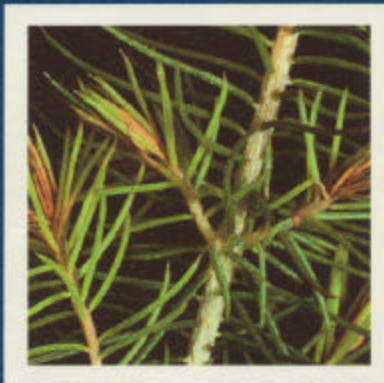




The Container Tree Nursery Manual • Volume Four

Seedling Nutrition and Irrigation



The Container Tree Nursery Manual

Volume One	Container Nursery Planning, Development, and Management
Volume Two	Containers and Growing Media
Volume Three	Container Nursery Environment
Volume Four	Seedling Nutrition and Irrigation
Volume Five	The Biological Component: Nursery Pests and Mycorrhizae
Volume Six	Seedling Propagation
Volume Seven	Seedling Processing, Storage, and Outplanting

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The Container Tree Nursery Manual

Volume Four Seedling Nutrition and Irrigation

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This publication reports research involving pesticides. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.



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Volume Four

Seedling Nutrition and Irrigation

Thomas D. Landis

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Preface

Work on the first comprehensive technical manual on the production of container tree seedlings, "How to grow tree seedlings in containers in greenhouses" by Richard W Tinus and Stephen E. McDonald, was begun in June 1975 and was published by the USDA Forest Service as a General Technical Report (GTR RM-60) in May 1979. This manual achieved worldwide acceptance as the primary reference on the culture of container tree seedlings. "How to grow tree seedlings in containers in greenhouses" was originally intended as an interim publication and has been reprinted several times; however, it is currently out of print.

In 1982, plans were begun for writing a new container nursery manual based on "How to grow tree seedlings in containers in greenhouses" but adding several new chapters. The writing team consisted of Thomas D. Landis, Richard W Tinus, Stephen E. McDonald, and James P Barnett. Realizing that container nursery management had changed considerably over the previous decade, the team surveyed container tree seedling nursery practices in North America in 1984. The Container Nursery Survey was distributed to 135 container nursery facilities in the United States and Canada. Response to the survey was excellent: 78 of 135 surveys were returned. Information from the survey has been used to determine writing priorities and emphasis, and information from it has been included in many of the chapters in this manual.

The Container Tree Nursery Manual consists of a series of separate, sequential volumes. Each volume contains chapters on closely related subjects concerning the production of tree seedlings in containers. The volumes can be accumulated and used as a complete nursery manual, or can be used separately by specialists needing information on a particular subject. Because several subjects must be discussed in more than one volume there will be some redundancy in the Manual. Such repetition is justified, however, because most readers will be using the Manual as a technical reference and will not be reading the entire text.

The Container Tree Nursery Manual is structured around an outline of numerical organizational headings that allow the reader to quickly locate a specific subject without referring to an index. The general outline of volume and chapter titles is as follows:

Volume One	Container Nursery Planning, Development, and Management
Chapter 1	Initial Planning and Feasibility Assessment
Chapter 2	Site Selection
Chapter 3	Nursery Layout and Growing Facilities
Chapter 4	Nonstructural Equipment and Controls
Chapter 5	Auxiliary Equipment and Buildings
Chapter 6	Shadehouses, Bedhouses, and Tunnels
Chapter 7	Nursery Management
Chapter 8	Troubleshooting Container Nursery Problems
Volume Two	Containers and Growing Media
Chapter 1	Containers: Types and Functions
Chapter 2	Growing Media
Volume Three	Container Nursery Environment
Chapter 1	Temperature
Chapter 2	Humidity
Chapter 3	Light
Chapter 4	Carbon Dioxide
Volume Four	Seedling Nutrition and Irrigation
Chapter 1	Mineral Nutrients and Fertilization
Chapter 2	Irrigation and Water Management
Volume Five	Biological Influences: Nursery Pests and Mycorrhizae
Chapter 1	Disease and Pest Management
Chapter 2	Mycorrhizae
Volume Six	Seedling Propagation
Chapter 1	Stock Types and Growing Schedules
Chapter 2	Seed Factors and Presowing Treatments
Chapter 3	Sowing and Other Propagation Methods
Chapter 4	Establishment Phase
Chapter 5	Rapid Growth Phase
Chapter 6	Hardening Phase
Volume Seven	Seedling Processing, Storage, and Outplanting
Chapter 1	Processing and Storage
Chapter 2	Handling and Transportation
Chapter 3	Outplanting

This Manual is based on the best current knowledge on container tree nursery management and should be used as a general reference. Recommendations were made using the best information available at the time and are, therefore, subject to revision as more knowledge becomes available. Much of the information in this manual was developed for western and southern conifer seedlings. Although the authors attempted to include information for species from other geographical areas, because of the wide variation in individual species responses, container nursery managers will need to adapt these principles and procedures to their own nursery situation. There is no substitute for individual experience, and recommended cultural practices should be tested before being implemented on an operational scale.

Trade names are used throughout the Manual but are only provided as examples and no endorsement of specific products, or the exclusion of equally suitable products, is implied. The mention of specific pesticides is intended only for general information and should not be construed as an endorsement. Because of frequent changes in pesticide registration and labeling, the reader should check with local authorities to make sure that an intended use is both safe and legal. Remember that pesticides can be harmful to humans, domestic animals, desirable plants, and fish or other wildlife if they are not handled or applied properly. Use all pesticides selectively and carefully, following the label directions. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

The Container Tree Nursery Manual was organized into separate volumes to allow for revisions and updating. The authors request that readers bring any errors in the text to their attention and also offer suggestions for improvement. Submit any suggestions to Thomas D. Landis, USDA Forest Service, State and Private Forestry, PO Box 3623, Portland, OR 97208.

Many people have been instrumental in the writing of this manual, and the authors would like to thank them for their suggestions and encouragement. Technical review of such a large publication involves considerable work, and the authors are extremely grateful for the invaluable service provided by the following nursery professionals for Volume Four:

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