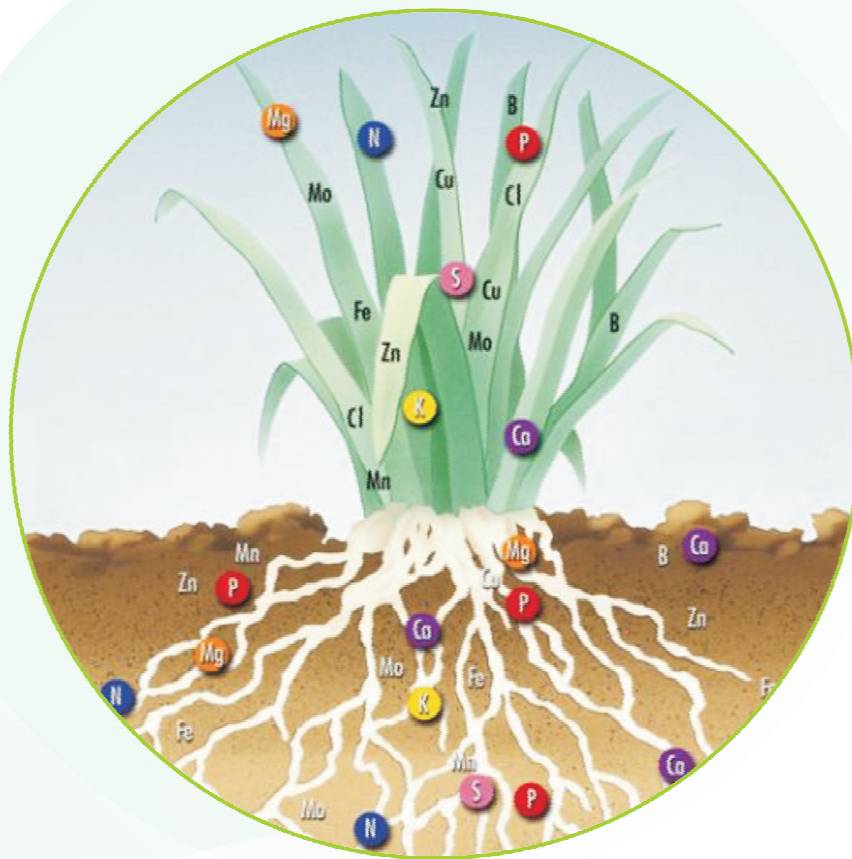




Handbook

Nutrition

Management Guide



June 2008



USAID
FROM THE AMERICAN PEOPLE



Acknowledgment

Improving Livelihood & Enterprise Development (I-LED), a USAID funded program was designed for the affected communities of the Mansehra and Bagh districts. I-LED programs focus on building back better based on the existing businesses of the community (before earthquake) such as agriculture, livestock and poultry. Interventions were made to help these businesses build on their inherent strengths and to provide opportunities to enhance income generation, local employment, and increased economic activities.

The support provided to the community was through Matching Grants (Financial Assistance) linked with the delivery of technical trainings and skill enhancement relevant to their businesses.

To address the deficiency of existing knowledge, a series of training manuals was created to support nursery and orchard growers. The following topics were included in this series of modules:

- | | |
|-------------------------------------|----------------------------------|
| 1. Introduction to Fruit Production | 2. Orchard Establishment |
| 3. Orchard Tree Pruning | 4. Orchard Irrigation Management |
| 5. Harvest/Post Harvest Management | 6. Orchard Nutrient Management |
| 7. Small Farm Business | 8. Integrated Pest Management |
| 9. Nursery Management | |

This interactive training series was designed for both trainers and potential business owners (potential partners). Pilot training were also conducted at village level with real farmers groups to test these modules. These modules were also evaluated by a diverse group of training providers and technical expert's to provide as appropriate a training resource as possible.

The communities, farmers and technical expert from agri industries appreciated the I-LED effort for the development of these modules and found the material to be an excellent contribution towards farmers' livelihood initiatives.

We acknowledge and appreciate Dr. John Bellow's dedicated technical input for the development of these modules, Empowerment thru Creative Integration (ECI)'s contribution in developing this complex subject into to participants handbook and instructional guide for trainers, easy and absorbable methodologies; and suitable visualization for non-literate farmers.

We also appreciate the support, inputs and suggestions of CNFA training department, agriculture and horticulture experts and local organizations (Hazara Agriculture Research Station, Bafa Agriculture Research Station, Cabi South Asia, CITRUS "Committed for improvement transformation& resource up-gradation of the social sector and Agriculture expert of CNFA I-LED) who provided continue support in providing technical inputs and suggestions to make this material more beneficial to the rural communities.

Various references from a variety of sources were used to develop and validate the contents. Its is not possible to individually acknowledge each source .However we hope this series of modules will not only help the farmers of rural areas but all relevant institutions, organization and trainers will also be benefited with the provided information. We are deeply grateful to very one who has gifted even a small input to make these materials unique and useful for the target groups.

These modules are CNFA I-LED's contribution towards knowledge transfer within the horticulture sector .We would therefore like all users to feel free to copy, distribute, display modules and benefit the sectors and more specifically the farmers. Electronic copies may be found at <http://www.cnfapakistan.org>

CNFA I-LED

Foreword

This training module focuses on presenting the importance of nutrients in the growth of plant and production of fruit. The purpose of this training is to provide sufficient information the orchard growers to use right nutrient for right plant, soil and fruit tree to increase the production, and also to warn them that the wrong application can spoil the yield. Farmers will also provide the corrective methods and their sources to cure the yield before it damage the fruit or tree.

The training will show results if the content is followed by demonstrations and hands-on activities. It is suggested that the training schedule confine the sessions for discussion, Q&A, demonstrations, the practical activities and hands on practice by participants.

The training material has been developed to make the Handbook relevant for semi-literate and non-literate participants.

