# Root Death In Landscapes

## Natural Causes, Accidents & Murder

Carolyn Scagel, USDA-ARS-HCRL

Corvallis, Oregon

# More In Depth Information

- Monday
  - Davis Sydnor – Planting Depth Issues
  - Hannah Mathers – Ornamental Weed Control
  - Jim Atland – Weed Control in Landscapes
  - Abiotic Disorders Workshop
- Tuesday
  - Mimi Rose – Fertilizing Ornamentals (9:15)
  - Larry Kuhns – Mulches in Landscapes (9:15)
  - John Lloyd – Plant Health (9:15 & 10:40)
  - Kuhns – Weed Control in Conifers (1:00)
  - Mathers – Weeds  Control in Herbaceous Beds (2:00)
  - Scagel – Mycorrhizae in Production (2:00)
- Wednesday
  - Mathers – Overwintering (9:15)
  - Craig Schaar – Tree/Sidewalk Conflicts (10:40)
  - Luke Case – Weed Control in Landscapes (1:00)

# Outline

- Plant decline & death in landscape plantings
- Root basics
- Natural Causes
- Accidents
  - Pre-transplant factors
  - Production, transport, storage, transplanting
- Murder
  - Post-transplant factors
  - Plant & site selection, amendments, mulches, etc.
- Symptoms

# Why Do Plants Die In the Landscape?

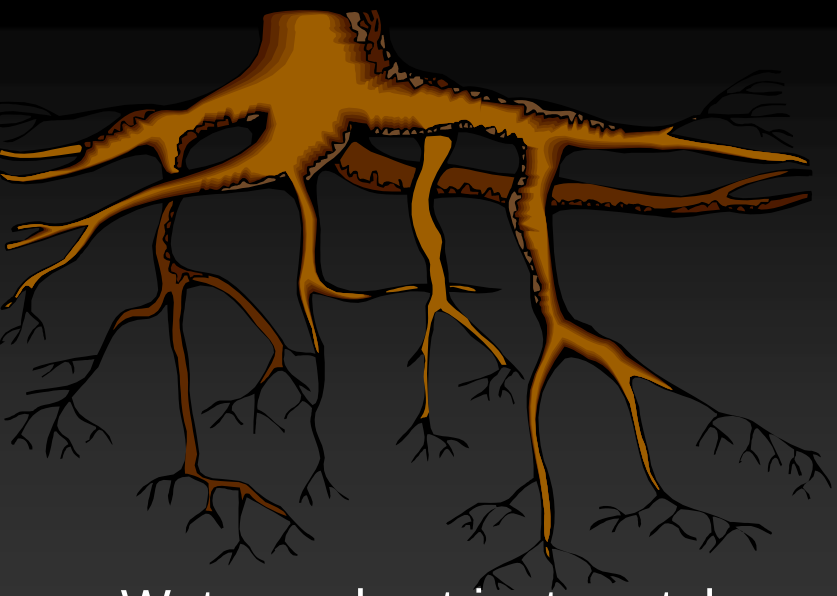
- Abiotic factors account for 85% of the plant death that occurs in landscape plantings.

- Pests and diseases are not the primary cause for plant decline and death in landscapes.

# Plant Success in Landscapes

- Unhealthy root system - slow plant growth or plant death after transplanting.

- Some of the reasons for poor root growth or root death in landscape plantings include:
  - Pre-transplant factors that influence stock quality
  - Planting method & time
  - Post-transplant factors (e.g. soil type, mulches, amendments, fertilizers, root treatments).

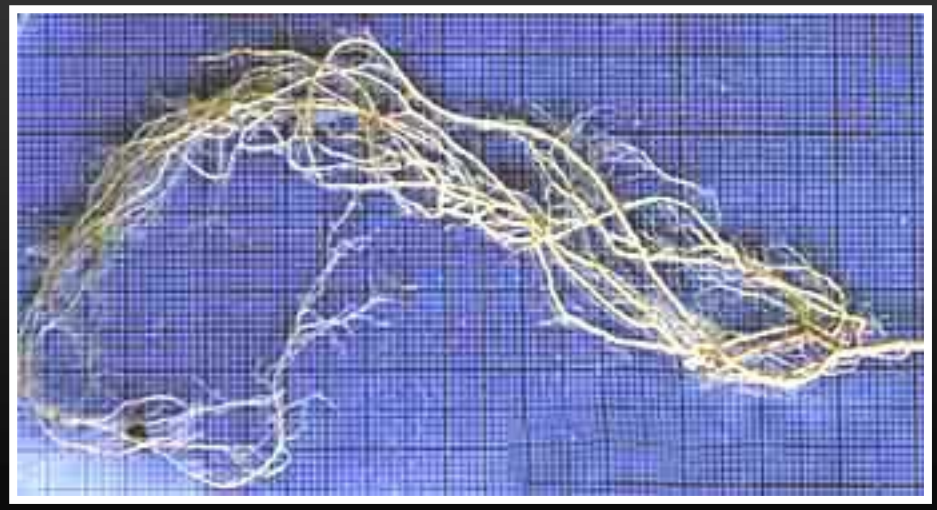


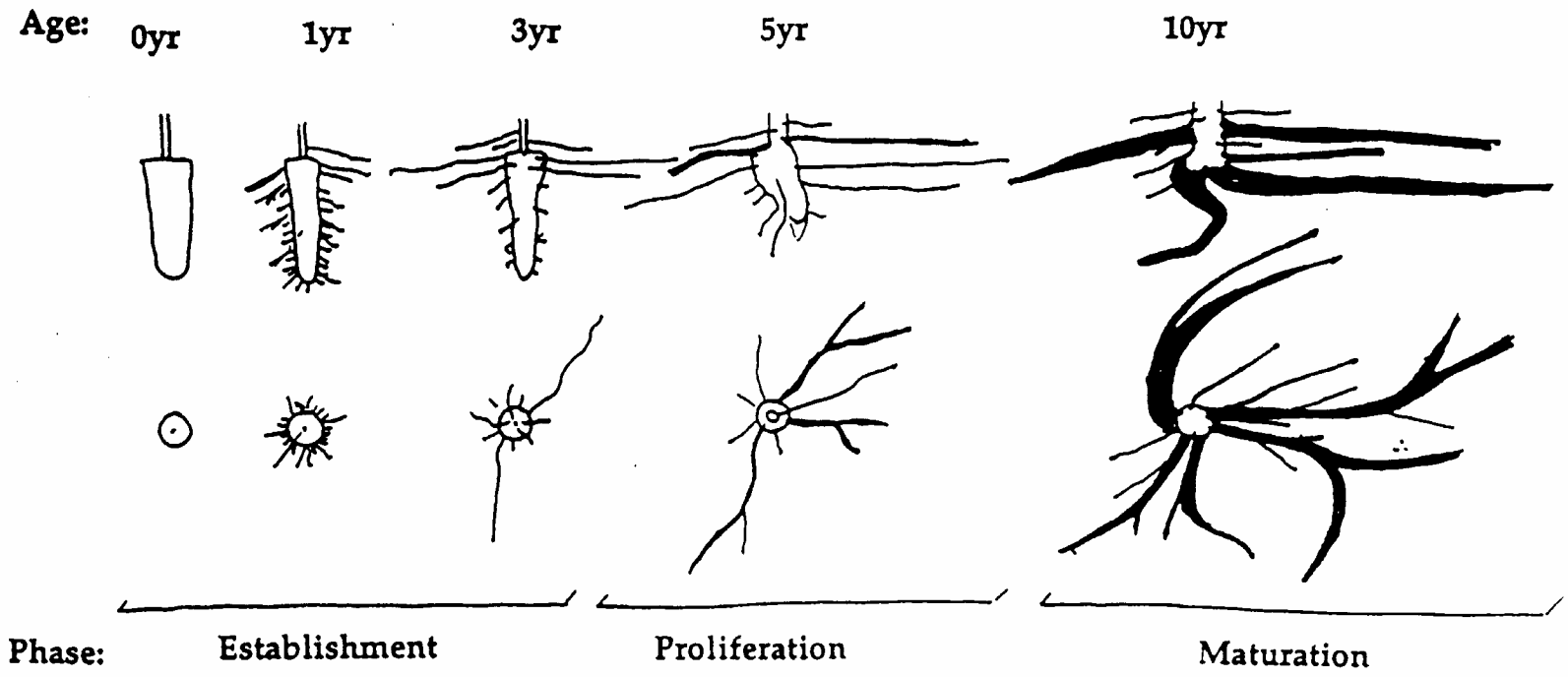
# Why is Root System Health Important?

