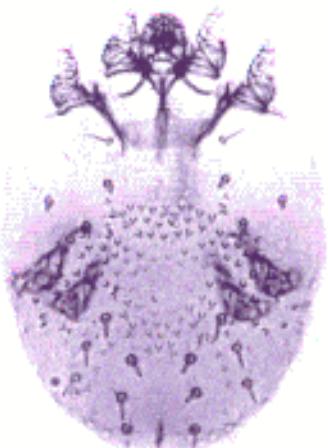




# **Encyclopedia of Pest Management**

edited by  
**David Pimentel**



# Contents

Acaricides / Douglas Walsh .....	1
Acute Human Pesticide Poisonings / E. D. Richter .....	3
Aerial Application / Ian P. Craig, Nicholas Woods and Gary J. Dorr .....	7
Airblast Sprayers / Andrew Landers .....	11
Allelochemicals / John H. Borden .....	14
Allergenic Reactions to Pesticides and Pests / Alicia Armentia .....	18
Antagonistic Plants / Philip Oduor Owino .....	21
Aquatic Weed Control With Herbicides / Joanna Davies .....	24
Areawide Pest Management / Marcos Kogan .....	28
Arthropod Host Plant Resistant Crops / Gerald Wilde .....	33
Augmentative Controls / Kent M. Daane, Nicholas J. Mills and Maurice J. Tauber .....	36
Auxiliaries: Deodorants, Diluents, Solvents, Stickers, Surfactants, and Synergists / Peter Messenger .....	39
Bacterial Endophytes / Chris P. Chanway .....	43
Banding of Pesticides / Sharon A. Clay .....	47
Bioaccumulation / Tomaz Langenbach .....	50
Biofertilizers / J. Renato de Freitas .....	54
Biological Control of Insects and Mites / Ann E. Hajek .....	57
Biological Control of Nematodes / Simon Gowen .....	61
Biological Control of Plant Pathogens (Fungi) / Timothy Paulitz .....	64
Biological Control of Plant Pathogens (Viruses) / Hei-Ti Hsu .....	68
Biological Control of Vertebrates / Peter Kerr .....	71
Biological Control of Weeds (Insects and Mites) / Peter Harris .....	74
Biological Control of Weeds (Microbes) / Karen L. Bailey, and Susan M. Boyetchko .....	77
Biological Control Successes and Failures / Heikki Hokkanen .....	81
Biopesticides / Gavin Ash .....	85
Bioremediation / Ragini Gothwal and P.S. Bisen .....	89
Biotic Community Balance Upsets / David P. Kreutzweiser .....	94
Bird Damage and Control / James J. Matee .....	98

