Citrus fruits are produced all around the world. They contain healthy nutrition content that works wonders for the body. Citrus fruits act as a fabulous source of vitamin C and a wide range of essential nutrients required by the body. India only represents a mere 4% of global citrus fruit production. But now a day, there is a rise in its cultivation. This rise in citrus production is mainly due to the increase in cultivation areas & the change in consumer preferences towards more health & convenience food consumption & the rising incomes. Citrus fruits have long been valued as part of a nutritious and tasty diet. The flavours provided by citrus are among the most preferred in the world, and it is increasingly evident that citrus not only tastes good, but is also good for people. It is well established that citrus and citrus products are a rich source of vitamins, minerals and dietary fiber (non starch polysaccharides) that are essential for normal growth and development and overall nutritional well being. However, it is now beginning to be appreciated that these and other biologically active, non nutrient compounds found in citrus and other plants (phytochemicals) can also help to reduce the risk of many chronic diseases. Appropriate dietary guidelines and recommendations that encourage the consumption of citrus fruit and their products can lead to widespread nutritional benefits across the population. All citrus fruit is acid fruit. The acid fruits are the most detoxifying fruits and excellent foods. Lemon oil is obtained from the fruits of citrus Limonum, Risso (Rutaceae). Although the majority of commercially available essential oils are extracted from the original botanical material by use of steam distillation, most citrus essential oils are extracted by pressing the rinds of the citrus fruits. The oil of sweet orange is obtained from the fruits of citrus Aurantium Risso and the oil of bitter orange from fruits of citrus Bigaradia Risso (Auranciacae). Orange Essential Oil is energizing and is usually well loved by men, women and children. Citrus fruit oils are cheaper than most other essential oils. Lemon or sweet orange oils that are obtained as by products of the citrus industry are even cheaper.

Some of the fundamentals of the book are botanical classification, classification of genus citrus, criteria for citrus classification, information on important citrus fruits, subgenus fucitrus (edible citrus fruits), citrus cultivation, citrus fruits, kinnow mandarin, citrus fruit breeding, soil inspection for citrus family, nutrition for citrus world, proper harvesting of citrus, post harvesting of citrus fruits, etc.

