




Article

Effects of Fungicides and Nontarget Pesticides on Accumulation of the Mycotoxin Deoxynivalenol in Wheat

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Abstract: Deoxynivalenol (DON) is an important virulence factor of the *Fusarium* head blight of wheat and threatens the health of humans. The effect of fungicides on DON production after stressing wheat to produce H₂O₂ and the effect of nontarget pesticides on DON accumulation are largely unknown. Five pesticides were selected to explore the effect of pesticide-induced oxidative stress on DON production in vitro and in vivo. Epoxiconazole and hexaconazole significantly induced an increase in H₂O₂ in vitro, and H₂O₂ further stimulated the production of DON and the expression of the Tr5 gene. Imidacloprid, isoproturon, and mesosulfuron-methyl had no direct effect in vitro. All pesticides activated the activities of superoxide dismutase, catalase, and peroxidase in wheat and caused the excessive accumulation of H₂O₂. However, excessive H₂O₂ did not stimulate the accumulation of DON. Imidacloprid indirectly stimulated the production of DON in vivo, which may be due to its impact on the secondary metabolism of wheat. In brief, pesticide-induced H₂O₂ in vitro is an important factor in stimulating DON production, but the stressed physiological H₂O₂ in wheat is not sufficient to stimulate DON production. The bioaccumulation results indicated that imidacloprid and epoxiconazole increase the risk of DON contamination, especially under field spraying conditions.

Keywords: deoxynivalenol; *Fusarium graminearum*; wheat; H₂O₂; pesticides; in vitro; in vivo



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1. Introduction

Fusarium head blight (FHB), which is mainly caused by *Fusarium graminearum*, is a devastating disease in wheat (*Triticum aestivum* L.) [1]. In addition to causing a serious loss of wheat yield, this pathogen can also produce a variety of trichothecene mycotoxins during infection, such as deoxynivalenol (DON), acetyl deoxynivalenol (15-ADON and 3-ADON), and nivalenol [2]. Among these mycotoxins, DON has been confirmed to be the dominant and most common mycotoxin, and can reduce the defense mechanisms of wheat plants and aggravate FHB epidemics [2–4]. Because DON can inhibit DNA, RNA, and protein synthesis and impair the immune response of humans and animals [5], the excessive consumption of DON-contaminated wheat can cause symptoms such as vomiting, diarrhea, anemia, growth retardation, and even spermatogenesis disorders [6,7]. The FAO and WHO also list DON as one of the most dangerous natural food contaminants [8]. In China, the relative contamination of wheat by DON and its products in different regions is much higher than that of other mycotoxins, with detection rates ranging from 58.7% to 97.2%, exceeding rates (>1000 µg kg^{−1}) ranging from 4.6% to 70%, and maximum detection concentrations reaching 3030 µg kg^{−1} to 56,100 µg kg^{−1} [9–13]. In addition, DON has a

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Nontarget Effects of Agricultural Fungicides Subhash C. Vyas,1988-04-30 Phylloplane microflora Plant nutrition and physiological and biochemical processes Growth yield and other characteristics of plants Mechanism of phytotoxic effects of fungicides on plants Iatrogenic diseases Virus and viral diseases Air Pollutants Phytotoxicity Soil microorganisms and their activities Rhizosphere microflora Mycorrhizae Algae Rhizobia and root nodulation Biocontrol agents Fungicide induced host resistance Fungicides with their coined formulated and chemical names and manufacturer *Non-Target Effects of Pesticides on Organisms Inhabiting Agroecosystems* Johann G. Zaller,Carsten A. Brühl,2019-10-17 Pesticide usage is increasing worldwide and considered among the main factors contributing to the global decline in biodiversity This Research Topic provides an overview of the state of knowledge regarding non target effects of herbicides fungicides insecticides and rodenticides on a variety of ecosystem functions and organisms Taxa covered in the contributions include algae amphibians aquatic fungi aquatic insects bats bumblebees butterflies earthworms enchytraeids honeybees plants rodents and soil microorganisms The papers also highlight many gaps in our understanding of non target effects of pesticides and their consequences for biodiversity and functions of various ecosystems Overall it became clear that priorities for future work on pesticides and their effects should more focus on investigating or simulating realistic field situations i e multiple applications of pesticides during the growing season including their temporal and spatial interactions with fauna and flora **Pesticide Interactions in Crop Production** J. Altman,2018-01-18 Pesticide Interactions in Crop Production Beneficial and Deleterious Effects evaluates the effects of pesticides on plants by exploring the physical chemical biological and ecological interactions of pesticides that influence a crop The effects of pesticides on the environment and on the crop pests themselves are considered as well Specific topics addressed include iatrogenic responses the fate of pesticides applied to cereals under field conditions the persistence of pesticides on target crops the effect of pesticides on soil symbionts and the role of ecological agriculture on conventional and organic cropping systems Pesticide Interactions in Crop Production Beneficial and Deleterious Effects will be an important volume for agriculturalists phytologists mycologists soil biologists plant pathologists tropical ecologists arboriculturalists and other researchers interested in the effects of pesticides on crops and soil