Bird Impacts / <i>Pierre Mineau</i> .....	101
Birds in Pest Management / <i>M.L. Avery</i> .....	104
Botanicals / <i>Bhupinder P.S. Khambay</i> .....	107
Cancers From Pesticides / <i>Jan Dich</i> .....	109
Canopy Management / <i>Victor O. Sadras</i> .....	112
Cattle Pest Management (Arthropods) / <i>Carl J. Jones</i> .....	115
Centers of Origin / <i>Amor Yahyaoui</i> .....	120
Chagas' Disease / <i>Jorge Rabinovich</i> .....	123
Chemical Sex Attractants / <i>Wendell L. Roelofs</i> .....	126
Chronic Human Pesticide Poisonings / <i>Birgitta Kolmodin-Hedman</i> .....	130
Compatibility of Chemical and Biological Pesticides / <i>Barbara Manachini</i> .....	134
Conservation of Biological Controls / <i>Douglas Landis and Steve Wratten</i> .....	138
Conservation of Natural Enemies / <i>Cetin Sengonca</i> .....	141
Control of House Flies and "Filth" Flies / <i>Tove Steenberg and Jørgen B. Jespersen</i> .....	144
Controlled Droplet Application / <i>G.A. Matthews</i> .....	148
Cosmetic Standards (Blemished Food Products and Insects in Foods) / <i>Kelsey A. Hart and David Pimentel</i> .....	152
Cover Crops / <i>Zeyaur R. Khan</i> .....	155
Crop Covers for Weed Suppression / <i>Fred Thomas</i> .....	159
Crop Diversity for Pest Management / <i>Marianne Karpenstein-Machan and     Maria Finckh</i> .....	162
Crop Pest Control Consultants / <i>Marjorie A. Hoy</i> .....	166
Crop Rotations (Insects and Mites) / <i>Michael E. Gray</i> .....	169
Crop Rotations (Plant Diseases) / <i>Jeffrey P. Wilson</i> .....	172
Cultural Controls / <i>B. Rajendran</i> .....	174
Cure (Therapeutics) / <i>Larry P. Pedigo</i> .....	179
Dairy Pest Management (Arthropods) / <i>Phillip E. Kaufman</i> .....	181
Decision Making / <i>Leon G. Higley and Robert K.D. Peterson</i> .....	184
Deer Damage and Control / <i>Paul D. Curtis</i> .....	187
Deposition / <i>G.A. Matthews</i> .....	190
Dispersal of Plant Pathogens / <i>Paul D. Hildebrand</i> .....	193
Disposal of Pesticides and Pesticide Containers / <i>Nancy Fitz and Jude Andreasen</i> .....	197
Domestic Animal Impacts / <i>D. Swarup</i> .....	201
Dormant Treatments / <i>Frank G. Zalom</i> .....	204
Durable Resistance in Crops to Pests / <i>Angharad M.R. Gatehouse</i> .....	207
Ecological Aspects of Pest Management / <i>David J. Horn</i> .....	211
Ecological Causes of Pest Outbreaks / <i>Mark D. Hunter</i> .....	214
Ecological Role of Pests / <i>Douglas A. Landis and Deborah A. Neher</i> .....	218
Economic and Social Aspects of Pest Management / <i>Frederick H. Buttel</i> .....	221
Economic Benefits of Pest Management / <i>Rajinder Peshin</i> .....	224
Economic Decision Levels / <i>Robert K.D. Peterson and Leon G. Higley</i> .....	228
Effects of Pesticides / <i>Ana María Evangelista de Duffard</i> .....	231
Effects of Transgenic (Bt) Crops On Natural Enemies / <i>Salvatore Arpaia</i> .....	234
Environmental and Economic Costs of Pesticide Use / <i>Kelsey A. Hart and     David Pimentel</i> .....	237
Environmental Controls / <i>Jeffrey A. Lockwood</i> .....	240
Environmental Impacts of the Release of Genetically Modified Organisms / <i>Sheldon Krimsky</i> .....	243
Eradication of Pests / <i>Alexei Sharov</i> .....	247
Ethical Aspects of Biotechnology / <i>Kathrine Hauge Madsen and Peter Sandøe</i> .....	250
Ethical Aspects of Pesticide Use / <i>Hugh Lehman</i> .....	253
Fallows / <i>Les Robertson</i> .....	257
Federal Insecticide, Fungicide, and Rodenticide Act / <i>Michael E. Gray</i> .....	261