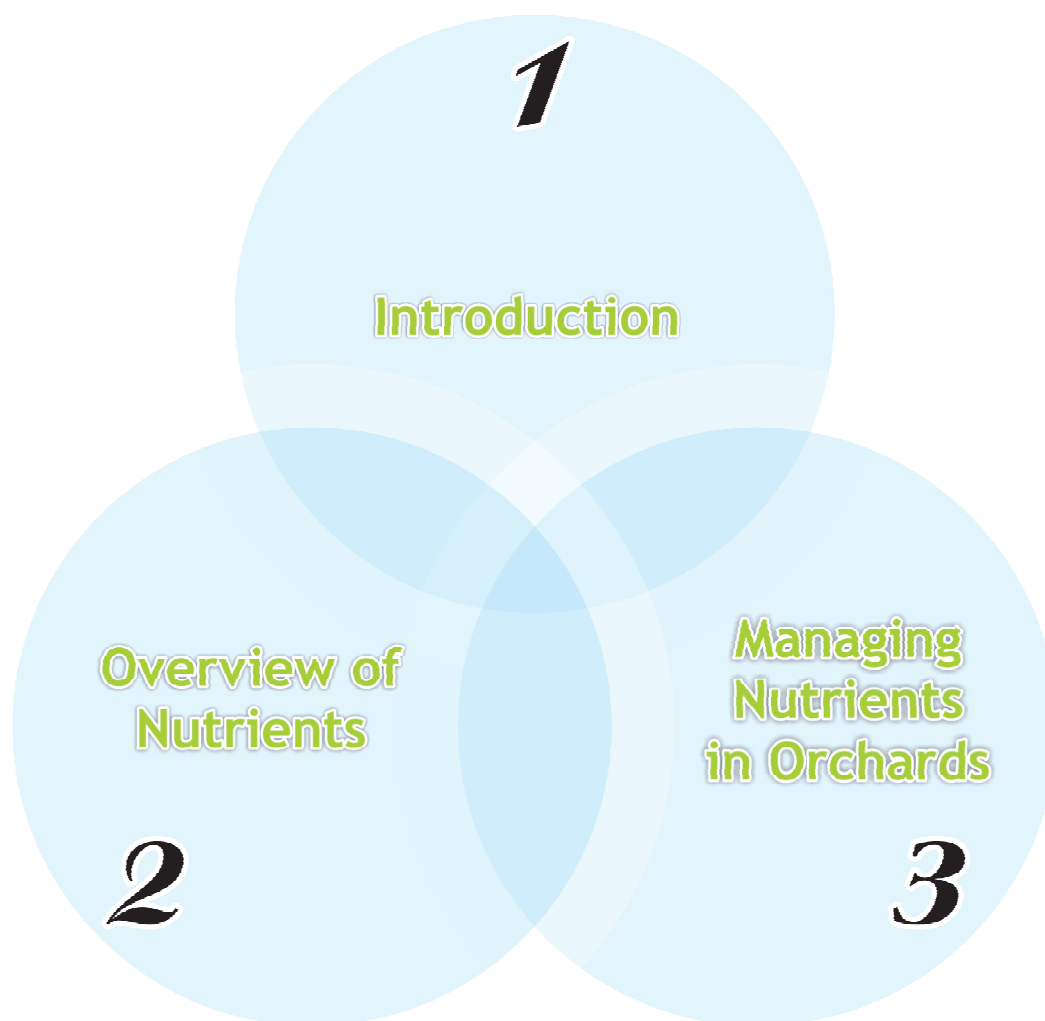
Objectives



By the end of the training, Participants will be able to understand:

- The importance of nutrients for the growth of plants.
- The important concepts of Nutrient Management
- The types of Nutrients and their role towards growth, effects and deficiency.
- Why soil tests are important for plants growth and what are the soil test procedures
- The fertilization difference between Dwarf, Semi Dwarf and Standard trees.
- What needs to consider for managing orchard floor

Structure of the Module



1



2



4



3



5



Plants and Nutrients

Plants require specific nutrients to grow.

When too much or too little is available trees and plants are unable to grow normally

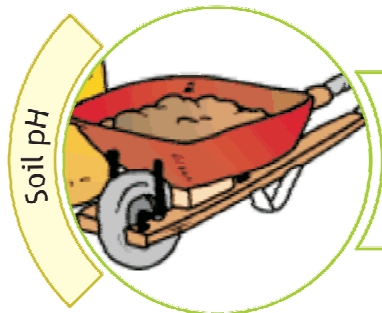


Important Concepts



Those chemical materials that plants need to grow and produce

Whether the nutrient is found in the proper form that the plant can use



Chemical property of soils that influences the type of reactions that occur and whether certain nutrients are available to plants

When a plant can not get enough of a nutrient to grow normally and reach its potential



Enough of a nutrient is available to meet the needs of the plant

Important Concepts

Fertilizers are graded by the NPK formula which indicates how much Nitrogen, Phosphorus, and Potassium is contained as a percentage of the weight (45-0-0,45%N,0%P,0%K)



NPK Formula

Fertilizer



Refers to chemical materials which can be added to the soil or sprayed on the trees to make nutrients more available to the plant. There are many different kinds of fertilizers which supply different amounts and kinds of nutrients

General term that refers to anything you may add to the soil that affects the availability of nutrients to the tree



Amendments

Mulch



Dead material from plants and animals that is added to the mineral part of the soil. Leaves, manure, straw, compost, corn stalks, wheat hulls, grass cuttings are all organic materials

Some nutrients are easily washed away by rainfall or improper irrigation. This is called leaching because they are removed from the soil by the movement of the water. Drip irrigation may reduce leaching



Leaching

Photosynthesis

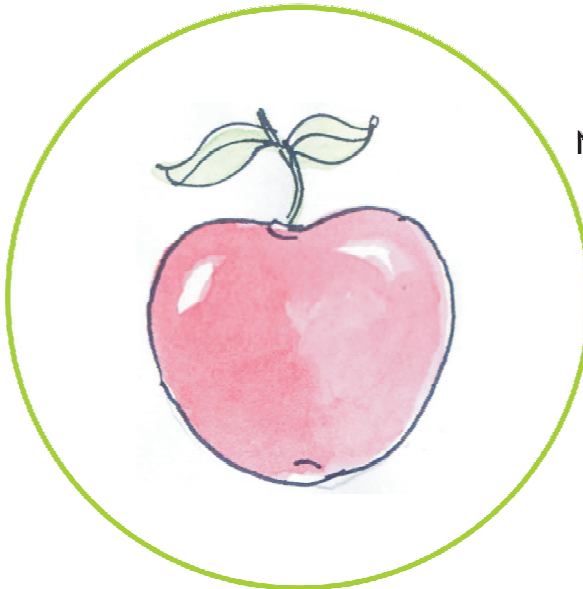


The process by which plants convert sunlight, water, and carbon di-oxide into sugar which they use as a source of energy and construction materials to produce more plant