This handbook on citrus fruits provides relevant information on most citrus crops, the basics of citiculture & production, pre & post harvest management, picking, storage etc. Selected topics on oil extraction of citrus fruits are also given to provide knowledge of the techniques used. This book will be helpful for technocrats, farmers, research scholar, institutions etc.
1. Botanical Classification
Classification of Genus Citrus
Criteria for Citrus Classification
Different Classification
Subgenus Eucitrus (10 Species)
Subgenus 2. Papeda (6 Species)
Subgenera 1. Archicitrus (5 Sections, 98 Species)
Subgenera 2. Meta Citrus (3 Sections, 46 Species)
Others of Somewhat Doubtful Classification
Information on Important Citrus Fruits
Subgenus Fucitrus (Edible Citrus Fruits)
Acid Group
Citrus Medica Linn. (Citron)
Citrus Lemon Burm (Lemon)
Citrus Aurantifolia Swingle (Acid Lime)
Citrus Latifolia Tanaka (Thai or Persian Lime)
Citrus Limettioides Tanaka (Sweet Lime)
Citrus Jambhiri Lush (Rough Lemon; Jambiri)
Citrus Limetta Risso (Limetta of the Mediterranean)
Citrus Karna Raff (Kharna Khatta)
Citrus Limonia Osbeck (Rangpur Lime)
Citrus Pennivesiculata Tanaka (Gajanimma)
Orange Group
Citrus Aurantium Linn (Sour, Bigarade or Soville Orange)
Citrus Sinensis Osbeck (Sweet Orange)
Citrus Myrtifolia Raffinesque
Citrus Bergemia Risso (Bargmot Orange)
Citrus Natsudaidai Hayata
Pumelo-Grapefruit Group
Mandarin Group
Citrus Reticulate Blance (loose skinned orange or Santra of India)
Citrus Unshiu M (Satsuma Mandarin)
Citrus Deliciosa Tenore
Citrus Nobilis Loureio (King Mandarin)
Citrus Reshni Tanaka (Spice Mandarin)
Citrus Medurensis Lou (Calamondin)
Citrus Madaraspatana Tanaka
Subgenus Papeda : (Inedible Citrus Fruits)
Eupapeda Citrus
Citrus Macroptera (Metanewsian Papeda)
Papeda Citrus
Citrus Ichangensis
Citrus Iatipes (Khasi Papeda)
Kumquats
Fortunella Margarita Swingle (Nagami or Oval Kumquat)
Fortunella Japonica Swingle (Marumi or Round Kumquat)
Fortunella Crassiflora Swingle (Meiwa Kumquat)
Fortunella Bindsii Swingle (Hong Kong wild Kumquat)
Poncirus Trifoliata L. (Trifoliate Orange)
Citrus Relatives
Aegle Marmelos Linn. (Bael)
Feronia Limonia (Linn) Swingle (Wood apple)
2. Citrus Cultivation
Sweet Oranges
Citrus Sinensis Osbeck
Batavian
Hamlin
Jaffa
Malta Blood Red
Mosambi
Pineapple
Sathgudi
Shamouti
Valencia Late
Washington Navel Oranges
Mandarin Oranges
Citrus Reticulata B.
Calamondin (Citrus Madurensis Lou)
Cleopatra (Spice Tangerine) C. reshni T.
Coorg Orange
Dancy Tangerine
Desi Mandarin (Pathankot)
Khasi Orange
King Mandarin
Kinnow Mandarin
Nagpur Santra
Satsuma Orange (C. unshiu M.)
Temple Mandarin
Lemon C. limon Burm
Eureka Lemon
Lisbon Lemon
Lucknowseedless
Hill Lemon (Galgal) C. pseudolimon Tanaka
Malta Lemon
Meyer Lemon
Napali Oblong
Villafranca
Lime
Acid Lime (Citrus aurantifolia Swingle)
Tahiti (Persian) Lime (C latifolia Tanaka)
Rangpur Lime (Citrus Limonia Osbeck)
Sweet Lime (Citrus Limettioides Tanaka)
Pummelo (C. Grandis Osbeck)
Nagpur (Chakotra)
Grapefruit (C. Paradisi Macf)
Duncan
Foster
Marsh Seedless
Ruby
Shaharanpur Special
Thompson (Pink Marsh)
Citrus Hybrids
Inter Generic Hybrids
Hybrids of Poncirus
Citranges
Citrangequats (Citrus Orange Kumquats)
Citrangeeins (Citrus Orange) — Calomons (Din)
Citranges
Cleitranges
Citrumelos
Hybrids of Fortunella
Procimequat (Procitrus—Limequat.
(Fortunella japonica—C.aurantifolia, Cv. “Mexican”) × F. hindsii.
Limequats (C. aurantifolia—F. japonica)
Orangequats. (C. reticulata Cv. satsuma—F. japonica—F. morgarita Cv. meiwa)
Hybrids of Genus Eremocitrus
Intrageneric Hybrids

3. Citrus Fruits
Sweet Orange
Climate
Soil
Cultivars
Mosambi
Blood Red Malta
Sathgudi
Pineapple
Washington Navel
Jaffa
Shamouti
Valencia Late
Hamlin
Batavian
Propagation
Raising of Seedlings for Rootstock
Budding
Planting
Manure and Fertilizers
Irrigation
Interculture and Intercropping
Training and Pruning
Bahar Treatment
Fruit Drop
Physiological Fruit Drop
Control Measures
Pathological Fruit Drop
Control Measures
Harvesting
Yield
Post Harvesting Handling and Storage

4. Mandarin
Uses
Climate
Soil
Varieties
Nagpur Santra
Khasi Orange (Mandarin)
5. Kinnow Mandarin
Uses
Climate
Soil
Propagation
Planting
Manures and Fertilizers
Irrigation
Interculture and Intercropping
Flowering and Fruiting
Harvesting
Yield
Post Harvest Handling and Storage

6. Sour Lime
Uses
Climate
Soil
Types/Varieties of Lime
Kagzi Lime
Chakradhar Lime
Rangpur Lime (Citrus limonia Osbeck)
Taheti (Persian) Lime (C. latifolia Tanaka)
Propagation
Raising of Seedlings
Planting
Manure and Fertilizers
Irrigation
Interculture and Intercropping
Training and Pruning
Flowering and Fruiting
Harvesting
Postharvest Handling and Storage