Ecological Effects of Pesticides on Non-target Species David Pimentel,1971 Ecological Effects of Pesticides on Non-target Species; Executive Office of the President, June 1971 United States. Science and Technology Office,1971

Fungicides in Practice Richard P. Oliver,Janna L. Beckerman,2022-07-13 This is an up to date guide on the science and practice of disease control based on fungicides in horticulture and broad acre agriculture It describes how conventional organic and biological fungicides are discovered how they work and how resistance evolves Chapters on formulation mode of action mobility and application inform decisions about which fungicides to use when to use them and how to rotate or tank mix them to manage both plant disease and fungicide resistance A chapter on experimental design of fungicide trials aids

practitioners in designing their own trials to evaluate how effective products are for their plant disease problem Based on the successful 2014 book of Fungicides in Crop Protection this edition has four entirely new chapters and extensive updates to the other nine chapters Written for crop protection professionals and scientists growers agronomists and consultants the book is also suitable for students of agriculture and agronomy **Basic Plant Pathology Methods** James B. Sinclair, Onkar Dev Dhingra, 2017-11-22 The Second Edition of this bestseller brings together basic plant pathology methods published in diverse and often abstract publications The Second Edition is updated and expanded with numerous new figures new culture media and additional methods for working with a greater number of organisms Methods are easy to use and eliminate the need to seek out original articles This reference allows for easy identification of methods appropriate for specific problems and facilities Scientific names of pathogens and some of their hosts are updated in this edition The book also acts as a research source providing more than 1 800 literature citations The Second Edition includes chapters on the following Sterilization of culture apparatus and culture media Culture of pathogens with detailed techniques for 61 fungi and selected bacteria Long term storage of plant pathogens Detection and estimation of inoculum for 28 soilborne fungal pathogens and 5 bacterial genera 15 methods for airborne inoculum and 13 methods for seedborne pathogens Establishment of disease and testing for disease resistance Work with soil microorganisms Fungicide evaluation Biological control Bright field microscopy

Handbook of Applied Mycology Dilip K. Arora, 1991-03-01 This first volume in a new series emphasizes the role of fungi in the fertility of soil and plant yield covering such topics as biodegradation of plant litter and pesticides microbial interactions mycorrhizal symbionts and mathematical modeling of diseases Major sections treat mycorrhizae and e **Climate Change, Intercropping, Pest Control and Beneficial Microorganisms** Eric Lichtfouse, 2009-09-23 Sustainable agriculture is a rapidly growing field aiming at producing food and energy in a sustainable way for humans and their children Sustainable agriculture is a discipline that addresses current issues such as climate change increasing food and fuel prices poor nation starvation rich nation obesity water pollution soil erosion fertility loss pest control and biodiversity depletion Novel environmentally friendly solutions are proposed based on integrated knowledge from sciences as diverse as agronomy soil science molecular biology chemistry toxicology ecology economy and social sciences Indeed sustainable agriculture decipher mechanisms of processes that occur from the molecular level to the farming system to the global level at time scales ranging from seconds to centuries For that scientists use the system approach that involves studying components and interactions of a whole system to address scientific economic and social issues In that respect sustainable agriculture is not a classical narrow science Instead of solving problems using the classical painkiller approach that treats only negative impacts sustainable agriculture treats problem sources Because most actual society issues are now intertwined global and fast developing sustainable agriculture will bring solutions to build a safer world This book series gathers review articles that analyze current agricultural issues and knowledge then propose alternative solutions It will therefore help all scientists

decision makers professors farmers and politicians who wish to build a safe agriculture energy and food system for future generations

Insecticides–Soil Microbiota Interactions Naga Raju Maddela,Kadiyala Venkateswarlu,2017-10-04 This book provides information about the nontarget nature of selected soil enzymes which are implicated in soil fertility and health and the methods for their assay It also shows how these soil enzymes are affected by two different pesticides buprofezin and acephate used both extensively and intensively in modern agriculture

Biological Control Roy Van Driesche,Thomas S. Bellows Jr.,2012-12-06 This text provides readers with an in depth exploration of how biological control functions and how it can be safely employed to solve pest problems and enhance nature conservation It covers the principles behind biological control techniques and their implementation and incorporates practical examples from the biological control of a variety of pests It contains detailed chapters on conserving natural enemies through environmental management importation of new natural enemies for control of pests augmentation of natural enemies through rearing and release and the development and application of pathogens and biopesticides

Environmentally Safe Approaches to Crop Disease Control Jack E. Rechcigl,2018-01-18 The use of chemicals in agriculture and home gardens has become an area of concern due to improper use and negative environmental effects Environmentally Safe Approaches to Crop Disease Control addresses alternative approaches for managing crop diseases It gives a balanced overview of state of the art environmentally safe approaches to crop disease control and discusses the latest trends