- Water and nutrients uptake
- Storage of nutrients and energy for growth
- Mechanical support
- A sensor network that helps regulate plant growth
- Chemical release that alters soil pH, poison competitors, filter out toxins
- Produce carbon that feed soil microbs and improve soil OM
- Habitats for mycorrhizal fungi, rhizosphere and rhizoplane organisms

# Structure and Function

- Different types of roots have different functions.
- The proportion of different types of roots changes with plant age, season, etc.




Age:
0yr
1yr
3yr
5yr
10yr
Phase:
Establishment
Proliferation
Maturation

# Natural Root Death

- Roots die or turnover as plants mature and as a result of seasonal or environmental conditions.
- The cyclic nature of root death is natural.
- The important thing isn’t that roots die, but that new roots are initiated and grow to meet the demands of the plant for water, nutrients, etc.


May 2000


July 2000


October 2000

# What You Don’t Look For Will Hurt You

Plant condition or stock quality prior to transplanting can alter plant performance in the landscape.

- Nursery production
  - Container effects
  - Harvest practices
  - Chemical applications
- Handling, transport, and sales conditions

# Plants in Containers

- Containers restrict root growth and can cause deformity.

- Container effects on root form can cause:
  - Insufficient anchorage
  - Girdling of stems and roots
  - Reduced shoot growth

- Reducing root deformity:
  - Container size and shape
  - Copper coatings

# Root Deformation

# Root Deformation

# Potato Roots

# Roots Girdling Roots

# Roots Girdling Stems

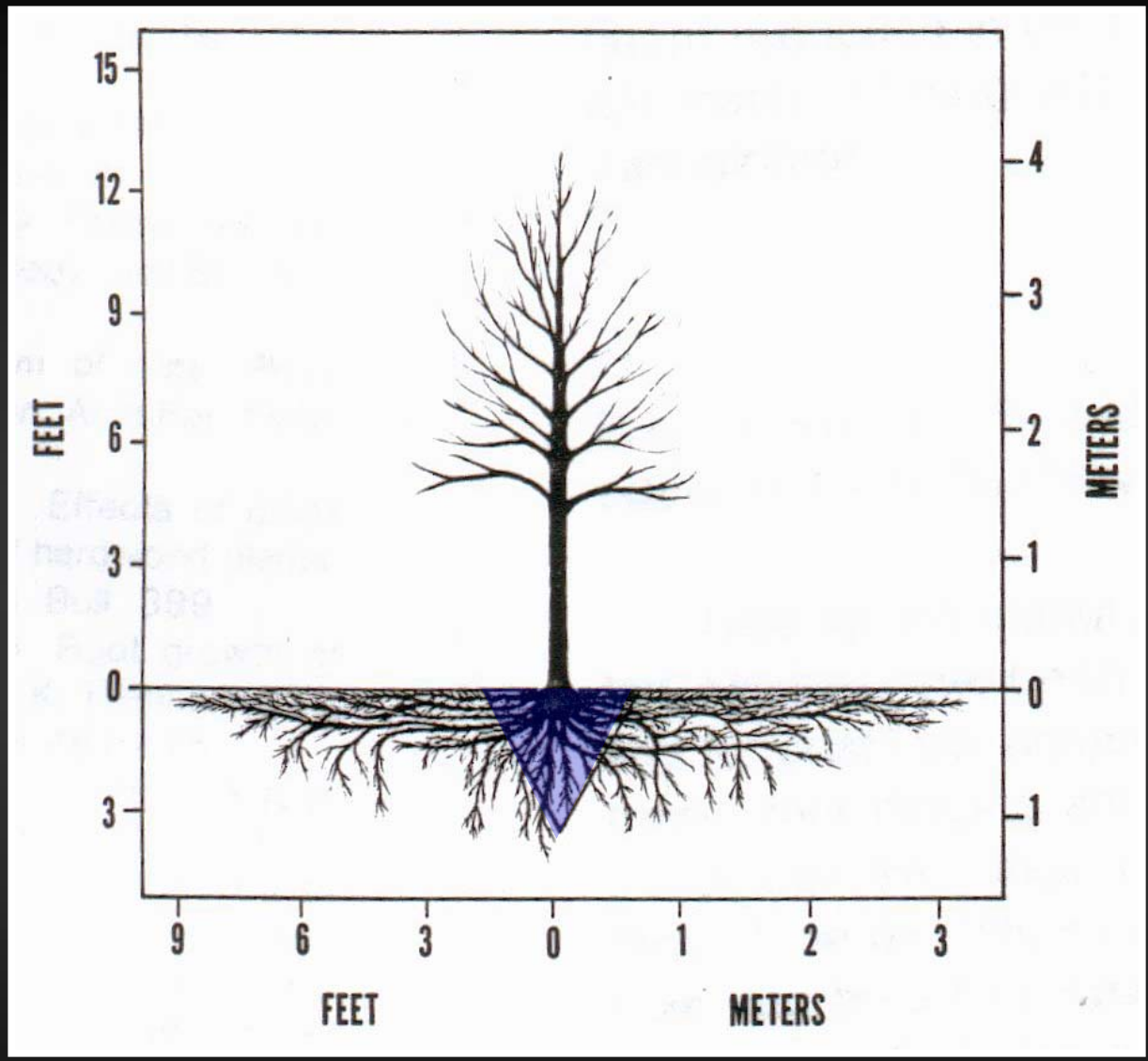
# Structural Instability

**(See Gary Johnson, UMinn Website)**

# Container Temperature


# Bareroot Harvesting

- Decreases the amount of roots and creates an imbalance between roots and shoots.
- Root loss can cause:
  - Transplant shock
  - Reduced shoot and root growth
  - Reduced nutrient and water uptake




Loss of root mass, volume, surface area, length, and type.