7. Sweet Lime
Uses
Climate
Soil
Varieties
Mitha Chikna
Propagation
Planting
Manures and Fertilizers
Irrigation
Training and Pruning

Flowering and Fruiting
Harvesting
Yield
Handling and Storage

8. Lemon
Uses
Climate
Soil
Varieties
Eureka
Lisbon Lemon
Villafranca
Lucknow Seedless
Nepali Oblong
Baramasi
Kagzi Kalam
Hill Lemon. (Galgal) C. pseudolemon Tanaka
Meyer Lemon
Pat Lemon
Italian Lemon
Rajamundary Lemon
European Lemon
Ponderosa Lemon or Japanese Lemon
Malta Lemon
Propagation
Planting
Irrigation
Manure and Fertilizers
Training and Pruning
Improvement in Yield
Harvesting
Yield
Post Harvest Handling and Storage

9. Grapefruit
Uses
Climate
Soil
Varieties
Marsh Feedless
Duncan
Foster
Saharanpur Special
Ruby
Thompson (Pink Marsh)
Triumph
Propagation
Planting
Irrigation
Training and Pruning
Flowering and Fruiting
Harvesting
Yield
Post-harvest Handling and Storage

10. Pummelo
Uses
Climate
Soil
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Propagation
Planting
Cultural Practices
Harvesting and Yield
Insect-pests of Citrus Fruits
Lemon Butterfly (Papilio demoleus Linn)
Control Measures
Citrus Leaf Miner (Phylloenistis Citrella Stainton)
Control Measures
Citrus Psylla (Diaphorina Citri Kuwayma)
Control Measures
Whiteflies
Control Measures
Control Measures
Aphids
Control Measures
Mites
Control Measures
Scale Insects
Control Measures
Nematodes
Control Measures
Stem and Bark Borers (Indarbela Tetraonis Moore and I. qudrinotata Walker)
Control Measures
Fruit Sucking Moths (Ophideres spp).
Control Measures
Fruit Flies (Daccus spp).
Diseases of Citrus Fruits
Gummosis (Photophthora spp, Diplodia Natalensis Pole Evans)
Control Measures
Ganoderma Root Rot (Ganoderma Lucidum Karst)
Control Measures
Pink Disease (Pellicularia Salmonicolor Dastur)
Control Measures
Powdery Mildew (Acrosporium Tingitaninum Subr).
Control Measures
Anthracnose (Colletotrichum Gloeosporioides and Gloeosporium Limethicolum Clausen)
Control Measures
Twig Blight (Diplodia and Fusarium spp.)
Control Measures
Citrus Canker (Xanthomanas Citri Dowsan)
Control Measures
Tristeza Virus Disease (Corium Vialoris)
Control Measures
Xyloporosis
Control Measures
Psorosis
Control Measures
Exocortis or Scalybutt
Control Measures
Citrus Greening
Control Measures
Dendrophthoe
Control Measures
Fruit Cracking
Control Measures
Citrus Decline
Control Measures
Granulation
Control Measures
Fruit Drop
Control Measures
Alternate Bearing
Control Measures

11. Citrus Fruit Breeding
Aims of Citrus Breeding
Related to Fruit Characters
Related to Tree Characters
Related to Rootstocks
Problems in Citrus Breeding
Time
Polyembryony
Sterility
Breeding Method
Introduction
Selection
Hybridization
Mutation Breeding
Choice of the Procedure
Cytogenetics
Blossom Biology in Citrus
Blooming Period
Flower Bud Differentiation
Flower Bud Development
Inflorescence
Sex Ratio
Anthesis
Dehiscence
Stigma Receptivity
Storage, Longevity and Fertility of Pollen
Pollen Germination
Pollination and Fecundation
Fruit Development
Technique of Hybridization
Structure of the Citrus Flower
Calyx
Corolla
Stamens
Pistil
Selection of Parents
Selection of Seed Parent Trees, Branches and Flowers
Bagging the Flowers
Emasculation
Pollination
Fruit Set