Fertilizer Nutrient Management / Joseph M. DiTomaso and Carl A. Bruice .....	263
Field Crop Pest Management (Insects and Mites) / Steve Wratten and Geoff Gurr.....	266
Field Crop Pest Management (Plant Pathogens) / Paul Vincelli.....	270
Field Crop Pest Management (Weeds) / Doug Derksen.....	274
Flame Weeding in Corn / Gilles D. Leroux.....	276
Fleas / Rory Karhu and Stanley Anderson .....	280
Flooding (Weed Control in Rice) / Alan K. Watson .....	283
Food Contamination with Pesticide Residues / Denis Hamilton .....	286
Food Laws and Regulations / Ike Jeon .....	290
Food Quality Protection Act / Christina DiFonzo .....	293
Forecasting Pest Outbreaks / Roland Sigvald .....	295
Forest Losses to Pest Insects/Mites and Plant Pathogens / Richard S. Hunt.....	298
Forest Pest Management (Insects) / James A. Allen.....	301
Forest Pest Management (Plant Pathogens) / Ken I. Mallett.....	304
Forest Pest Management (Weeds) / Michael A. Valenti .....	306
Formulation / Peter Messenger.....	309
Fruit Crop Pest Management (Insects and Mites) / Serge Quilici.....	313
Fumigants / Nick Price.....	317
Fungal Control of Pests / David Moore.....	320
Fungicides / W.S. Washington .....	325
Genetic Improvement of Biocontrol Agents / Marjorie A. Hoy.....	329
Genetically Modified Foods / Jim M. Dunwell.....	333
Geographic Location of Crop / Bruce D. Gossen and Karen L. Bailey .....	336
GIS and GPS Systems in Pest Control / Shelby J. Fleischer .....	338
Glasshouse Crop Pest Management (Insects and Mites) / Gillian Ferguson and Graeme Murphy .....	341
Glasshouse Crop Pest Management (Plant Pathogens) / Piara S. Bains and Mohyuddin Mirza .....	345
Greenhouse Crop Losses (Diseases) / Ruguo Huang and William R. Jarvis .....	348
Ground Sprayers / Mohamed Khelifi .....	351
Herbicide Alteration of Crops / Kelsey Hart and David Pimentel .....	355
Herbicide-Resistant Crops / Stephen O. Duke .....	358
Herbicides / Malcolm D. Devine .....	361
Historical Epidemics (e.g., Irish Potato Famine) / Phillip Nolte.....	365
History / John H. Perkins.....	368
History of Biological Controls / William L. Bruckart III .....	373
History of Pesticides / Edward H. Smith and George G. Kennedy .....	376
House Dust Mites / Matthew Colloff.....	381
Human Lice / Davy Jones and Richard J. Pollack.....	385
Human Pesticide Poisonings / Margareta Palmborg .....	388
Hygiene (Including Destruction of Crop Remains) / William W. Bockus .....	391
Inorganic Pesticides / David B. South .....	395
Insect Growth Regulators / Meir Paul Pener.....	398
Insectistasis as a Means of Controlling Pest Populations in the Storage Environment / Hermann Levinson and Anna Levinson.....	402
Insect-Vectored Crop Diseases / Peter A. Burnett and Lawrence M. Kawchuk .....	407
Integrated Farming Systems / John M. Holland .....	410
Integrated Pest Management / Helmut van Emden .....	413
Integration of Tactics / John All .....	416
Interaction of Host-Plant Resistance and Biological Controls / Helmut van Emden .....	420
Intercropping for Pest Management / Maria R. Finckh and Marianne Karpenstein-Machan .....	423
Invasion Biology / Jennifer Ruesink .....	426

Invertebrate Pests / Thomas W. Culliney .....	431
Landscape Patterns and Pest Problems / F. Craig Stevenson .....	437
Lawn-Care Treatments (Plant Pathogens) / W.J. Florkowski .....	439
Leaching / Lars Bergström .....	442
Legal Aspects of Pest Management and Pesticides / Michael T. Olexa .....	445
Lethal Genes for Use in Insect Control / Thomas A. Miller .....	448
Licensing and Certification of Pesticide Applicators / Patrick J. O'Connor-Marer .....	451
Light Traps / S. Mohan .....	455
Livestock Pest Management (Insects) / Richard Wall .....	460
Living Mulches / John R. Teasdale .....	463
Losses from Aquatic Weeds / Lori Lach .....	466
Losses to Nematodes / Robert McSorley .....	470
Losses to Vertebrate Pests / Grant R. Singleton .....	473
Lyme Disease / A.E. Kiszewski and Andrew Spielman .....	476
Malaria / Mike W. Service .....	479
Mechanisms of Resistance: Antibiosis, Antixenosis, Tolerance, Nutrition / Helmut van Emden .....	483
Minilivestock / Maurizio G. Paoletti and Darna L. Dufour .....	487
Minor Use / Bent Bromand .....	493
Mite-Borne Diseases (Such as Scrub Typhus) / William John Hannan McBride .....	496
Modeling Pest Management / Andrew Paul Gutierrez .....	500
Modified Atmospheric Storage / Adel A. Kader .....	504
Molluscicides / Bernhard Speiser .....	506
Monocultures and Pests / Michael J. Weiss .....	509
Mosquito-Borne Arboviral Encephalitides / Carl J. Mitchell .....	511
Mycorrhizae / James A. Traquair .....	514
Mycotoxins / J. David Miller .....	517
Natural Pesticides / Franck E. Dayan .....	521
Nematode Control of Pests / Simon R. Gowen and N.G.M. Hague .....	526
Nematode Management / Graham Stirling .....	530
Nonchemical or Pesticide-Free Farming / Inger Källander and Gunnar Rundgren .....	533
North American Forest Losses Due to Insects and Plant Pathogens / Elizabeth Harausz and David Pimentel .....	539
Onchocerciasis / Mike W. Service .....	543
Optimizing Pesticide Applications / Miriam Austerweil and Abraham Gamliel .....	547
Organic Agriculture / Kathleen Delate .....	550
Organic Farming / Brenda Frick .....	554
Origins of Weeds: Benefits of Clean Seed / Heike Vibrans .....	558
Ornamental Crop Pest Management (Insects) / Tetsuo Gotoh and Xiao-Yue Hong .....	562
Other Mammal Damage and Control / Rex E. Marsh .....	568
Ovipositional Disruption Employing Semiochemicals / P. Larry Phelan .....	571
Pest Concept / Larry P. Pedigo .....	575
Pest Management in Ecological Agriculture / Barbara Dinham .....	576
Pest Management in Organic Farming / Ján Gallo .....	580
Pest Management in Tropical Agriculture / Charles J. Muangirwa .....	583
Pest Population Monitoring / Johann Baumgärtner and Cesare Gessler .....	587
Pest Status / Joe Funderburk .....	590
Pest/Host-Plant Relationships / Zamir K. Punja .....	593
Pesticide Mutagenesis / Geraldo Stachetti Rodrigues .....	595
Pesticide Reduction in Developing Countries / George Ekstrom .....	598
Pesticide Risk to Bee Pollinators / Gavin Lewis, John H. Stevenson and Ingrid H. Williams .....	603