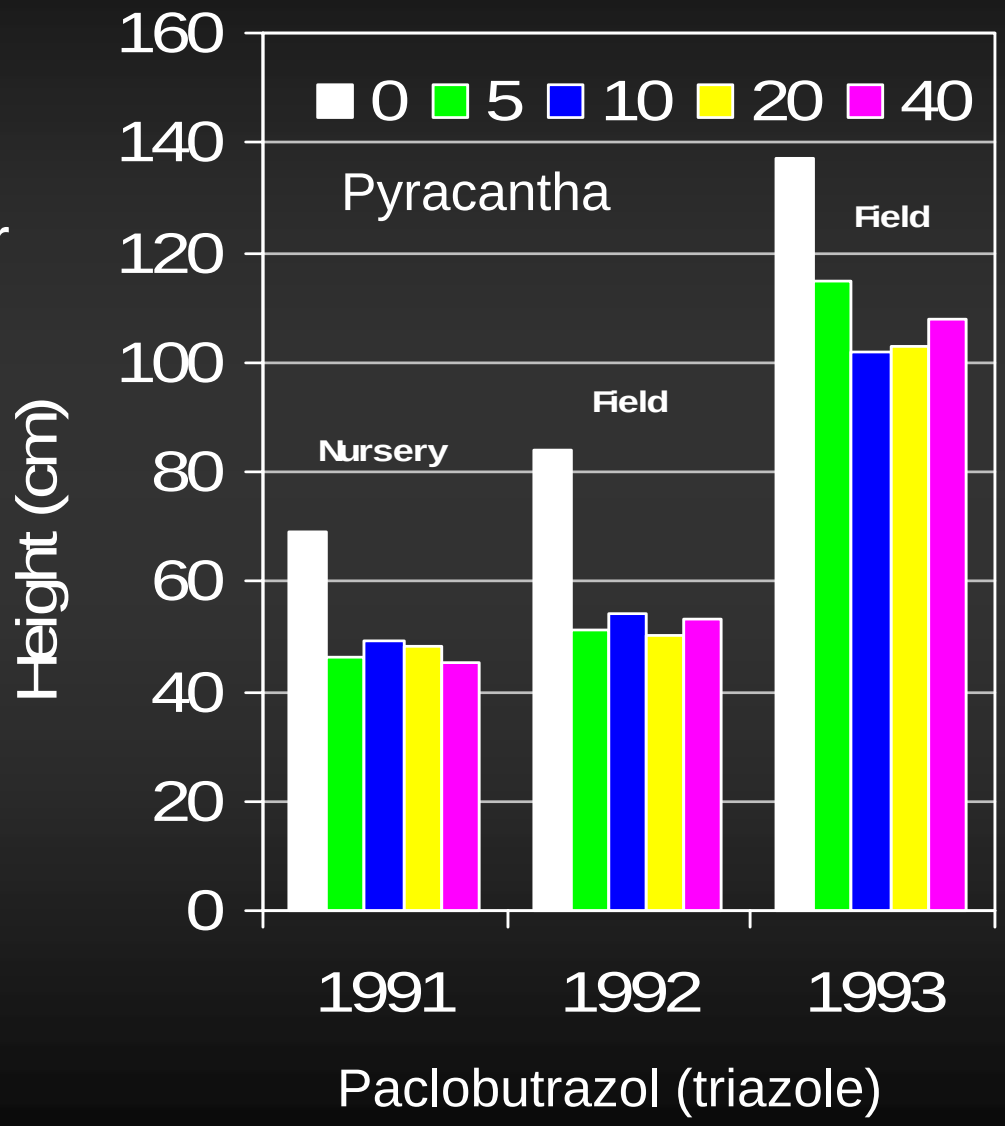
# Stock Choice and Performance

| Production Method | Root Ball | Staking | Irrigation | Growth | Survival |
|---|---|---|---|---|---|
| **Containers** | Light | Frequent | Frequent | VG to E | VG to E |
| | | | Infrequent | F to G | F |
| **B&B Not Root Pruned** | Heavy | Sometimes | Frequent | G | F to G |
| | | | Infrequent | F to G | P to F |
| **B & B Root Pruned** | Heavy | Sometimes | Frequent | E | E |
| | | | Infrequent | G | G |
| **Bareroot** | Light | Usually | Frequent | E | E |
| | | | Infrequent | G | G |

E. Gilman, UFl.

# Chemical Applications

- Any chemical that influences plant growth in the nursery may carry-over into the landscape:
  - Plant growth regulators
  - Herbicides
  - Pesticides
  - Fungicides




Ruter 1994

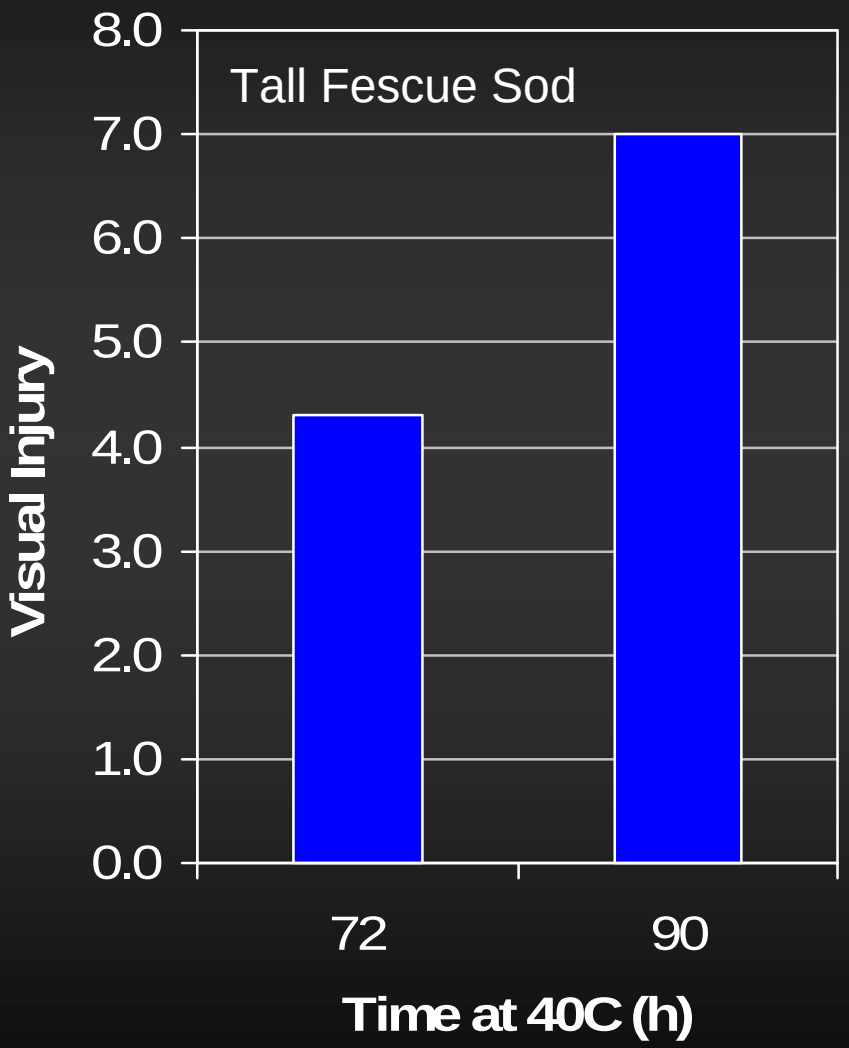
# Herbicide Application

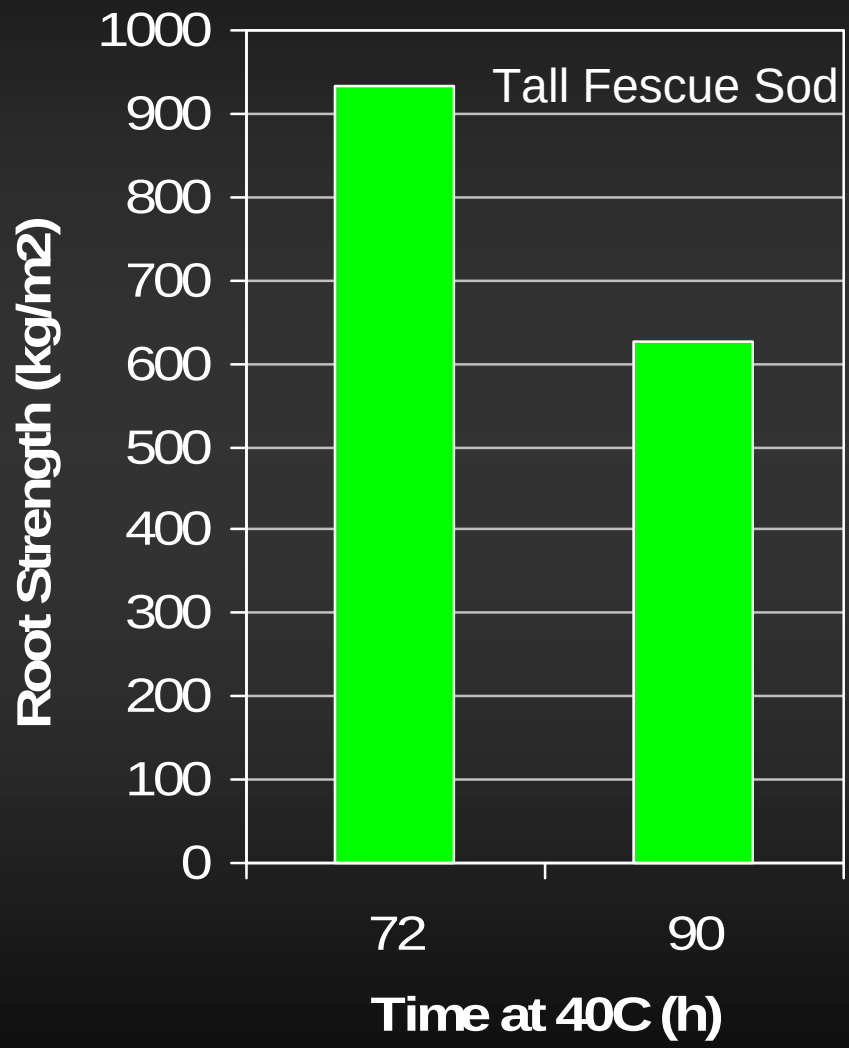
Poor rooting out between medias from DNA herbicide injury

# Extreme Conditions

- Transport, Storage and Sales:
  - Extreme temperatures
  - Low light
  - Nutrient and water stress
- Decrease reserves
- Suppress root growth
- Injury or dieback of roots
- Decreasing root growth after transplanting

# Heat Stress During Transport




Zhang et al. 2003

# Look Before You Plant

- Inspect for root system damage prior to purchase or transplanting to minimize the impact of root damage on transplanting success

- Select container-grown plants that are not pot bound and have healthy looking root systems.