12. Suitable Climate
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Relative Humidity
Rainfall
Winds
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Climatic Requirements of Different Citrus Species
Sweet Oranges (Citrus Sinensis Osbseck)
Mandarin Oranges (Citrus Reticulata Blanco)
Acid Lime (Citrus Aurantifolia Swingle)
Sweet Lime (Citrus Limettiodae Tanaka)
Lemon (Citrus Limon B)
Grapefruit (Citrus Paradisi Macf)
Pummelo (Citrus Grandis Osbeck)
Climate in Different Regions of India

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Water Drainage
Depth of the Soil
Nature of the Subsoil
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Salts
Type and Fertility of the Soil
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Citrus Soils of Elsewhere
Work Done in India
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Tangelos (Tangerine Â— Grapefruit)
Citranges (Poncirus Trifoliata Â— Citrus Sinensis)
Citrangequats (Citrange Â— Kumquat)
Limequats (Mexican Lime Â— Kumquat)
Hybrid acid Citrus fruit
Mandarin Types
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New Approaches in Citrus Breeding in India

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Layout
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Planting
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15. Cultivation of an Orchard
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Cultivation
Greenhouse
Orchard House and its Management
Composts, Potting Methods, and Containers
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Feeding of Orchard Plants
Outdoor Cultivation of Orchards
Growing Orchards in Outdoor Beds
Vegetative Propagation
Raising of Orchards from Seeds
Care of Seedling
Shoot Tip or Meristem Culture
Differentiation of Flower Buds and Induction of Flowering
Resting
Method of Hybridisation
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16. Propagation of Citrus Fruits
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Preparation of Stock Seedling
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Method of Operation
Height of the Budding
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Care of Young Budlings in the Nursery
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Budwood Certification Programmes
Cuttings
Layering
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Purchasing of Seedlings or Budlings
Care of Plants on Arrival from the Nursery
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Classification or Variations
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Nucellar Emorbyony in Citrus Species and Cultivars
Strongly Polyembryonic
Weekly Polyembryonic
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Number of Nucelear Seedlings Per Seed
Horticultural Significance
Significance of Nucelear Embryony in Citrus Breeding
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Performance of Nucelear Lines
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17. Budded Roots
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Citrus Rootstocks in India
Citrus Rootstocks of the World
Rootstock Trials in India
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Assam
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Maharashtra
Karnataka
Tamil Nadu
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Troyer Citrange
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Swingle Citrumelo
Duncan Grapefruit Â— Trifoliate Orange
Stock and Scion Relationships in Citrus
Effect of Root stock on Vigour of the Scion
Effect on Precocity
Effect on Productivity and Yield
Effect on Fruit Size, Colour and Quality
Effect on Winter Hardiness
Effect on Nutrition
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Effect of the Scion on Rootstock
Effect of Interstocks
CITRUS ROOTSTOCK PROBLEMS
Stionic Failures
Viruses
Diseases
Nematodes
Salts

18. Cutting of Weak/Neglected Parts
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Pruning Neglected Trees
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19. Soil Inspection for Citrus Family
Soil Tillage
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20. Inter Cultivation
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21. Nutrition for Citrus World
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Nitrogen
Phosphorus
Potassium
Calcium
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Sulphur
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Manganese
Boron
Molybdenum
Combined Nutritional Sprays
Factors Governing the Nutrition
Nutrient Elements Balance
Manuring and Fertilization
Manuring of Young and Pre-bearing Trees
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Methods of Application
Foliar Analysis
Soil Vs. Foliar Analysis
The Concept of Foliar Analysis
Factors Affecting Mineral Composition of Leaves
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Preliminary Survey of Orchard and Selection of Initial Sampling Technique
Methods of Analysis
Leaf Analysis Standards
Interpretation of the Leaf Standards of Different Elements

22. Control Irrigation
Irrigation Requirement of Citrus Trees
Time and Frequency of Irrigation
Quality of Irrigation Water
Systems of Irrigation
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Furrow System
Flood Irrigation System
Check System
Sprinkler Irrigation
Advantages
Disadvantages
Drip- or Trickle-irrigation
Advantages
Disadvantages
Pitcher System
Sub-surface Irrigation
Irrigation to Young and Pre-Bearing Trees
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23. Unwanted Weed Removal
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Weed Control in Nurseries
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Herbicidal Effects
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Other Effects

