

Hartmann and Kester's

Plant Seventh Edition Propagation

Principles and Practices

Hudson T. Hartmann Dale E. Kester Fred T. Davies, Jr. Robert L. Geneve

CONTENTS

Preface xi
About the Authors xv

PART I	GENERAL ASPECTS OF PROPAGATION	1
	CENERAL ABILE IS OF TROTAGATION	

HOW PLANT PROPAGE	ation Evolved
IN HUMAN SOCIETY	3

Introduction 3
Chapter Objectives 4
Stages of Agricultural Development 4
Organization of Human Societies 5
Exploration, Science, and Learning 6
The Development of Nurseries 8
The Modern Plant Propagation Industry 9

BIOLOGY OF PLANT PROPAGATION 13

Introduction 13
Chapter Objectives 13
Alternation of Generations in Reproduction 14
Seedling versus Clonal Populations 18
How Genes Impact Plant Propagation 22
Plant Hormones and Plant Development 27
Biological Life Cycles in Plants 30
Legal Protection of Cultivars 36

THE PROPAGATION ENVIRONMENT 41

Introduction 41

Chapter Objectives 42
Environmental Factors Affecting Propagation 42
Physical Structures for Managing the Propagation Environment 46
Containers for Propagating and Growing Young Liner Plants 66
Management of Media and Nutrition in Propagation and Liner Production 72

Management of Microclir	natic Conditions in Propagation
and Liner Production	82
Biotic Factors—Pathogen	and Pest Management in Plant Propagation

Biotic Factors—Pathogen and Pest Management in Plant Propagation 89 Post-Propagation Care of Liners 100

PART II SEED PROPAGATION 111

THE DEVELOPMENT OF SEEDS 113

Introduction 113 Chapter Objectives 113

What is a Seed? 114

Relationship Between Flower Parts and Seed Parts 11.

General Parts of a Seed 11

Ripening and Dissemination

Stages of Seed Development 120
Unusual Types of Seed Development 131

Plant Hormones and Seed Development 133

PRINCIPLES AND PRACTICES OF SEED SELECTION 141

Introduction 141

Chapter Objectives 141
Breeding Systems 142

Categories of Seed-Propagated Cultivars and Species 146
Control of Genetic Variability During Seed Production 15

Seed Production Systems 153

TECHNIQUES OF SEED PRODUCTION AND HANDLING 163

Introduction 163

Chapter Objectives 163

Sources For Seeds 165

Harvesting and Processing Seeds 167

Seed Testing 172

Seed Treatments to Improve Germination 183 Seed Storage 188

PRINCIPLES OF PROPAGATION FROM SEEDS 199

Introduction 199

Chapter Objectives 199

The Germination Process 199

Dormancy: Regulation of Germination 220

Kinds of Primary Seed Dormancy

Secondary Dormancy 235

Hormonal Control of Dormancy and Germination 236

TECHNIQUI	ES OF PROPAGATION BY SEED	249
Introduction	249	

Chapter Objectives 249
Seedling Production Systems 250

PART III VEGETATIVE PROPAGATION 275

Principles of Propagation by Cuttings 277

Introduction 277

Chapter Objectives 278

Descriptive Observations of Adventitious Root and Bud (and Shoot)

Formation 278

1 Officiation 270

Correlative Effects: How Hormonal Control Affects Adventitious Root and Bud (and Shoot) Formation 292

The Biochemical Basis for Adventitious Root Formation 299

Molecular/Biotechnological Advances in Asexual Propagation 302

Management and Manipulation of Adventitious Root and Shoot Formation 304

Management of Stock Plants to Maximize Cutting Propagation 306

Treatment of Cuttings 317

Environmental Manipulation of Cuttings 323

TECHNIQUES OF PROPAGATION BY CUTTINGS 341

Introduction 341

Chapter Objectives 341

Types of Cuttings 342

Sources of Cutting Material 357

Rooting Media 363

Wounding 366

Treating Cuttings with Auxins 367

Preventative Disease Control 374

Environmental Conditions for Rooting Leafy Cuttings 377

Preparing the Propagation Bed, Bench, Rooting Flats, and Containers,

and Inserting the Cuttings 388

Preventing Operation Problems with Mist and Fog Propagation Systems

388

Management Practices 391

Care of Cuttings During Rooting 395

Hardening-Off and Post-Propagation Care 397

Handling Field-Propagated Plants 400

Container-Grown Plants and Alternative Field Production Systems 40.