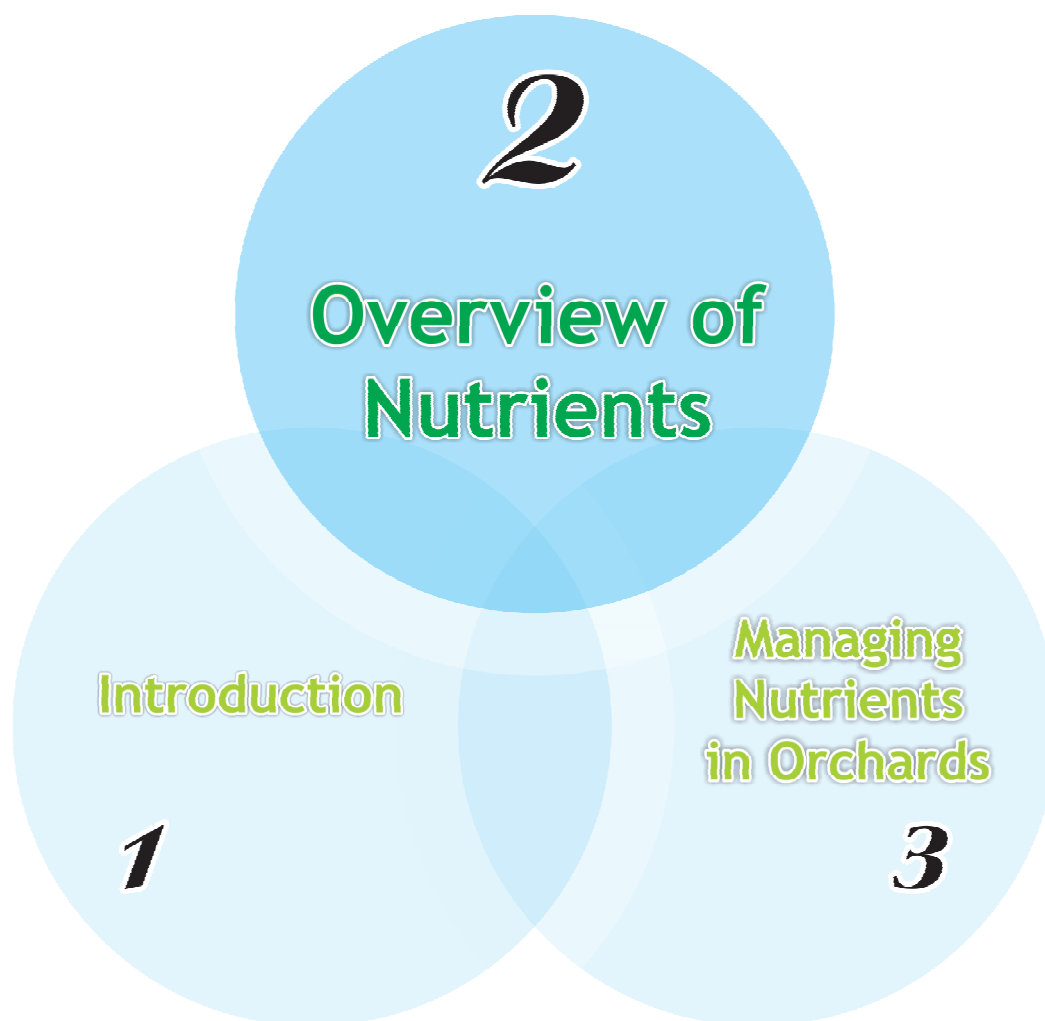
Nutrients and Orchards

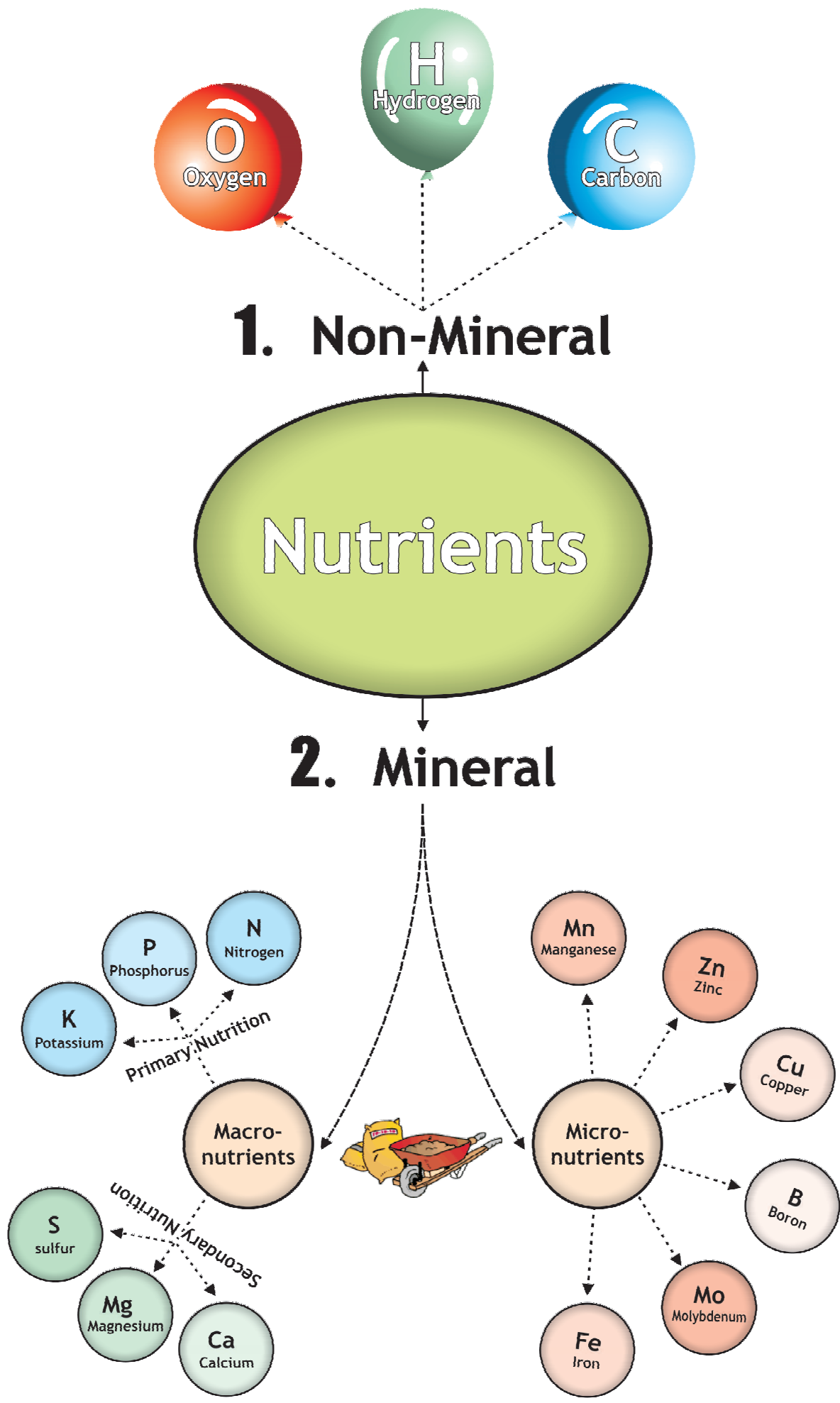
Orchard Production

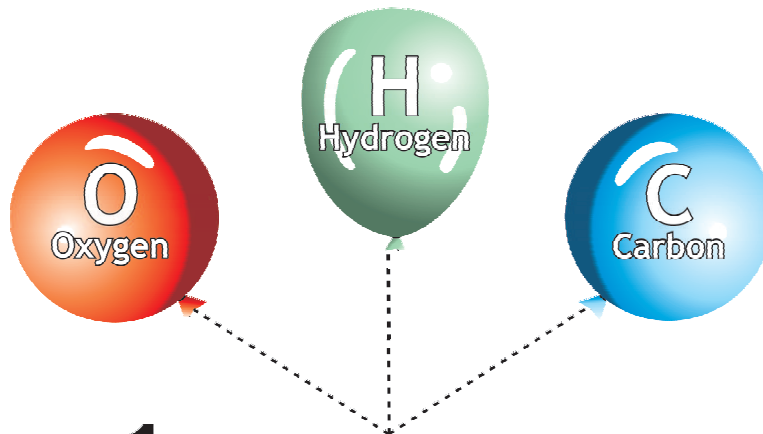
Successful only where high yields of high quality fruit are produced. High yield of low quality fruit or low yields of premium fruit will not be acceptable.



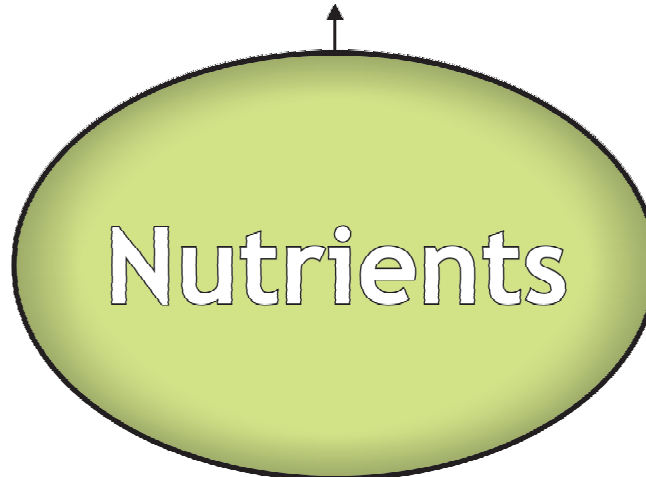
Nutrition Management
 Providing the trees the nutrients that they need is an important factor in both fruit quantity and quality.







1. Non-Mineral



These nutrients are found in the air and water.