- Choose bareroot plants with fibrous rootballs (more feeder roots and secondary structural roots)

(ANLA Standards)

# What You Do May Hurt You More

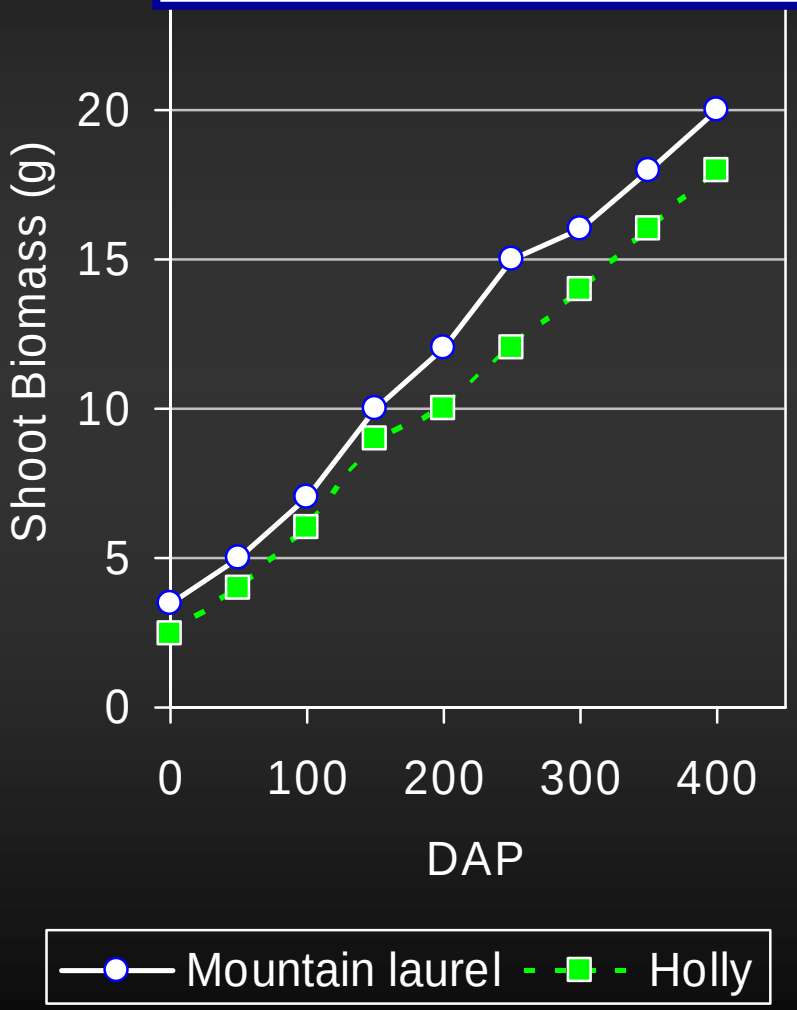
- When, how, and where you plant
- What you do afterwards
- Even when stock quality is high, poor planting technique or maintenance after planting can result in root death.

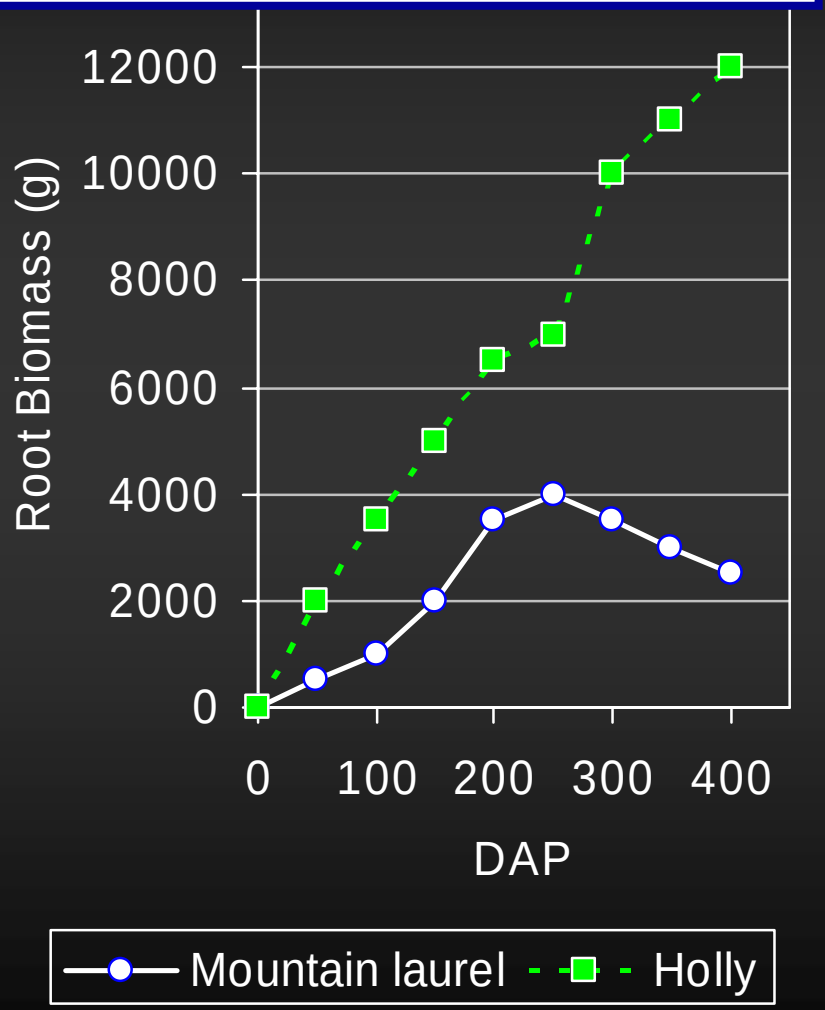
# Time of Planting

- Root growth following transplanting is necessary for water and nutrients uptake.
- The rate of root growth and root growth periodicity vary with species, environmental conditions, and season.
- Autumn transplanting can improve transplanting success of some species while other species perform better when planted in the spring.

