

TABLE OF CONTENTS

Preface

1. An Introduction to Weed Biology

1.1 Introduction

1.2 Distribution

1.3 The importance of weeds

1.4 Problems caused by weeds

1.5 Biology of weeds

1.6 A few examples of problem weeds

1.7 Positive attributes of weeds

1.8 The ever-changing weed spectrum

1.9 Weed Control

References

2. Herbicide Discovery and Development

2.1 Introduction

2.2 Markets

2.3 Prospects

2.4 Environmental impact and relative toxicology

2.5 Chemophobia

2.6 The search for novel active ingredients

2.7 The search for novel target sites

2.8 Mode of action studies

2.9 The role of natural chemistry

2.10 Recent developments

2.11 A lower limit for rates of herbicide application

References

3. Herbicide Uptake and Movement

3.1 Introduction

3.2 The cuticle as a barrier to foliar uptake

3.3 Physico-chemical aspects of foliar uptake

3.4 Herbicide formulation

3.5 Uptake by roots from soil

3.6 Herbicide translocation from roots to shoots

3.7 A case study: The formulation of acids

3.8 The formulation of glyphosate

3.9 Further developments

References

4. Herbicide Selectivity and Metabolism

4.1 Introduction

4.2 General principles

4.3 Herbicide safeners and synergists

References

5. Herbicides That Inhibit Photosynthesis

5.1 Introduction

5.2 Photosystems

5.3 Inhibition at Photosystem II

5.4 Photodamage and repair of Photosystem II

5.5 Structures and uses of Photosystem II inhibitors

5.6 Interference with electron flow at Photosystem I

5.7 RuBisCO activase

5.8 How treated plants die

5.9 Chlorophyll fluorescence

5.10 Inhibition of photosynthetic carbon reduction in C4 plants

References

6. Inhibition of Pigment Biosynthesis

6.1 Introduction: Structures and functions of photosynthetic pigments

6.2 Inhibition of chlorophyll biosynthesis

6.3 Inhibition of carotenoid biosynthesis

6.4 Inhibition of plastoquinone biosynthesis

6.5 How treated plants die

6.6 Selectivity and metabolism

6.7 Summary

References

7. Auxin-Type Herbicides

7.1 Introduction

7.2 Structure and uses of auxin-type herbicides

7.3 Auxin, a natural plant growth regulator

7.4 Biosynthesis and metabolism of auxins

7.5 Auxin receptors, gene expression and herbicides

7.6 Signal transduction

7.7 Auxin transport

7.8 Resistance to auxin-type herbicides

7.9 An “auxin overdose”

7.10 How treated plants die

7.11 Selectivity and metabolism

References

8. Inhibitors of Lipid Biosynthesis

8.1 Introduction

8.2 Structures and uses of graminicides

8.3 Inhibition of lipid biosynthesis

8.4 Activity of graminicides in mixtures

8.5 How treated plants die

8.6 Plant oxylipins: Lipids with key roles in plant defence and development

8.7 Selectivity

References

9. Inhibition of Amino Acid Biosynthesis

9.1 Introduction

9.2 Overview of amino acid biosynthesis in plants

9.3 Inhibition of glutamine synthetase

9.4 Inhibition of aromatic amino acid biosynthesis

9.5 Inhibition of branch-chain amino acid biosynthesis

9.6 Inhibition of histidine biosynthesis

References

10. Disruption of the Plant Cell Cycle

10.1 Introduction

10.2 The plant cell cycle

10.3 Control of the plant cell cycle

10.4 Microtubule structure and function

10.5 Herbicidal interference with microtubules

10.6 Selectivity

References

11. The Inhibition of Cellulose Biosynthesis

11.1 Introduction

11.2 Cellulose biosynthesis

11.3 Cellulose biosynthesis inhibitors

11.4 How treated plants die

11.5 Selectivity

References

12. Plant kinases, phosphatases and Stress Signalling

12.1 Introduction

12.2 Plant kinases

12.3 Plant phosphatases

12.4 Cyclin-dependent kinases and plant stress

12.5 Post-translational modification of proteins

References

13. Herbicide Resistance

13.1 Introduction

13.2 Definition of herbicide resistance

13.3 How herbicide resistance occurs

13.4 A chronology of herbicide resistance

13.5 Mechanisms of resistance

13.6 Case Study: Blackgrass (*Alopecurus myosuroides* Huds)

13.7 Strategies for the control of herbicide-resistant weeds

13.8 The future development of herbicide-resistance

References

14. Herbicide-Tolerant Crops

14.1 Introduction

14.2 History of genetically-modified, herbicide-tolerant crops

14.3 How genetically-modified crops are produced

14.4 Genetically engineered herbicide-tolerance to glyphosate

14.5 Genetically-modified herbicide-tolerance to glufosinate

14.6 Genetically-modified herbicide-tolerance to bromoxynil

14.7 Genetically-modified herbicide-tolerance to sulphonylureas

14.8 Genetically-modified herbicide-tolerance to 2,4-D

14.9 Genetically-modified herbicide-tolerance to fops and dims

14.10 Genetically-modified herbicide -tolerance to phytoene desaturase inhibitors

14.11 Herbicide-tolerance due to engineering of enhanced metabolism

14.12 Herbicide-tolerance through means other than genetic modification

14.13 Gene editing

14.14 Economic, environmental and human health benefits from the adoption of GM technology

14.15 Gene stacking

14.16 Will the rise of glyphosate be inevitably followed by a fall?

14.17 Why is there so much opposition to GM technology?

14.18 Future prospects

References

15. Further Targets For Herbicide Development

15.1 Introduction

15.2 Protein turnover

15.3 The promotion of ageing in weeds?

15.4 Herbicide leads at the apicoplast

15.5 Control of seed germination and dormancy

15.6 Natural products as leads for new herbicides

References

Glossary

Index