24. Proper Harvesting of Citrus
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Methods of Picking
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Grading
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25. Oil of Bergamot

26. Oil of Lemon

27. Oil of Mandarin
28. Oil of Orange

29. Study of Orange Essential Oils
   Analysis by Infrared Spectroscopy

30. Study of Orange Essential Oils
   Chemical Modifications During Aging

31. Citrus Carotenoids (I) The Structure of Citranaxanthin, a New Carotenoid Ketone
   Experimental
   Isolation of Citranaxanthin I
   Anal. Calcd.
   Alkali Cleavage of Citranaxanthin (I).
   Reduction of Citranaxanthin
   Citranaxanthin (I)
   Anal. Calcd.

32. Citrus Carotenoids (II) The Structure of Reticulataxanthin

33. Factors Direct Fruit Variety
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   Water
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   Phosphorus
   Potassium
   Magnesium
   Manganese
   Copper
   Boron
   Rootstock Effects
   Fruit Size
   Colour of Rind
   Juice
   Total Soluble Solids
   Total Acidity
   Ascorbic Acid Content

34. Post Harvesting of Citrus Fruits
   Degreening
   Pre-harvest Treatment
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   Storage
   Waxing
   Polyethylene Covers
   Growth Regulators
   Cold Storage
   Controlling Moulds in Storage

35. New Problems for Citrus Family
   Alternate Bearing
Factors Affecting Alternate Bearing
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Resting Treatment
Choice of Bahar
Granulation
Analogy of Granulation
Physico-chemical Characteristics of Granulated Fruits
Incidence and Progress of Granulation
Factors Affecting Granulation
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Temperature
Light
Tree age
Tree health
Tree Vigour
Tree Aspect
Tree Variation
Fruit Size
Rootstock
Varietal Susceptibility
Control Measures
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Effect of Time Sprays
Effect of Growth Regulators
Nutritional Sprays
Citrus Decline
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Soil Factors
Nutritional Factors
Rootstock Factors
Orchard Management Factors
Insect-pests
Nematodes
Fungal Diseases
Viruses
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Fruit Drop
Retarding or Inhibiting Factors
Accelerating or Initiating Factors
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Insect Pests and Diseases
Physiological Factors
Nitrogen
Carbohydrates
Auxins
Embryo Development
Control of Fruit Drop
Mandarins
Sweet Oranges
Grapefruit
Lemons
36. Use of Plant Growth Regulators
2,4-Dichlorophenoxy Acetic Acid (2,4-D)
2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T)
Napthalene Acetic Acid (NAA)
Gibberellins
Cytokinins
Growth Retardants
Ethylene
Limitations

37. Serious Diseases of Citrus
Diseases Caused by Fungi
Gummosis
Symptoms
Etiology and Spread of Disease
Varietal Susceptibility
Control Measures
Preventive Measures
Curative Measures
Diplodia Gummosis
Symptoms
Spread
Control
Ganoderma Root Rot
Symptoms
Control
Pink disease
Symptoms
Control
Powdery Mildew
Symptoms
Etiology and Spread
Control
Felt Disease
Symptoms
Etiology and Spread
Varietal Susceptibility
Control
Anthracnose
Symptoms
Etiology and Spread
Control Measures
Scab
Symptoms
Etiology and Spread
Varietal Susceptibility
Control
Dry Root-rot
Symptoms
Etiology
Control
Armillariella Root-rot
Symptoms
Control
Sooty Mould
Symptoms
Damage
Etiology and Spread
Control
Melanose
Symptoms
Etiology and Spread
Control
Twig Blight
Etiology
Symptoms
Control
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Symptoms
Etiology
Control
Sphaeropsis Knots
Limb Breakage
Greasy Spot
Nursery Diseases
Diseases Caused by Bacteria
Citrus Canker
Symptoms
Etiology and Spread
Varietal Resistance
Control
Citrus Blast
Bacterial Root Rot
Diseases Caused by Viruses
Diseases Affecting Certain Stionic Combinations
Tristeza or Quick Decline
Symptoms
Etiology
Transmission of the Virus
Varietal Susceptibility
Control
Saving the Existing Infected Orchards
Avoiding Losses in New Citrus Plantings
Xyloporosis
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Virus Diseases Occurring Irrespective of Rootstocks
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Symptoms
Etiology
Diseases Caused by Viroids
Exocortis or Scalybutt
Other Miscellaneous Virus Diseases
Budunion Crease
Citrus Mosaic
Infectious Variegation
Yellow-Corky Veins
Blastomania
Leaf-curl-disease
Other Virus-Like Disorders
Creeping Stem
Bark Eruptions
Woody Galls
Young Tree Decline
Gummy Pitting
Tatter Leafâ€™ Citrange Stunt Complex
Citrus Mosaic, Navel Infections Mottling and Natsudaidai dwarf
Citrus Greening
Symptoms
Etiology
Transmission
VARIetal Susceptibility
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Dendrophthoe (Loranthus)
Cassytha
Physiological Disorders
Foam Disease
Symptoms
Cause
Fruit Splitting
Symptoms
Cause
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Endoxerosis
Symptoms
Cause
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Creasing (Puffiness)
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Market for Storage Diseases
Penicillium Moulds
Alternaria Rot
Black Core Rot
Diplodia-Stem-end Rot
Aspergillus Rot
Miscellaneous Diseases