# Root Periodicity

**Potential for success higher when roots are actively growing**

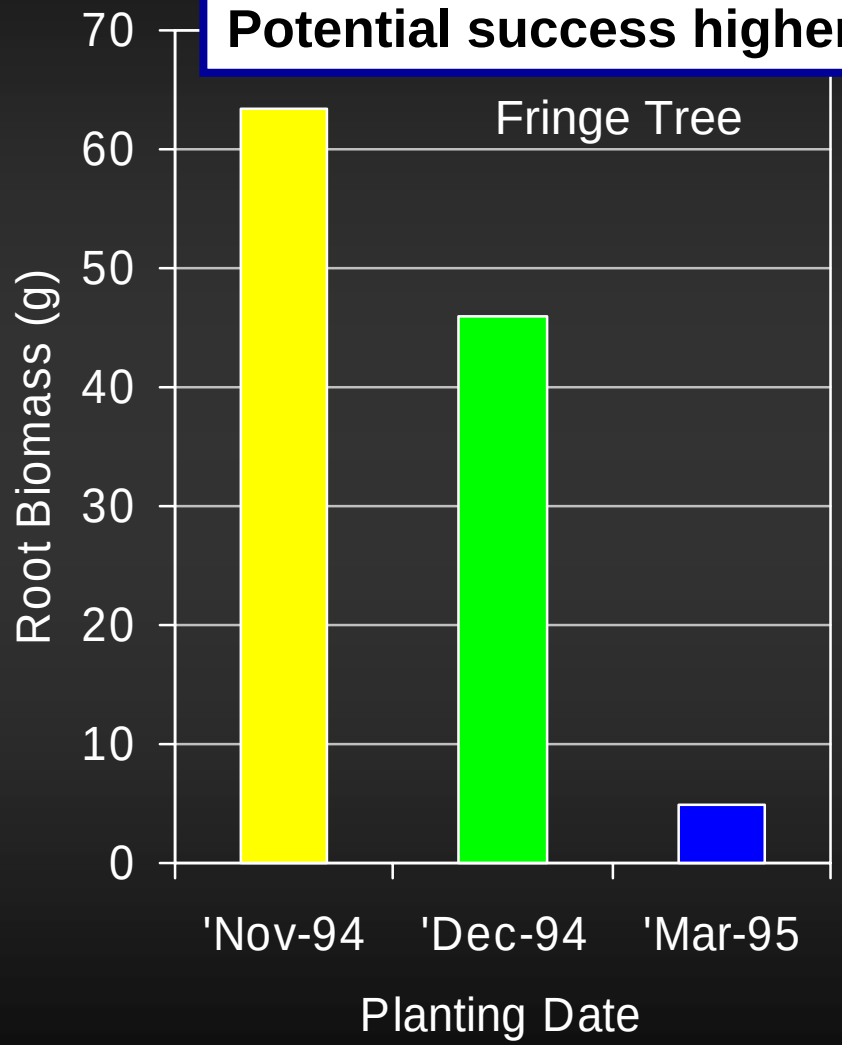


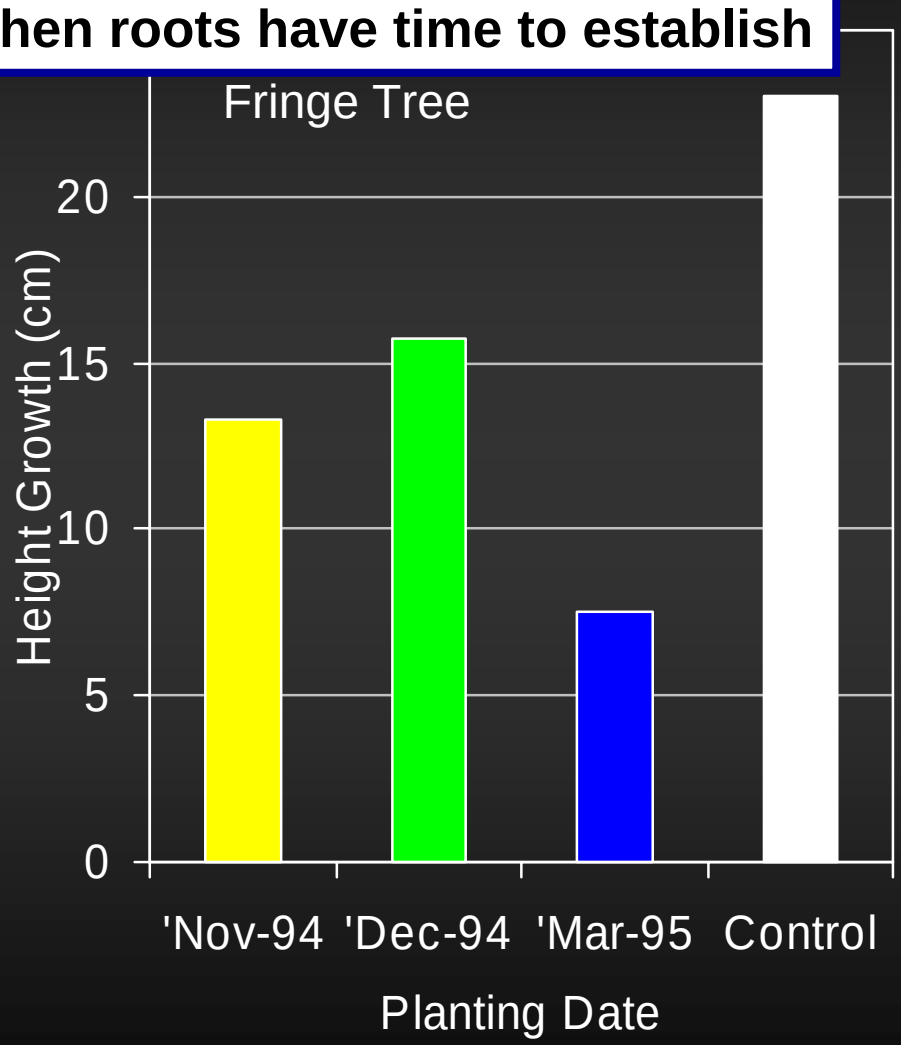




Wright et al. 2004

# Time of Planting

**Potential success higher when roots have time to establish**




Harris et al. 1996

# Planting Method

- One standard planting procedure does not apply to every plant.
- Basic Principles:
  - Hole size > root ball
  - Root ball disruption
  - Depth of planting
  - Back filling ~10% below root collar

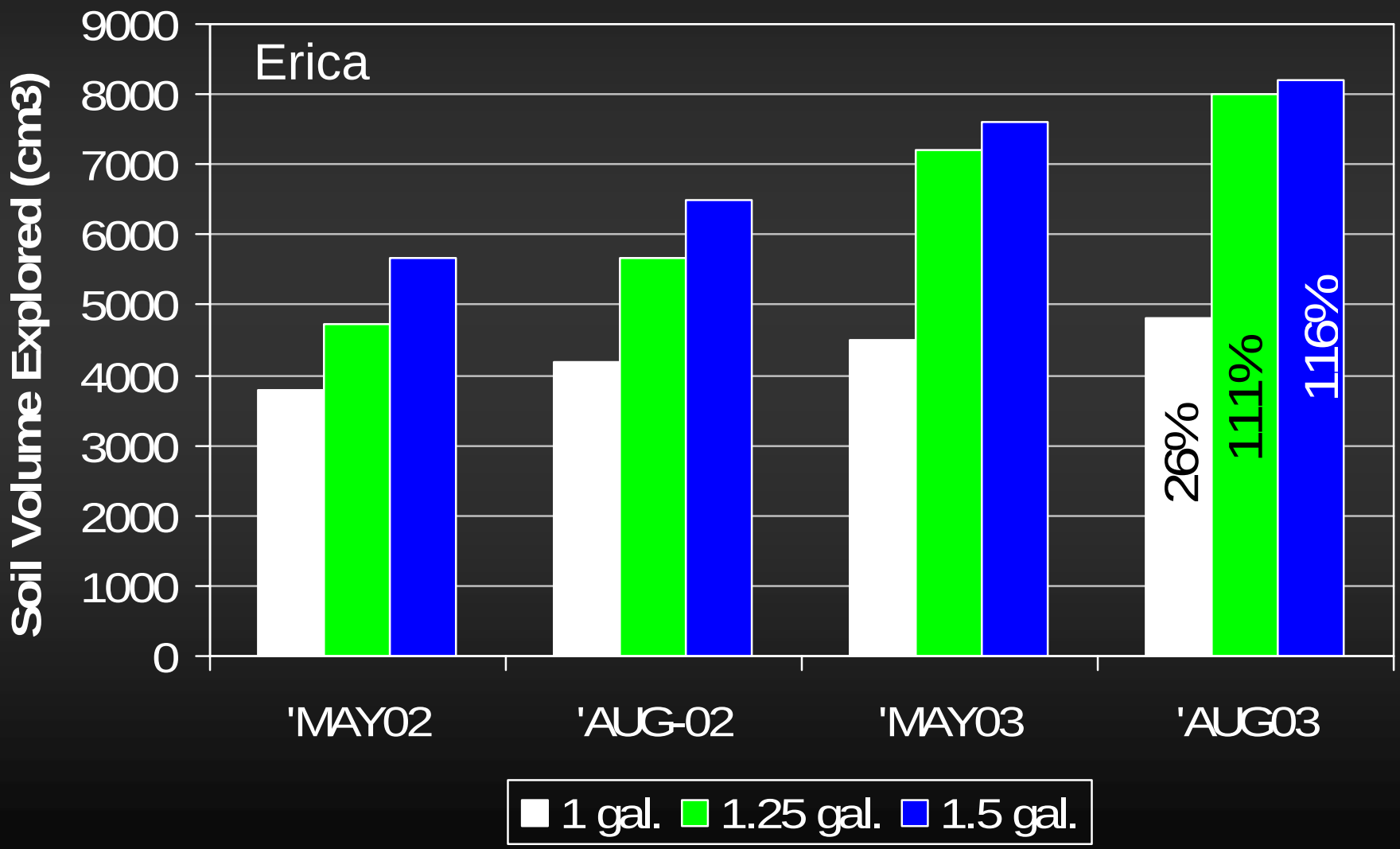


- Decrease nutrient, water, heat and light stress after transplanting until plant becomes established

(ANLA-BMP)