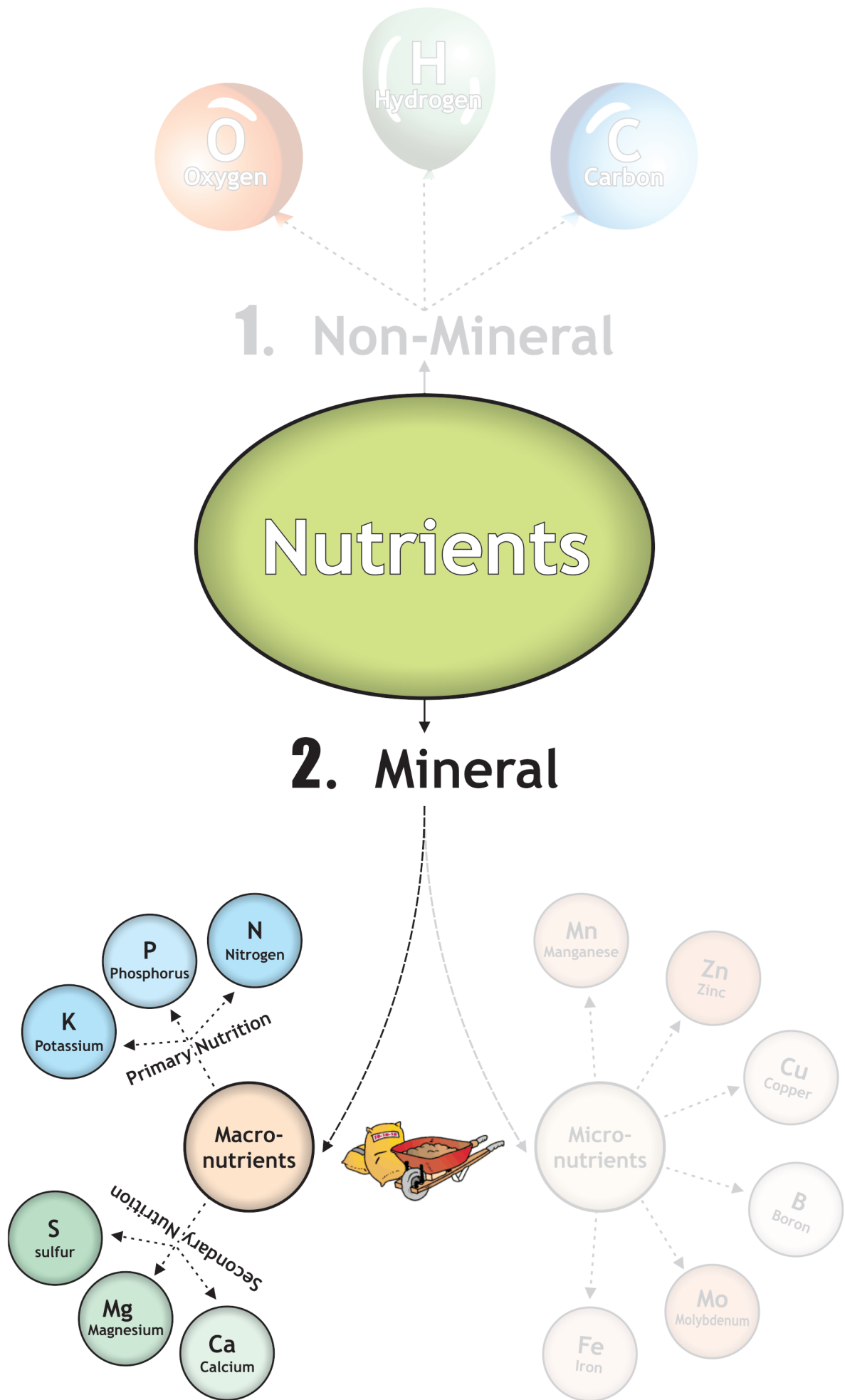


In a process called photosynthesis, plants use energy from the sun to change carbon dioxide (CO₂ - carbon and oxygen) and water (H₂O - hydrogen and oxygen) into starches and sugars.

These starches and sugars are the plant's food.

Photosynthesis means "making things with light".

Since plants get carbon, hydrogen, and oxygen from the air and water, there is little farmers and gardeners can do to control how much of these nutrients a plant can use. Farmers can make sure water is available with irrigation.



N
Nitrogen

Nitrogen



Macronutrients

- Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.
- Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.
- Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.
- Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen)
- Fruit growers often apply too much Nitrogen.

Symptoms



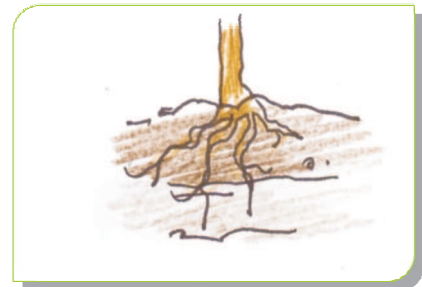
- New leaves pale
- Older leaves turn yellow or red
- Yellow leaves, stunted growth
- Trees growth weekly
- Increased summer drop
- Small fruit



Deficiency Causes



- Low soil N, leaching from the soil, inadequate N applied
- Too much "N" is a much greater access of "N" problem than too little can cause problem than less "N"



Sources



- Manure (NPK 0.5-0.3-0.5)
- Dried blood (blood meal) (NPK 12-1-1)
- Urea (NPK 46-0-0)
- Ammonium nitrate (NPK 34-0-0)
- Calcium nitrate (NPK 15-0-0)
- Ammonium sulfate (NPK 21-0-0)
(do not use if soil pH >6)
- Ammonium phosphate (NPK 11-21-0)

P
Phosphorus

Phosphorus



Macronutrients

- Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
- Involved in the formation of all oils, sugars, starches, etc.
- Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.
- Encourages rapid growth.
- Encourages blooming and root growth.
- Phosphorus often comes from fertilizer, bone meal, and superphosphate.

Symptoms



- Small plants, reddish-purple leaves, slow growth, loss of plant vigor brown, leaves abort.
- Blue to purple coloring on new Leaves.
- Thin vertical branches.
- Few flower and fruit.
- Stone fruits may be soft.
- Poor flavor.



Deficiency Causes



- low soil P; cool, wet soils; inadequate P applied
- Deficiency uncommon in mature trees



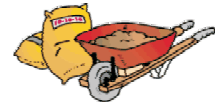
Sources



- Manure (NPK 0.5-0.3-0.5)
- MAP (NPK 11-48-0) and DAP (→, →, →)

K
Potassium

Potassium

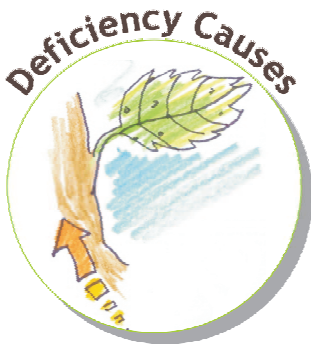


Macronutrients

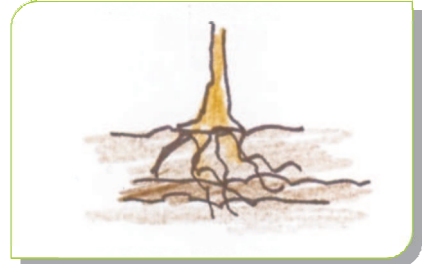
- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.
- Potassium deficiency can be caused by inadequate irrigation.
- Potassium deficiencies occur in poorly drained soils like clays and heavy silts.



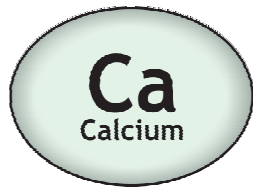
- Small plants, brown margins on lower leaves, small weak stems, lodging of plants, poor yield and quality
- Edges of leaves look burnt.
- Small fruit.
- Old leaves do not Fall from tree.



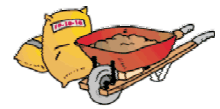
low soil K, leaching from the soil, inadequate K applied



Soil	Foliar
Manure (NPK 0.5-0.3-0.5) Sulphate of Potash (K_2SO_4 0-0-47) 10-20 kg/8 Kanals.	Potassium nitrate KNO_3 up to 40 lbs/ 100 g 25 lbs acre.

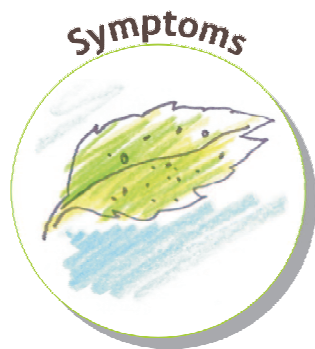


Calcium



Macronutrients

- Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.
- Sources of calcium are dolomitic lime, gypsum, and super phosphate.



Symptoms

- Small plants, deformed buds, distorted leaves, failure to grow, poor fruit development.
- Bitter pit in apples.
- Brownish bruises on surface and interior.



Deficiency Causes

low soil pH, leaching from the soil, inadequate lime applied



Sources

Soil	Foliar
Apply limestone (calcium carbonate) or superphosphate $\text{CaH}_4(\text{PO}_4)_2$	spray 2% solution of calcium hydroxide

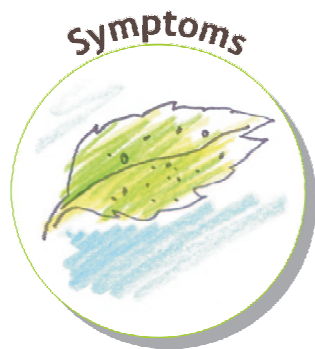
Mg
Magnesium

Magnesium



Macronutrients

- Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.
- Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.
- Poor management of potassium fertilization to soil may create Mg deficiency.