PRINCIPLES OF GRAFTING AND BUDDING 411

Introduction 411

Chapter Objectives 411

The History of Grafting 412

Terminology 412

Seedling and Clonal Rootstock Systems 414

Graft Union Formation in T- and Chip Budding 427	
Factors Influencing Graft Union Success 429	
Genetic Limits of Grafting 436	
Graft Incompatibility 438	
Scion-Rootstock (Shoot-Root) Relationships 448	
Techniques of Grafting 461	
Introduction 461	
Chapter Objectives 461	
Requirements for Successful Grafting 462	
Types of Grafts 463	
Production Processes of Graftage 491	
Aftercare of Grafted Plants 501	
Field, Bench, and Miscellaneous Grafting Systems 504	
TECHNIQUES OF BUDDING 514	
Introduction 514	
Chapter Objectives 514	
Importance and Utilization of Budding 515	
Rootstocks for Budding 515	
Time of Budding—Summer, Spring, or June 517	
Types of Budding 524	
Top-Budding (Topworking) 535	
Double-Working by Budding 537	
Microbudding 538	
LAYERING AND ITS NATURAL MODIFICATIONS 539	
Introduction 539	
Chapter Objectives 539	
Reasons for Layering Success 540	
Management of Plants During Layering 541	
Procedures in Layering 541	
Plant Modifications Resulting in Natural Layering 551	
PROPAGATION BY SPECIALIZED STEMS AND ROOTS 5	60
Introduction 560	
Chapter Objectives 560	
Bulbs 561	
Corms 574	
Tubers 577	
Tuberous Roots and Stems 580	
Rhizomes 583	
Pseudobulbs 586	

Reasons for Grafting and Budding 414

Formation of the Graft Union 420

Natural Grafting 420

PRINCIPLES AND PRACTICES OF CLONAL SELECTION 59

Introduction 592

Chapter Objectives 592

History 593

Using Clones as Cultivars 593

Origin of Clones as Cultivars 596

Phenotypic Variations Within Clones 598

Patterns of Genetic Chimeras Within Clones 602

Management of Phase Variation During Vegetative Propagation 608

Pathogens and Plant Propagation 614

Selection and Management of Propagation Sources 617

Propagation Sources and Their Management 625

PART IV CELL AND TISSUE CULTURE PROPAGATION 637

PRINCIPLES OF TISSUE CULTURE

AND MICROPROPAGATION 639

Introduction 639

Chapter Objectives 639

A Brief History of Tissue Culture and Micropropagation 641

Types of Tissue Culture Systems 643

Control of the Tissue Culture Environment 672

Special Problems Encountered by In Vitro Culture 673

Variation in Micropropagated Plants 676

TECHNIQUES FOR MICROPROPAGATION 690

Introduction 690

Chapter Objectives 690

Uses for Micropropagation

Disadvantages of Micropropagation 693

General Laboratory Facilities and Procedures 694

Micropropagation Procedures 703

Stage I—Establishment and Stabilization 703

Stage II—Shoot Multiplication 706

Stage III—Root Formation 707

Stage IV—Acclimatization to Greenhouse Conditions 708

PART V PROPAGATION OF SELECTED PLANT SPECIES 715

PROPAGATION METHODS AND ROOTSTOCKS FOR FRUIT AND NUT SPECIES 717

Propagation of Ornamental Trees, Shrubs, and Woody Vines 758

PROPAGATION OF SELECTED ANNUALS AND HERBACEOUS PERENNIALS USED AS ORNAMENTALS 813

SUBJECT INDEX 851

PLANT INDEX, SCIENTIFIC NAMES 865

PLANT INDEX, COMMON NAMES 873