# Hole Size

# Root Ball Disruption

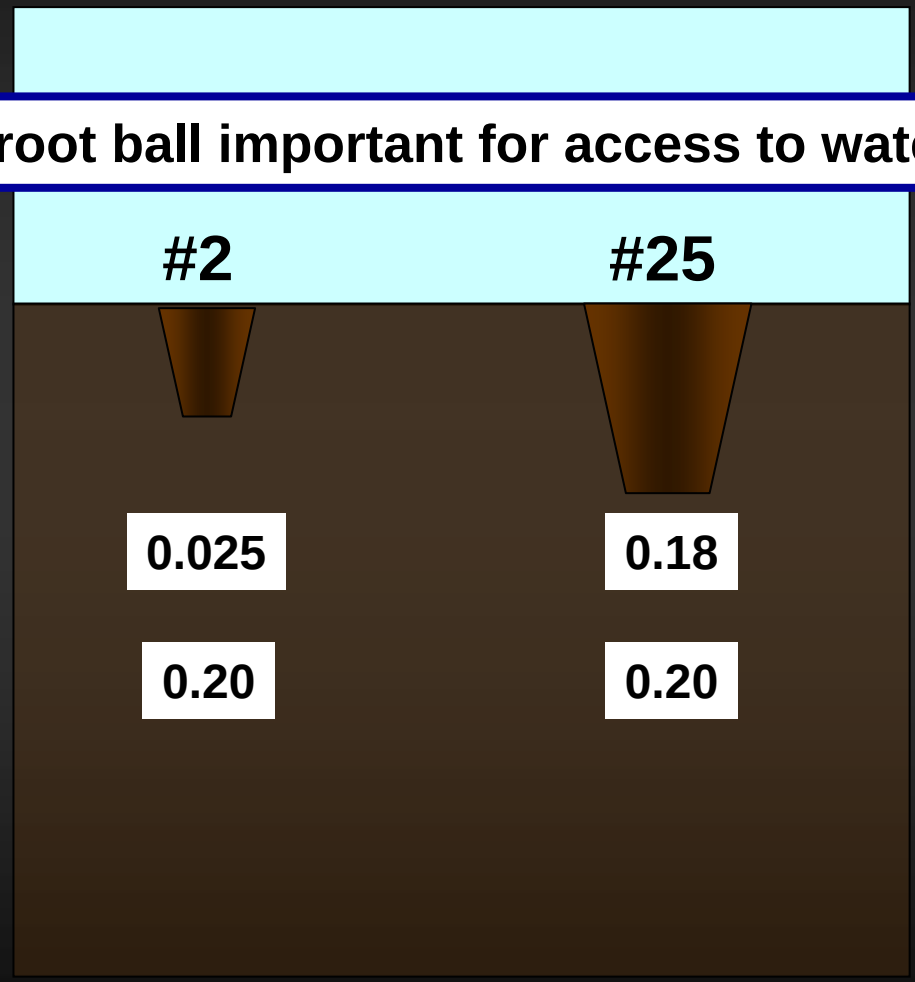


# Planting Depth

- Deep planting:
  - Low oxygen kills roots.
  - High moisture at base of trunks increases root and collar rot diseases.
- Shallow planting:
  - Temperature extremes kills roots.
  - Increases moisture and nutrient stress.
  - Decreases stability.


# Container Media and Soil Interface

**Root growth outside of root ball important for access to water**



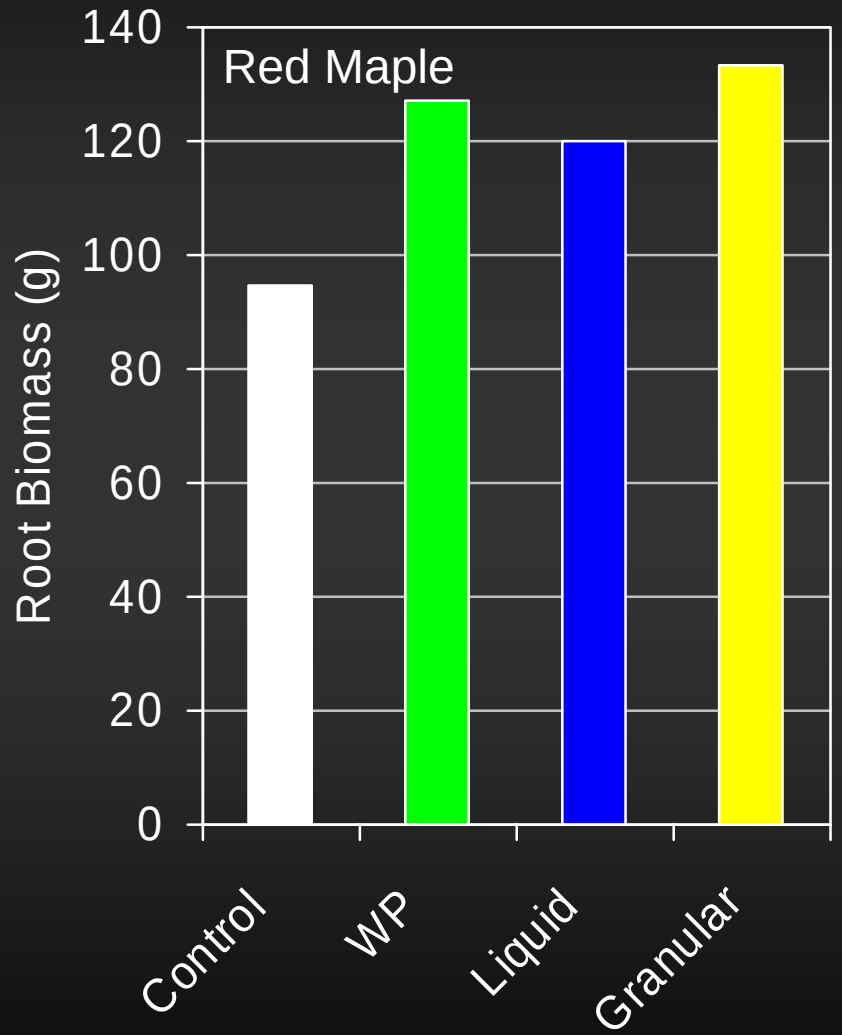

| Plant Available Water | #2 | #25 |
|---|---|---|
| Pine-bark substrate | 0.025 | 0.18 |
| Mineral Soil | 0.20 | 0.20 |

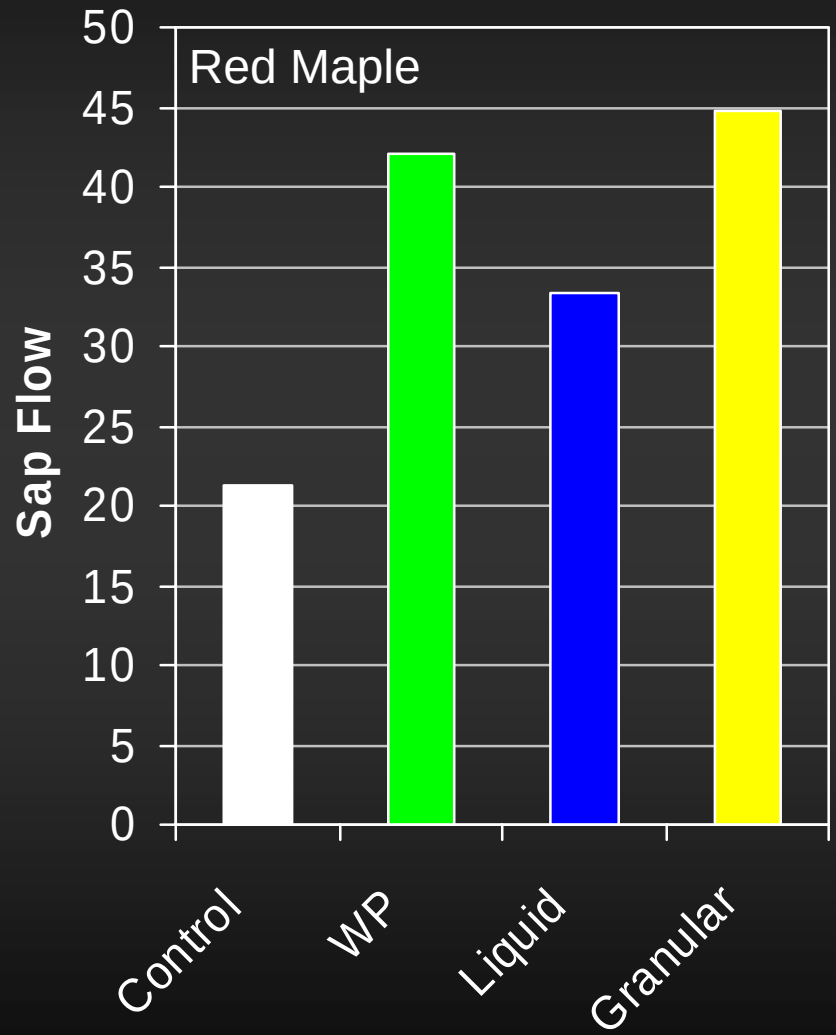
Hanson et al. 2004

# Amendments

- Non-nutritional and nutritional products reported to reduce transplanting stress and stimulate roots.
- Biostimulants, humates, seaweed, yucca, hormones, alginates, acrylimides, beneficial fungi and bacteria, etc.
- Successes and failures due to: species-specific responses, timing, and environmental and cultural practices interfering with product activity.