- Appear on older leaves
- Lower leaves---in severe cases, entire plants---turn yellow with green interveinal areas
- Loss of chlorophyll.
- Loss starts at leaf base.
- Leaves Fall from the tree early.



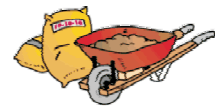
- Low soil pH, leaching from the soil, no Mg applied in lime or fertilizer
- Excessive applications of potassium can make management unavailable



Soil	Foliar
<ul style="list-style-type: none"> ● Not effective on soils with pH higher than 7.0 ● If pH is suitable, apply Mg sulfate or Mg oxide ● Application of dolomitic limestone is the most common approach for correcting magnesium deficiencies where soil pH is low 	Mg nitrate 10 lbs/ 100 gallon water (8 gal/ mature tree)

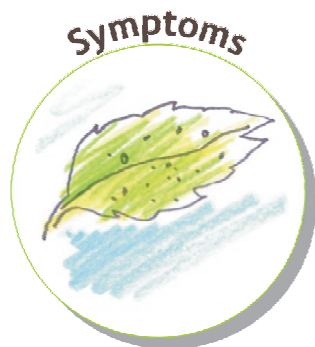
S
Sulfur

Sulfur



Macronutrients

- Essential plant food for production of protein.
- Promotes activity and development of protein & Hormones..
- Trees need about the same amount of Sulfur & Phosphorus.
- Helps with vigorous plant growth and resistance to cold.
- Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers.



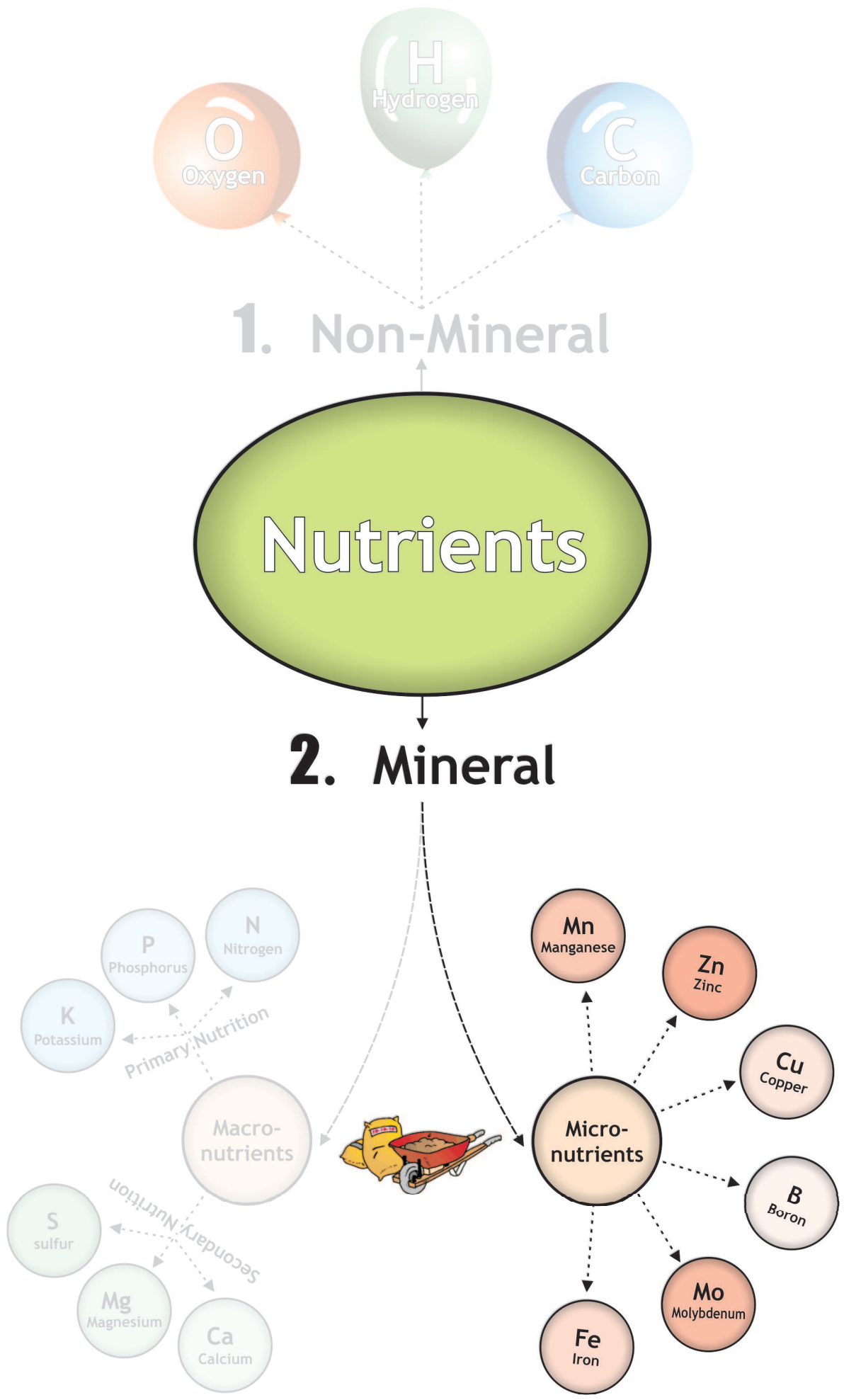
- Young leaves at tips turn.
- Yellow, slow growth, low vigor, low crop yield and quality
- Very uncommon looks like nitrogen deficiency



low soil S, leaching from the soil, low organic matter content, no S fertilizer applied

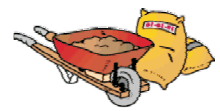


- Ammonium sulphate
- Ammonium sulphate nitrate
- Use of copper sulphate in bordeaux mixtures to control fungal disorders is likely to eliminate sulfur deficiencies completely.



Mn
Manganese

Manganese



Micronutrients

- Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.
- Soil is a source of manganese.

Symptoms



- Interveinal chlorosis of leaves, stunted plants, yellow cast over deficient areas, reduced yield & quality
- Looks like Iron deficiency.



Deficiency Causes



- Low soil Mn, high soil pH
- Excessive use of lime leaching in low pH soils



Sources

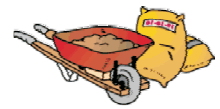


Sources of the nutrient for fertilization

- Foliar sprays
 - 1) 1 lb Mn sulfate/ 100 gal water (300 ppm Mn)
add 7.5 lb of biuret will increase uptake
 - 2) combination Zn and Mn
 - 3) Combination Zn, Mn, and urea
- Apply to young growth leaves before fully grown

Zn
Zinc

Zinc



Micronutrients

- Essential for the transformation of carbohydrates.
- Regulates consumption of sugars.
- Part of the enzyme systems which regulate plant growth.
- Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.

Symptoms



- Chlorotic leaves, slow growth, reduced vigor, white streaks parallel to leaf blade.
- Leaf bunches at tips.
- Leaves small, narrow, pointed
- Fruit ripen too early.
- Poor yield of Fruits.



Deficiency Causes



Low Zn in soil, high soil pH, high soil P



Sources



Soil

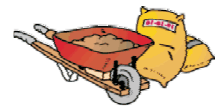
Low pH: banded around the tree
High pH: do not correct deficiency

Foliar

standard spray: 0.5 lb Zinc sulfate/ 100 gallons - apply 8-10 gallons per tree
another spray: 2-3 lb zinc oxide/ 100 gallons water

Cu
Copper

Copper



Micronutrients

- Important for reproductive growth.
- Aids in root metabolism and helps in the utilization of proteins.
- Required to produce pollen.

