control Handbook 1990 The change in the title and contents of the book from previous editions reflects both the current emphasis on producing crops in a sustainable and environmentally friendly manner and the new weed management challenges presenting themselves This landmark publication contains cutting edge chapters each written by acknowledged experts in their fields and carefully drawn together and edited by Professor Robert Naylor known and respected world wide for his knowledge of the area The sequence of chapters included reflects a progression from the biology of weeds through the underpinning science and technology relating to weed management techniques including herbicides and their application to crops leading to principles of weed management techniques Finally a set of relevant case studies describes the main management options available and addresses the challenges of reduced chemical options in many crops Weed Management Handbook is a vital tool for all those involved in the crop protection agrochemical industry including business managers horticultural and agricultural scientists plant physiologists botanists and those studying and teaching BASIS courses As an important reference guide for undergraduate and postgraduate students studying horticultural and agricultural sciences plant physiology botany and crop protection copies of the book should be available on the shelves of all research establishments and universities where these subjects are studied and taught Weed Management Handbook is published for the British Crop Protection Council BCPC by Blackwell Publishing

**Achieving sustainable cultivation of soybeans Volume 2** Prof. Henry T. Nguyen,2018-02-20

Detailed coverage of oomycete fungal viral and bacterial diseases affecting soybeans Reviews developments in disease and pest resistant varieties as well as integrated pest and weed management Summarises research on developing food and non food uses from improving nutritional properties to uses in animal feed and biodiesel

*Biology, Physiology and Molecular Biology of Weeds* Mithila Jugulam,2017-07-12 The book provides comprehensive information on a wide range of topics from biology physiology genetics to the use of genomic tools in weed science The book covers information at a more advanced level than the previously published books in weed science It covers not only weed genetics and genomics research but also weed management from an ecological perspective Furthermore the book also gives a broad coverage of novel mechanisms of weed resistance to herbicides More importantly it includes next generation sequencing techniques and bioinformatics of herbicide resistant genes in weeds

**Weed Research** Paul E. Hatcher,Robert J. Froud-Williams,2017-05-24 This book presents the most up to date and comprehensive guide to the current and potential future state of weed science and research Weeds have a huge effect on the world by reducing crop yield and quality delaying or interfering with harvesting interfering with animal feeding including poisoning reducing animal health and preventing water flow They are common across the world and cost billions of dollars worth of crop losses year on year as well as billions of dollars in the annual expense of controlling them An understanding of weeds is vital to their proper management and control without which the reduction in

crop yields that they would cause could lead to mass starvation across the globe Topics covered include weed biology and ecology control of weeds and particular issues faced in their control Authored and edited by internationally renowned scientists in the field all of whom are actively involved in European Weed Research Society working groups this succinct overview covers all the relevant aspects of the science of weeds Weed Research Expanding Horizons is the perfect resource for botanists horticultural scientists agronomists weed scientists plant protection specialists and agrochemical company personnel

Encyclopedia of Environment and Society Paul Robbins, 2007-08-27 As befits the topic this beautifully packaged wonderfully illustrated interdisciplinary resource has more than 1200 entries written by specialists A helpful reader's guide groups topics like agriculture conservation and ecology movements and regulations politics pollution and society A resource guide chronology glossary and list of the UN's economic indicators complete the set Library Journal this important work gives a well focused snapshot of environmentalism in the early 21st Century and it will remain valuable into the future both for its content and as a yardstick to measure progress toward sustainability and conservation Summing Up Recommended Undergraduates and general readers CHOICE Booklist Editors Choice 2008 This superb interdisciplinary work should find a place on the shelves of every public and academic library that has the least bit of interest in environment issues which should mean just about all Booklist Starred Review Where does the environment leave off and society begin When expanding production and consumption drives greenhouse gas emissions that warm the planet which in turn influence the conditions of economic expansion it is unclear where the climate ends and the economy begins This fact is not new to our era however our social and natural sciences have only recently come to grips with the incredible complexity of the world described by understanding the environment and society as being of a piece As a result in the last decade there has been an unprecedented explosion of new concepts theories facts and techniques that follow from such an understanding The Encyclopedia of Environment and Society brings together multiplying issues concepts theories examples problems and policies with the goal of clearly explicating an emerging way of thinking about people and nature With more than 1 200 entries written by experts from incredibly diverse fields this innovative resource is a first step toward diving into the deep pool of emerging knowledge The five volumes of this Encyclopedia represent more than a catalogue of terms Rather they capture the spirit of the moment a fascinating time when global warming and genetic engineering represent only two of the most obvious examples of socio environmental issues Key Features Examines many new ideas about how the world works what creates the daunting problems of our time and how such issues might be addressed whether by regulation markets or new ethics Demonstrates how theories of environmental management based on market efficiency may not be easily reconciled with those that focus on population and both may certainly diverge from those centering on ethics justice or labor Offers contributions from experts in their fields of specialty including geographers political scientists chemists anthropologists medical practitioners development experts and sociologists among many others Explores the emerging socio