Pesticide Sensitivities / Ann McCampbell .....	606
Pesticide Teratogenesis / Geraldo Stachetti Rodrigues.....	610
Physical Barriers for the Control of Insect Pests / Gilles Boiteau.....	616
Phytotoxicity / Céline Boutin.....	619
Plant Density / Kohji Yamamura.....	622
Plant Growth Promoting Rhizobacteria / Susan M. Boyetchko.....	625
Plant Pathogen Pest Management / Jalpa P. Tewari .....	628
Plant Quarantine / Guy J. Hallman .....	631
Planting Times / R.A. Balikai .....	634
Pneumatic Control of Agricultural Insect Pests / Charles Vincent.....	639
Population Theory and Pest Management / Alan A. Berryman.....	642
Postharvest Crop Losses (Insects and Mites) / Dongfeng Cao, David Pimentel and Kelsey Hart.....	645
Postharvest Food Losses (Vertebrates) / Dongfeng Cao, David Pimentel and Kelsey Hart.....	648
Postharvest Insect Control with Inert Dusts / Paul Fields and Zlatko Korunic .....	650
Postharvest Pest Losses / Somiahnadar Rajendran .....	654
Poultry Pest Management (Arthropods) / Nancy C. Hinkle .....	657
Predacides / Peter J. Savarie.....	661
Prevention / Larry P. Pedigo.....	664
Principles of Pest Management with Emphasis on Plant Pathogens / Kitty F. Cardwell and Chris J. Lomer.....	666
Protective Clothing / Andrew Gilbert.....	670
Protozoan Control of Pests / Leslie C. Lewis .....	673
Public Health and Costs of Pesticides / Kelsey Hart and David Pimentel.....	677
Quality and Yield Losses / Elke Pawelzik.....	681
Reflective Mulches / Charles G. Summers .....	683
Refugia for Pests and Natural Enemies / Robert Verkerk.....	685
Regulating Pesticides / Matthias Kern.....	689
Regulating Pesticides (Laws and Regulations) / Praful Suchak .....	692
Repellents / John A. Pickett and T.O. Olaagbemiro.....	696
Reproductive and Developmental Effects From Occupational Pesticides Exposure / Shao Lin.....	698
Reproductive Control Methods / Lowell A. Miller.....	701
Resistance Management / Kun Yan Zhu .....	705
Resistance Management in Host-Plant Resistance / Sanford D. Eigenbrode.....	708
Resistance to Host-Plant Resistance / Sanford D. Eigenbrode .....	712
Resistance to Pesticides / Steven J. Castle .....	715
Rhizobia / F.L. Walley and J.H. Stephens .....	718
Risks of Biological Control / Barbara I.P. Barratt .....	720
Risks of Vertebrate Pests / Mary Bomford .....	723
Rodent Damage and Control / Thomas J. Mbise .....	727
Rodenticide (and Vertebrate Pesticide) Effects on Wildlife Health / Charles Eason.....	731
The Role of EPA in Pesticide Regulation / Janice King Jensen and Lindsay Moose .....	735
Role of FDA in Pesticide Laws / Michael A. Kamrin .....	738
Role of USDA in Pesticide Laws / Michael A. Kamrin .....	741
Sampling / David E. Legg .....	745
Scabies Mites / Baik Kee Cho .....	747
Scouting / Stephen Lefko .....	751
Seed Treatments / Mark M. Stevens .....	754
Seeding Rate / Randy Anderson.....	757
Sheep Pest Management (Arthropods) / John E. Lloyd .....	760
Shifting Cultivation / Joseph D. Cornell and Charles A.S. Hall.....	763