Symptoms



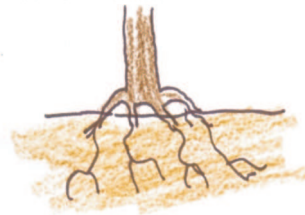
Reduced growth, leaf-tip dies back, leaf tip breaks down, leaves ragged in summer.



Deficiency Causes



- Low soil Cu, high organic matter
- Copper deficiencies are uncommon.



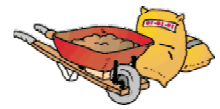
Sources



- Use of bordeaux mixture for fungus control will eliminate any possibility of deficiency
- Maintain soil pH of 6.0 to 7.0 in order to avoid problems with excess copper

B
Boron

Boron



Micronutrients

- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.
- Sources of boron are organic matter and borax

Symptoms



Terminal bud dies, multiple lateral branches (rosette with short internodes, older leaves thick and leathery, petioles short, twisted and ruptured), cork spot (in apples)



Deficiency Causes



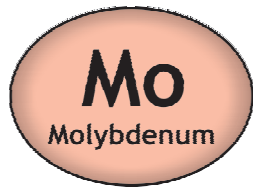
- Deficiency is rare
- Excess is common.
- Low soil B, esp, on sandy soils



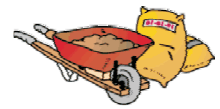
Sources



- Deficiency is rare
- Deficiency : Borax 1 to 2 OZ per tree
- Excess is common
- Excess: Add line



Molybdenum



Micronutrients

- Helps in the use of nitrogen
- Soil is a source of molybdenum.

Symptoms



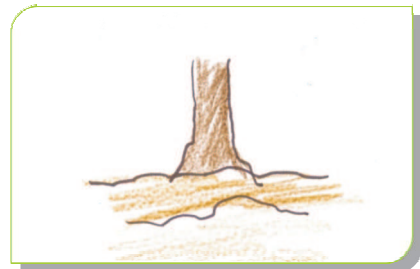
- Older leaves affected
- Reduced growth; pale green color; necrotic areas adjacent to midrib, between veins and along leaf edges; twisted stems
- Spots with brown centers and yellow or orange Halos.



Deficiency Causes



- Extremely Rare
- Low soil pH, low Mo content in soil



Sources

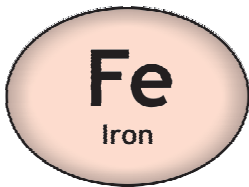


Soil

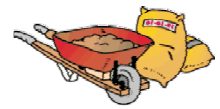
Correct pH to 6.0 to 6.5 - resolves availability issues

Foliar

1 oz of sodium molybdate or ammonium molybdate in 100 gallon water



Iron



Micronutrients

- Essential for formation of chlorophyll.
- Required for photosynthesis.
- Sources of iron are the soil, iron sulfate, iron chelate.

Symptoms



- Seen on young leaves.
- Leaves with chlorosis patterns.
- Feather-like straight green veins on light green background
- Severe deficiency - leaves yellow
- Tree leaves and branches begin to die back
- Leaves are normal size and shape



Deficiency Causes



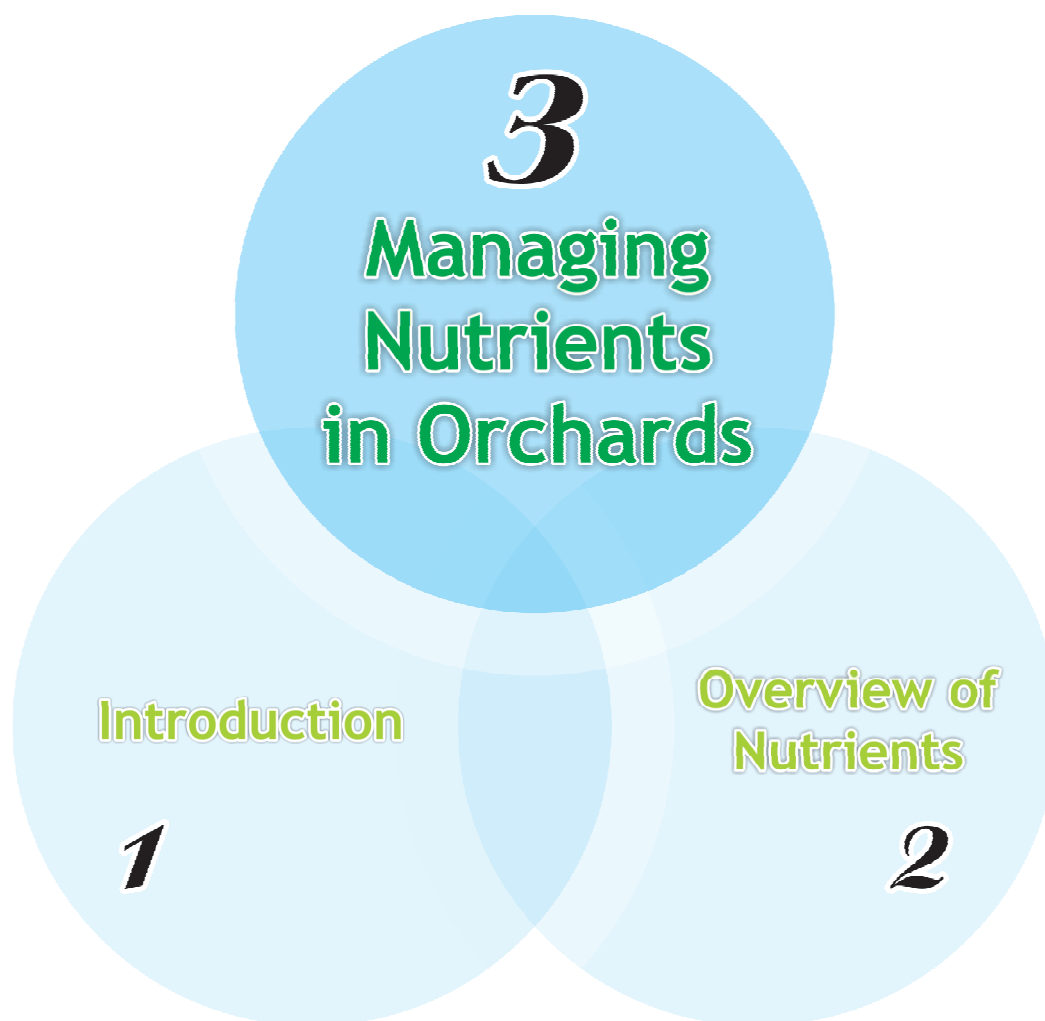
- Low availability of Fe in high pH soils
- Flood irrigation with inadequate drainage.



Sources



- Difficult to correct
- Iron chelates added to soil
- Foliar sprays
- Addition of iron containing fertilizers to organic matter mulches may enhance availability



Management Nutrients in Orchard

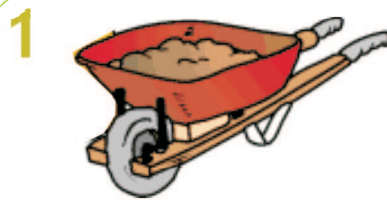
Management of most nutrients should be based on these indications:

Soil test indications
of excess or
deficiency

Leaf test indications
of excess or
deficiency

Observation of
nutrient deficiencies
or excesses in tree
growth or appearance
- DEFICIENCY
SYMPTOMS

Where excesses or deficiencies of nutrients are observed refer to specific nutrients for corrective actions



Soil pH



Managing Nutrient



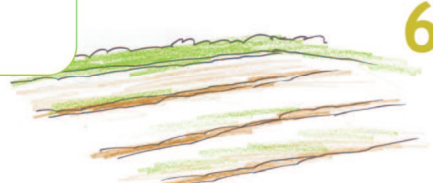
Fertilization Tips



Nitrogen Fertilizer Tips



Tree Fertilization



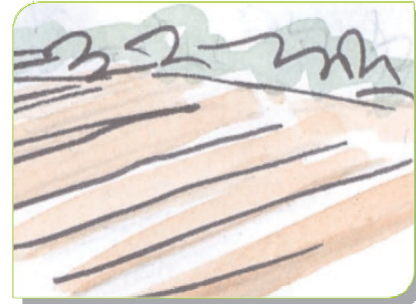
Orchard Floor Management

Soil pH

(Soil acidity or alkalinity)

- pH is a measure of the chemical potential of a soil
- Soil pH is referred to as the “acidity” of the soil and is measured by the number of Hydrogen ions present in the soil solution.