environmental problems that we face in the next century as well as the shifting and expanding theoretical tools available for tackling these problems Covers regions of North America in greater detail but also provides a comprehensive picture that approaches as effectively as possible a cohesive global vision Key Themes Agriculture Animals Biology and Chemistry Climate Conservation and Ecology Countries Geography History Movements and Regulations Organizations People Politics Pollution Society Packed with essential and up to date information on the state of the global socio environment the Encyclopedia of Environment and Society is a time capsule of its historic moment and a record of where we stand at the start of the 21st century making it a must have resource for any library These inspiring volumes provide an opportunity for more new ways of thinking behaving and living in a more than human world **Modern Crop Protection Compounds, 3**

**Volume Set** Wolfgang Krümer,Ulrich Schirmer,Peter Jeschke,Matthias Witschel,2012-01-17 This one stop reference for everyone working in the agrochemical business is the leading reference in the field with first class authors from all major crop protection companies including Bayer Dow Syngenta and BASF In three volumes one each on herbicides fungicides and insecticides it provides up to date information on the chemical properties mode of action range of application industrial scale synthesis and commercial products The new edition has been updated and expanded by more than 50 new compounds and their mechanisms for a complete picture of agrochemicals introduced since 1990 A truly comprehensive source of top quality information **The Triazine Herbicides** Janis Mc Farland Ph.D.,Orvin Burnside Ph.D.,2011-08-19 Over the past 50 years triazines have made a great impact on agriculture and world hunger by assisting in the development of new farming methods providing greater farming and land use capabilities and increasing crop yields Triazines are registered in over 80 countries and save billions of dollars a year The Triazine Herbicides is the one book that presents a comprehensive view of the total science and agriculture of these chemicals With emphasis on how the chemicals are studied and developed reviewed and used at the agricultural level this book provides valuable insight into the benefits of triazine herbicides for sustainable agriculture Presents previously unpublished information on the discovery development and marketing of herbicides Includes a vital section on the origin use economics and fate of triazine herbicides Covers benefits of triazines in corn and sorghum sugarcane citrus fruit and nut crops Establishes best management practice and environmental benefits of use in conservation tillage

**Rice Production Worldwide** Bhagirath S. Chauhan,Khawar Jabran,Gulshan Mahajan,2017-02-16 This book addresses aspects of rice production in rice growing areas of the world including origin history role in global food security cropping systems management practices production systems cultivars as well as fertilizer and pest management As one of the three most important grain crops that helps to fulfill food needs all across the globe rice plays a key role in the current and future food security of the world Currently no book covers all aspects of rice production in the rice growing areas of world This book fills that gap by highlighting the diverse production and management practices as well as the various rice genotypes in the salient rice producing areas in Asia Europe Africa the Americas and Australia Further this text highlights



harvesting threshing processing yields and rice products and future research needs Supplemented with illustrations and tables this text is essential for students taking courses in agronomy and production systems as well as for agricultural advisers county agents extension specialists and professionals throughout the industry *Weeds* Bruce Archibald Auld, Richard William Medd, 1987 Reprint of a reference book first published in 1987 Lavishly illustrated it contains detailed descriptions of all the important weeds of Australia Suitable for primary producers students agricultural advisers and research workers

**Sustainable Agriculture** R.S. Meena, 2019-01-01 The book promotes the study and application of the agro ecology for developing alternatives to the complex problems of resource depletion environmental degradation a narrowing of the agrobiodiversity consolidation and industrialization of the food system climate change and the loss of farmland This book covers food systems approaches and seek experiences in an ecofriendly that are on farm participatory change oriented and backed by broad based methodologies for sustainability analysis and evaluation The objectives of this book are 1 to understand the role sustainable agricultural productivity and its importance to the sustainable soil management 2 to restore the soil health to transforming agriculture for sustainability and 3 to understand the matching of management rules in the climatic perspective

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sauvage l aspect extérieur des lapins domestiques peut toutefois varier considérablement selon les races sélectionnées par les éleveurs et l animal se démarquer du lapin de garenne tant par sa taille puisqu il existe des races dites

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