Short Season Crops / <i>Chris Sansone</i> .....	768
Site-Specific Farming/Management (Precision Farming) / <i>Adrian Johnston</i> .....	771
Sleeping Sickness / <i>Jamie Stevens</i> .....	773
Soil Erosion and Pesticide Translocation Control / <i>Monika Frielinghaus</i> .....	777
Solarization / <i>James J. Stapleton</i> .....	781
Spray Drift / <i>Franklin R. Hall</i> .....	784
The Sterile Insect Technique / <i>E.S. Krafur</i> .....	788
Sterility Caused by Pesticides / <i>William W. Au</i> .....	792
Sticky Traps / <i>Mary L. Cornelius</i> .....	795
Stored Food Pest Management / <i>Judy Johnson</i> .....	798
Strategy / <i>Ron B. Hammond</i> .....	802
Structural Pests / <i>H. Robinson William</i> .....	805
Surface Waters: Pesticide Pollution / <i>Victor de Vlaming</i> .....	808
Sustainable Agricultural Practices / <i>Clive A. Edwards</i> .....	812
Swine Pest Management (Arthropods) / <i>D.W. Watson</i> .....	815
Swine Pest Management (Vertebrates) / <i>Robert M. Corrigan</i> .....	818
Synchrony and Asynchrony Plantings / <i>Ida Nyoman Oka</i> .....	822
Systems Management / <i>Glen C. Rains, Dawn M. Olson, W. Joe Lewis and James H. Tumlinson</i> .....	826
Tactics / <i>Vincent P. Jones</i> .....	829
Thresholds for Pesticide Treatment / <i>Uri Regev</i> .....	831
Ticks / <i>Daniel E. Sonenshine</i> .....	834
Tillage / <i>Karen L. Bailey and Bruce D. Gossen</i> .....	837
Toxins in Plants / <i>David S. Seigler</i> .....	840
Traditional Cropping Systems / <i>H. David Thurston</i> .....	843
Transgenic Crops (Annuals) / <i>Donald Boulter and Vaughan A. Hilder</i> .....	846
Transgenic Crops (Perennials) / <i>Matthew Escobar and Abhaya M. Dandekar</i> .....	850
Trap Crops / <i>Fred A. Gray and David W. Koch</i> .....	852
Trapping Pest Populations / <i>Crawford McNair</i> .....	855
ULV Applications / <i>G.A. Matthews</i> .....	859
UN Development Program/UNIDO Experience Toward Risk Reduction in Pesticide Production and Usage in Asia and The Pacific Region / <i>S.P. Dhua</i> .....	861
Use of Preplant and Postharvest Immersion for Disease Management in Horticultural Crops / <i>Robert J. McGovern</i> .....	866
Vectors of Human Disease / <i>Christopher F. Curtis</i> .....	871
Vegetable Crop Pest Management (Plant Pathogens) / <i>Mary Ruth McDonald</i> .....	875
Vegetable Crop Pest Management (Weeds) / <i>Wayne Thomas Lanini</i> .....	878
Vertebrate Pests / <i>Robert M. Timm</i> .....	881
Vertebrate Pests of Cattle / <i>Michael J. Bodenchuk</i> .....	884
Virulence in Plant Pathogens / <i>Etienne Duveiller</i> .....	886
Virus Controls of Pests (Insect and Mites) / <i>Brian A. Federici</i> .....	888
Weed Dispersal / <i>Anne Légère</i> .....	893
Weed Electrocution / <i>Clément Vigneault</i> .....	896
Wildlife Kills / <i>Pierre Mineau</i> .....	899
<b>Index</b> .....	905