When the soil pH is too “acid” (low pH) or “alkaline” (high pH), nutrients present in the soil become locked-up or unavailable.



High rainfall areas
Dry or desert lands

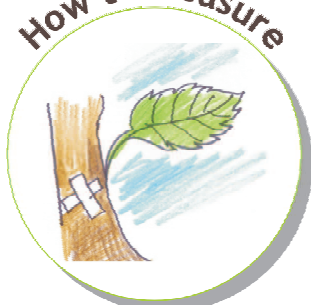


Corrective Methods



- Grow pH suitable crops of your soil and region
- Decrease the use of lime or limestone if pH is high.
- Application of sulfurs and continued use of urea fertilizers if pH is high.
- Where pH is low apply 20-30 kg per kanal per year until corrected.

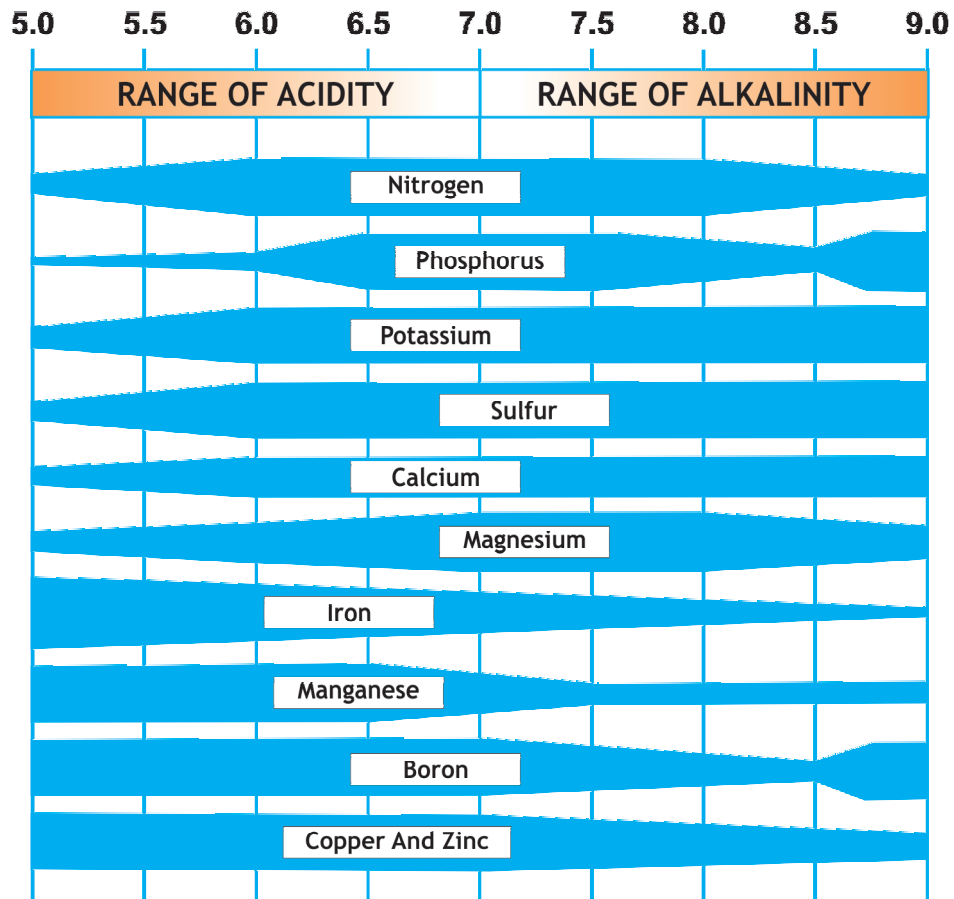
How to Measure



pH is measured on a scale from 0 to 14

- pH near 7 is termed neutral
- Below 7 we call soils acidic
- Above 7 we call soils alkaline

Effects of Soil Nutrition



Even when the soil nutrients are present they may not be available because of soil pH

Where Band is wide nutrient is available at that pH.

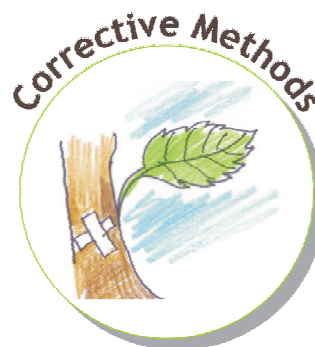
Where Band is narrow nutrient is not available at that pH.

1 - Soil Organic Matter

- Dead plant and animal wastes that have been allowed to rot and decompose



- When lacking organic matter, nutrients and fertilizers are easily washed from the soil by rain
- Soil with very low organic matter will be recognized as weak or poor soils by farmers
- Soils with sufficient organic matter will be recognized as strong or rich soils by farmers



- Grow Cover crops and plow them into soil.
- Spread Compost and rotted manures
- Apply based on Nitrogen needed for orchard.
- Apply before required in summer and autumn
- Don't apply during bud break



- Improves the health of the
- Acts as source of nutrition to the plants.
- Increases the stored water for the plant.
- Contributes mineral nutrients like a fertilizer.

2 - Managing Nutrition

- We need to pay attention to the nutrients in our orchard to be sure that the proper nutrients are present and are available to our fruit trees
- Without proper nutrients the trees will not grow or produce well and the orchard will not be profitable
- If one nutrient is very deficient the orchards growth will be reduced even if the other requirements are there in abundance



Pay attention to the nutrients



Build and maintain biologically active soil with plenty of organic matter



Supplement with fertilizers from approved sources



Adopt a patient and dynamic approach

a - Soil & Leaf Testing

Soil Test Procedure

At each location remove the surface vegetation, leaves, and the top 2 to 3 centimeters of soil

Dig a hole at least 30 centimeters deep

Take a small amount (less than a handful) of soil from the side of the hole near the surface and another from near the bottom

Keep these two samples in separate bags

Move to a new location and repeat

Again add the soil from the shallow point to the bag or bucket with the previous shallow point soils and the soil from the bottom of the hole to the bag with the bottom soil

When you have collected a small amount from enough different locations, you will have two bags of soil: one a mixture of soil collected from the shallow layer and one from the deep.

You will need to label the two samples shallow and deep and your name

You will send about ½ to 1 liter of soil from each bag to the laboratory and discard the rest

For Initial Test you need to know:

Soil pH

Soil P, K, Ca

Soil texture

- Soil tests for nitrogen are useless and of no value
- A good soil test will also provide you with estimates of micro-nutrients
- Soil testing should be done every three to four years to be aware of changes



DO NOT mix soil that appears quite different from different parts of the orchard

You need to end up with two large samples

- One from the top layer of the soil (1-8 inches)
- One from the lower layer (8-16 inches deep)
- You should collect the soil from at least two locations per kanal of orchard

b - Tissue & Leaf Testing

- Soil tests for nitrogen are useless and of no value
- A good soil test will also provide you with estimates of micro-nutrients
- Soil testing should be done every three to four years to be aware of changes



Tissue Testing

- Collect mature leaves from trees of the same age
- A sample of 100 leaves will be adequate
- Not more than 2 leaves should be taken from a single branch
- Leaves should be collected from branches and trees that are representative of the entire orchard - do not collect from the best or the worst individuals
- Leaves are best collected in late summer as the results will be most useful
- Send leaves to a qualified test laboratory with a request for appropriate tests



Leaf Testing

- Soil analysis only tells us if the nutrient is present BUT not whether the tree can get the nutrient
- Testing of nutrient contents of tree leaves provides the best indication of the nutrient requirements of the tree
- Testing should be done on mature leaves in the late summer

3 - Fertilizing Tips

Take a soil test to determine fertility level and pH.