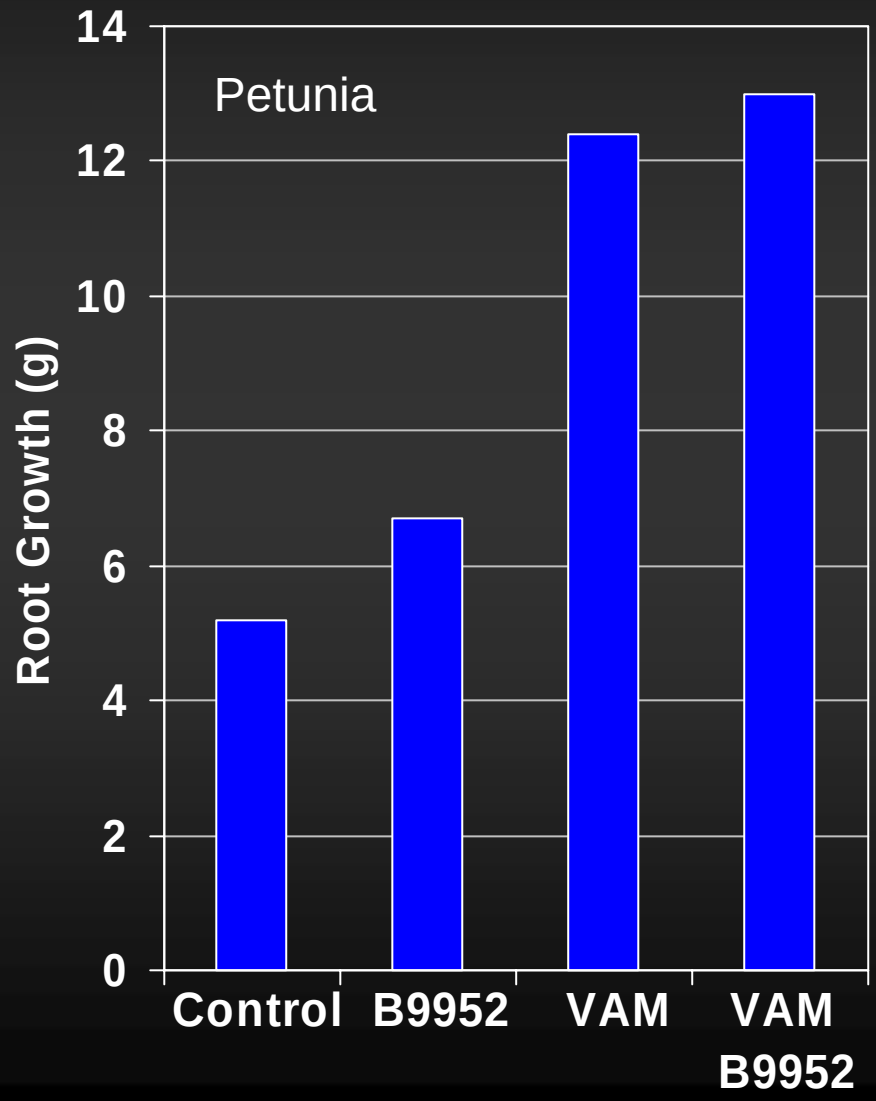
# Humates & Root Growth

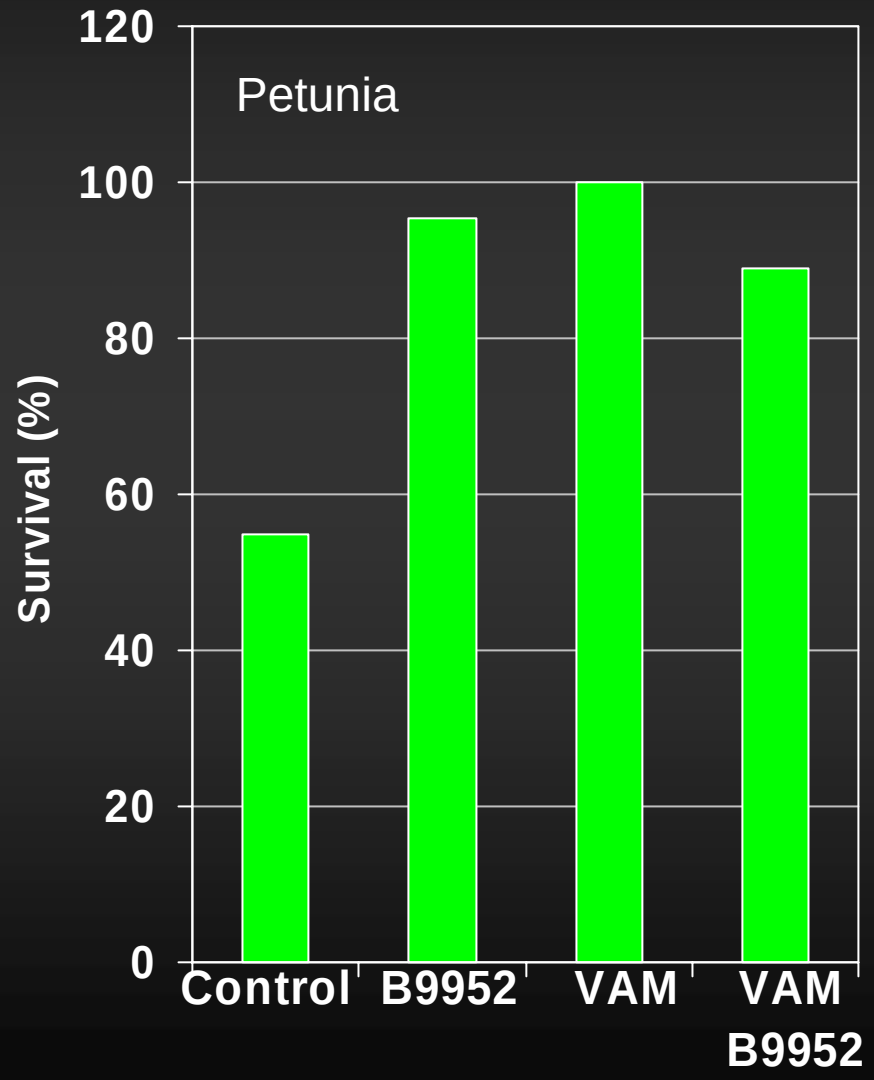



Kelting et al. 1998

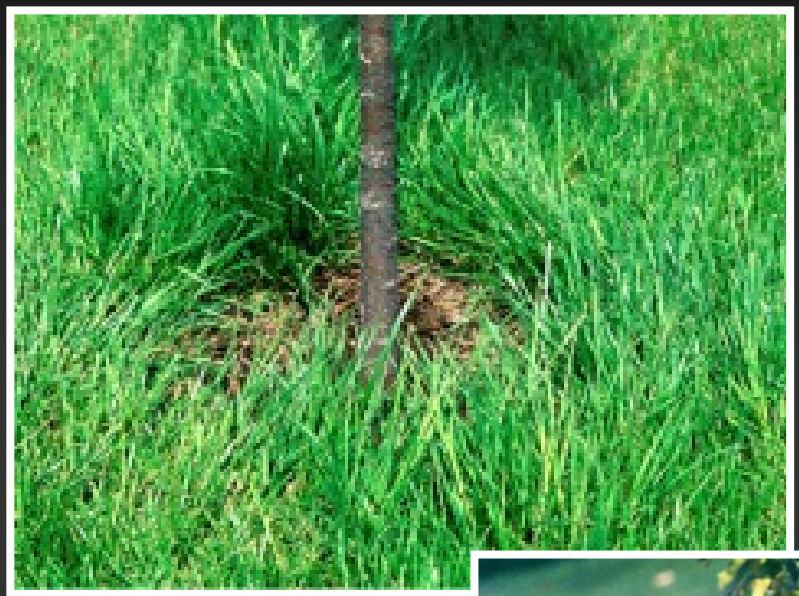
# Microbes & Root Growth



# Hormones & Root Growth

# How Much Mulch Is Too Much



# Root Murder

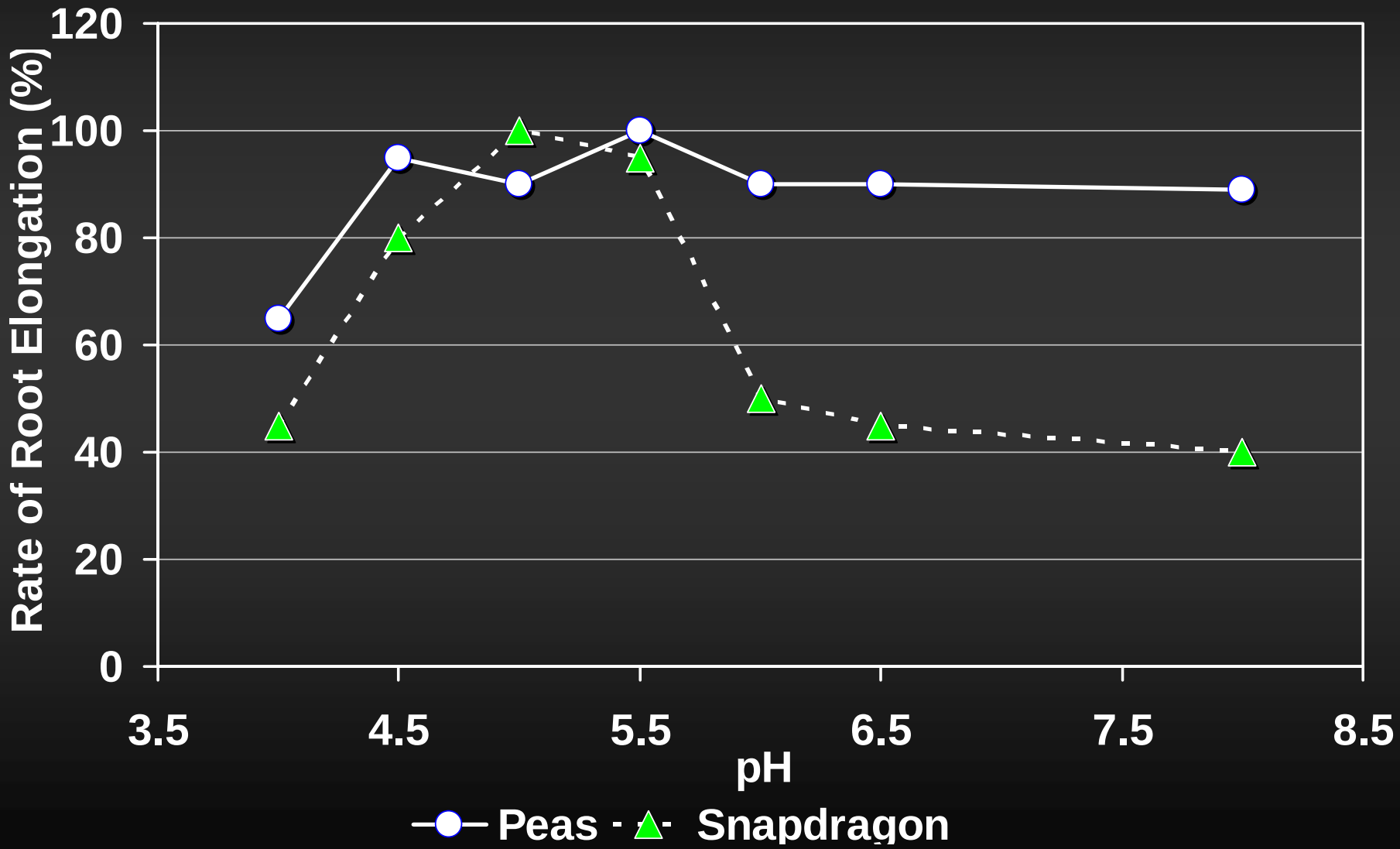
- Everything has potential:
  - Fertilization and irrigation
  - Herbicides and pesticides
  - Pruning, mowing
  - Mulching, weeding & disturbance
  - Equipment, pets, and wildlife

- The majority of roots are in the top few inches of soil; therefore disturbance can cause root death.

# What You Want May Not Be What You Need

- Plants grow best within a specific range of various abiotic and biotic factors.
- Landscapes:
  - Stresses seldom similar to native habitats.
  - Conditions marginally meet requirements for growth.

# pH & Root Growth



# Compatibility

- To maintain healthy roots - carefully select plant species and cultivars best suited for the environmental constraints of a specific landscaping.

- Even high quality stock will not thrive if environmental conditions are not suitable.

- Have reasonable expectations