Microbial Ecology of Soil and Plant Growth Pierre Davet,2004-01-11 The book is divided into three parts that are logically connected The first part defines the principal characteristics of the subterranean world and describes the microorganisms that live there as well as the environmental constraints they are subjected to The second part shows how the action of the microorganisms can modify the physico chemical

Bibliography of Agriculture with Subject Index ,1993-10

Mycorrhizal Biology K.G. Mukerji,B.P. Chamola,Jagjit Singh,2012-12-06 The fundamental problem the world faces today is the rapidly increasing pressure of population on the limited resources of the land To meet the ever increasing demands of expanding populations agricultural production has been raised through the abundant use of inorganic fertilizers the adoption of multicropping systems and liberal application of chemical pesticides fungicides bactericides etc Though the use of chemicals has increased the yield dramatically it has also resulted in the rapid deterioration of land and water resources apart from wastage of scarce resources This has adversely affected the biological balance and lead to the presence of toxic residues in food soil and water in addition to imposing economic constraints on developing countries From the Preface Mycorrhizal Biology addresses the global problem of land degradation and the associated loss of soil productivity and decline in soil quality caused by exploitative farming practices and poor management in developing countries and the far reaching socio economic and ecological consequences of its impact on agricultural productivity and the environment In the light of a need for sustainable development a new system of productive agriculture to ensure the efficient management of agricultural inputs for long term high crop productivity with minimum damage to the

ecological and socio economic environment is essential The management of mycorrhizal fungi will form a significant part of such a system and this work investigates the key association of plant roots with mycorrhizal fungi known to benefit plants under conditions of nutritional and water stress and pathogen challenge and analyses the developments in our understanding of the genetic loci that govern mycorrhiza formation *Impact of Xenobiotic Chemicals on Microbial Ecosystems* American Society for Microbiology. Applied and Environmental Microbiology Division. Meeting,1982 *Modern Selective Fungicides* Horst Lyr,1995 **Nanofungicides** Kamel A Abd-Elsalam,2023-11-21 Nano and Nanohybrid Fungicides Novel Applications in Plant Pathology addresses nanofungicides and the opportunities that nano agrochemicals can provide Organized into three parts this book addresses the synthesis and formulation of nanofungicides and nanohybrid fungicides as well as their sensing degradation and commercialization Furthermore the book assesses the potential hazards and safety of nanofungicides for agroecosystems in addition to startup patents regulatory concerns and prospects Plant scientists plant pathologist agriculture and food scientists and professionals and students working in related fields will all benefit from this timely resource Explains the synthesis or biosynthesis of nanofungicides Determines the active ingredients of nanofungicides Describes the applications of nanofungicides in plant disease control and crop protection Explores the mechanisms of antifungal activity

Agrochemicals: Advances in Research and Application: 2011 Edition ,2012-01-09 Agrochemicals Advances in Research and Application 2011 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Agrochemicals The editors have built Agrochemicals Advances in Research and Application 2011 Edition on the vast information databases of ScholarlyNews You can expect the information about Agrochemicals in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Agrochemicals Advances in Research and Application 2011 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at <http://www.ScholarlyEditions.com>

Agrochemicals in Plant Disease Management N.G. Ravichandra,2018-08-01 The book is fabricated exclusively for M Sc Agri and Ph D degree programmes in Plant Pathology for all the universities of Agriculture Horticulture Forestry Sericulture and the related streams of Botany Chemicals in Plant Disease Management is a compulsory subject in several degree programmes The present book solely caters to the students of Plant Pathology as it covers a wide range of topics related to chemicals used to control plant diseases viz Agrochemicals used in plant disease management Current scenario History and development of agrochemicals Formulations application and phytotoxicity of agrochemicals Classification and modes of action of agrochemicals Registration and regulation of agrochemicals Safe handling and use of agrochemicals Compatibility and persistence of agrochemicals Pollution and hazards by agrochemicals and New generation fungicides Special Features

There has been a gap of 30 years since the publication of a book on the subject addressed here therefore this book makes a novel appearance on Agrochemicals in recent times Presently there is no book available in the market covering the whole syllabus prescribed by the ICAR on Agrochemicals To meet this requirement the book is designed to cover the entire syllabus prescribed by the ICAR for the courses in P G programmes on Plant Pathology Recent developments in chemicals used in Plant Disease Management have been added updated and presented in a detailed manner Serviceable Tables Illustration Figures and Data are provided for an effective understanding of both the students and the faculty Appendices on Read the Label and Preparation of spray volume are provided Detailed Glossary of key words used has been given for important and frequently occurring topics Exhaustive Bibliography for further reading is also provisioned Since the book is first of its kind it is highly recommended for the students faculty policy makers private and government pesticide industries NGO s State Government Departments of Agriculture Horticulture Forestry and Sericulture Apart from the students appearing for U G P G Entrance Examinations in various Universities several competitive examinations such as ARS NET SRF JRF IAS KAS progressive farmers and planters and Seed companies are also expected to be benefited by the book

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