Fertility amended prior to planting.

Ideal soil pH should be 6.0 - 6.6.

Phosphate level should be about 70 ppm.

Potash level should be about 300 ppm.

Work fertilizer and lime into the soil.

Lime, phosphate, and potash move down through the soil slowly.

Conduct new soil tests every 3 to 4 years

pH in 6.5 to 7 range best for most fruit trees

Leaf analysis - useful in alternate years

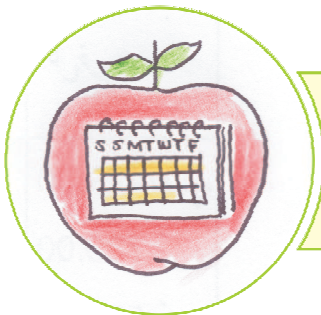
4 - Nitrogen Fertilizer TIPS

Do not fertilize at planting



Nitrogen is the key element for plant growth.

Amount of nitrogen needed depends on rootstock, variety, tree age, and bearing capacity.



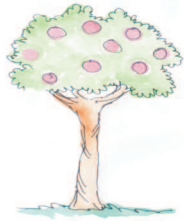
N application rates can be based on amount of annual growth that takes place.

How much new growth should occur??



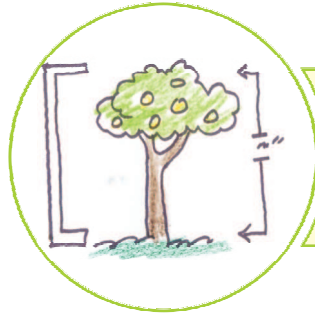
Dwarf Tree

Dwarf



20 kg/tree/5th yr
80 kg/tree/9th yr

- Terminal growth on young non-bearing trees should be 30-45 cm.
- Terminal growth on bearing trees should be around 15 cm.
- If more than 15 cm inches, decrease nitrogen fertilizer.
- Before bearing apply nutrients annually as a complete fertilizer (ex. NPK 17-17-17)
- After production begins, focus on N



Terminal growth on young non-bearing trees should be 30-45 cm.

Terminal growth on bearing trees should be around 15 cm.



If more than 15 cm inches, decrease nitrogen fertilizer.

Before bearing apply nutrients annually as a complete fertilizer (ex. NPK 17-17-17)



After production begins, focus on N

Sami-Dwarf Tree

Semi-Dwarf



40 kg/tree/5th yr
160 kg/tree/9th yr



Terminal growth for non-bearing should be 45 - 60 cm.

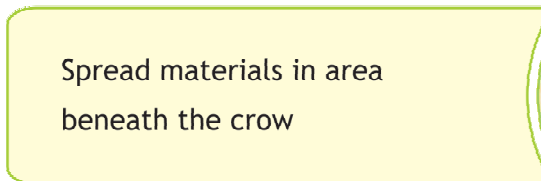


Terminal growth for bearing trees should be 16 to 30 cm.

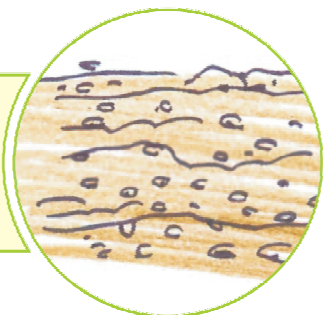


Before bearing apply nutrients annually as NPK 17-17-17 After bearing NPK 45-0-0

- Terminal growth for non-bearing should be 45 - 60 cm.
- Terminal growth for bearing trees should be 16 to 30 cm.
- Before bearing apply nutrients annually as NPK 17-17-17
- After bearing NPK 45-0-0
- Spread materials in area beneath the crown



Spread materials in area beneath the crown



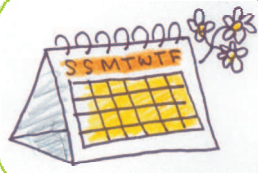
Standard Trees

Standard



80 kg/tree/5th yr
320 kg/tree/9th yr

- Apply twice per year in late March and mid May.
- Terminal growth for non-bearing trees should be 60-75 cm.
- Terminal growth for mature bearing trees should be 30-38 cm.
- Before bearing apply nutrients annually as NPK 17-17-17
- After bearing NPK 45-0-0 (urea) or MAP 11-48-0
- Without other guidance 250 g per tree
- Soil test every 3 years.



Apply twice per year in late March and mid May.

Terminal growth for non-bearing trees should be 60-75 cm

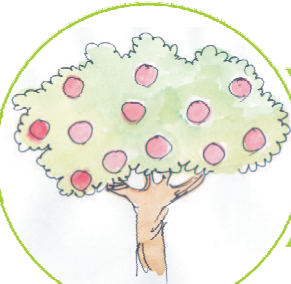


Terminal growth for mature bearing trees should be 30-38 cm.

Before bearing apply nutrients annually as NPK 17-17-17



After bearing NPK 45-0-0 (urea) or MAP 11-48-0



Without other guidance 250 g per tree



1..2..3



Soil test every 3 years

6 - Orchard Floor Management



Intercropping of vegetables
(Legumes, tomatoes, peppers,
eggplant, okra - NOT maize, NOT
wheat, NOT potatoes)



Clean cultivation with periodic
tilling. Only used in areas with low
erosion potential

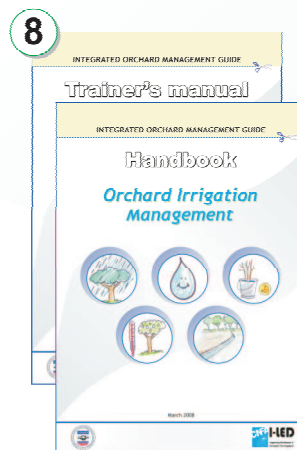
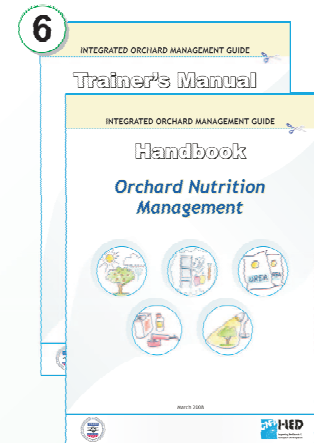
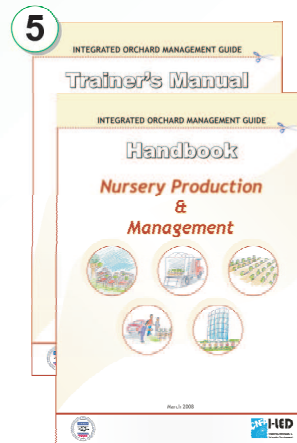
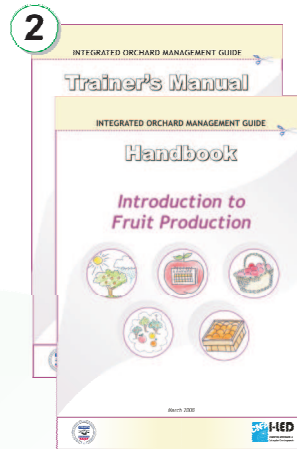
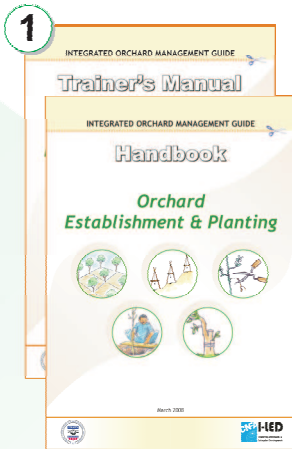


Sod or sod/mulch. Reduces
fluctuations in soil moisture and
temperature but harbors disease
and insects. Competition a problem
for young trees



Combination - sod in aisleways,
herbicide strip down row to width
of canopy

INTEGRATED ORCHARD MANAGEMENT GUIDE



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