38. Important Pests of Citrus
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Root Pests
Stem and Trunk Pests
Borers
Chloridolum Alemene Thomson
Monohanmus Versteegi Nitzema (Trunk Borer)
Stein and Bark Borers (Indarbela Spp.)
Damage by Borers
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Foliage Pests
Lemon Butterfly (Papilo Demoleus Linn.)
Papilionidae : Lepidoptera.
Distribution
Host Plants
Life History
Damage
Control

Citrus Leaf-Miner: (Phyllocnistis Citrella Stainton) (Phyllocnistidae: Lepidoptera).
Distribution
Host Plants
Life History
Damage
Control

Citrus Psylla: Diaphornia Citri Kuwayama
Distribution
Host Plants
Life-history
Damage
Control

Whiteflies (Aleurocanthus Spp, Dialeurodes Spp)
Distribution
Host Plants
Life History
Damage
Control

Weevils: (Myllocerus Discolor BOH)
Mealy Bugs : Pseudocoecus Spp (Pseudococcidae : Hemiptera)
Distribution
Host Plants
Life History
Damage
Control

Aphids: Hemiptera Aphididae
Distribution
Host Plants
Life History
Damage
Control

Thrips: (Scirtothrips spp, Heliothrips spp)
Distribution
Host Plants
Damage
Life History
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Scale Insects: (Coccidoe: Homoptera)
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Mites: (Tetranychidae: Acarina)
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Life History
Damage
Citrus Rust Mite: Phyllocoptruta Oleivorus Ashm
Six-spotted Mite: Tetranychus Sexmaculatus Riley
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Minor Pests
Hairy Caterpillars Euprotctis Fraterna M
The Citrus Leaf-roller (Psorosticha Zizyphi Staintor)
Orange Hair Streak: (Taraucus Theophrastus)
A Grass Hopper: Poekilocerus Pictus Fab
Cricket: Braehytrypes Portentosus Light
Longhorn Beetle: Oberea Mangalorensis

Flower Pests
Citrus Flower Moth: Prays Citri Milliers
Cacoecia Epicyrta Meyrick
Blossom Midge Sayneura Citri G & P

Fruit Pests
Fruit Sucking Moths (Noctudidae: Lepidoptera)
Calpe Emarginata

Distribution
Host Plants
Life History
Damage
Control
Fruit Flies
Distribution
Host Plants
Life History
Damage
Control
Fruit Sucking Bugs
Distribution and Host Plants
Life History
Damage
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Citrus Rind Borer: Prays Endocarpi Meyrick.

General Control Measures

39. Nematodes of Citrus
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Tylenchulus Semipenetrans Cobb. 1913
Host Range
Control Measures
Cultural Control
Biological Control
Resistant Rootstocks
Reniform Nematode (Rotylenchulus Reimformis)
Burrowing Nematode (Radopholus Similies)
The Lesion Nematode (Pratylenchus Coffeae)
Root-knot Nematode (Meloidogyne Africane)

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The Lance Nematode (Hoplolaimus Indicus)
Porcirus
Fortunella (Kumquats)
Citrus

About NIIR

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