(see Ed Gilman, UFl Website)

# What You Can See May Not Be The Problem

- Visual symptoms aboveground occur before you realize roots are in trouble.
- Root death generally does not arise from one factor.
- Abiotic or cultural factors that cause root death usually predispose plants to further decline
  - decreased ability to take up water and nutrients
  - increased pest and disease susceptibility

# Nutrient Deficiency Symptoms

- Similar to the effects of heat, drought, waterlogged soil, herbicide injury on root growth and function.

- When roots are unhealthy treating nutrient deficiency symptoms by increasing fertilization may accelerate plant decline.

# Scorch/Drought Symptoms

- Symptoms of low water availability or low water uptake of an unhealthy root system are similar.

- When roots are unhealthy, treating water stress symptoms by increasing water application may accelerate plant decline.

# Air Pollution

- Chronic air pollution can indirectly cause root death.
- Foliar senescence, reduced growth and decline in plant health.
- Root death occurs before visual symptoms appear on leaves.

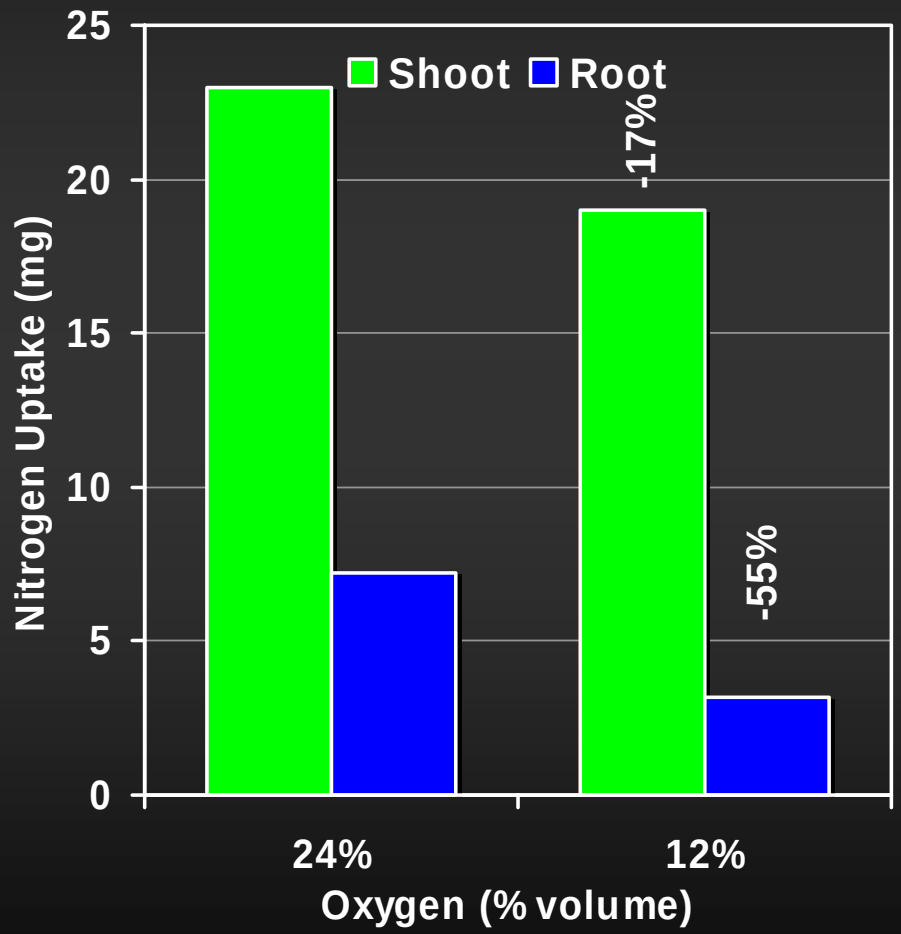

# Herbicides

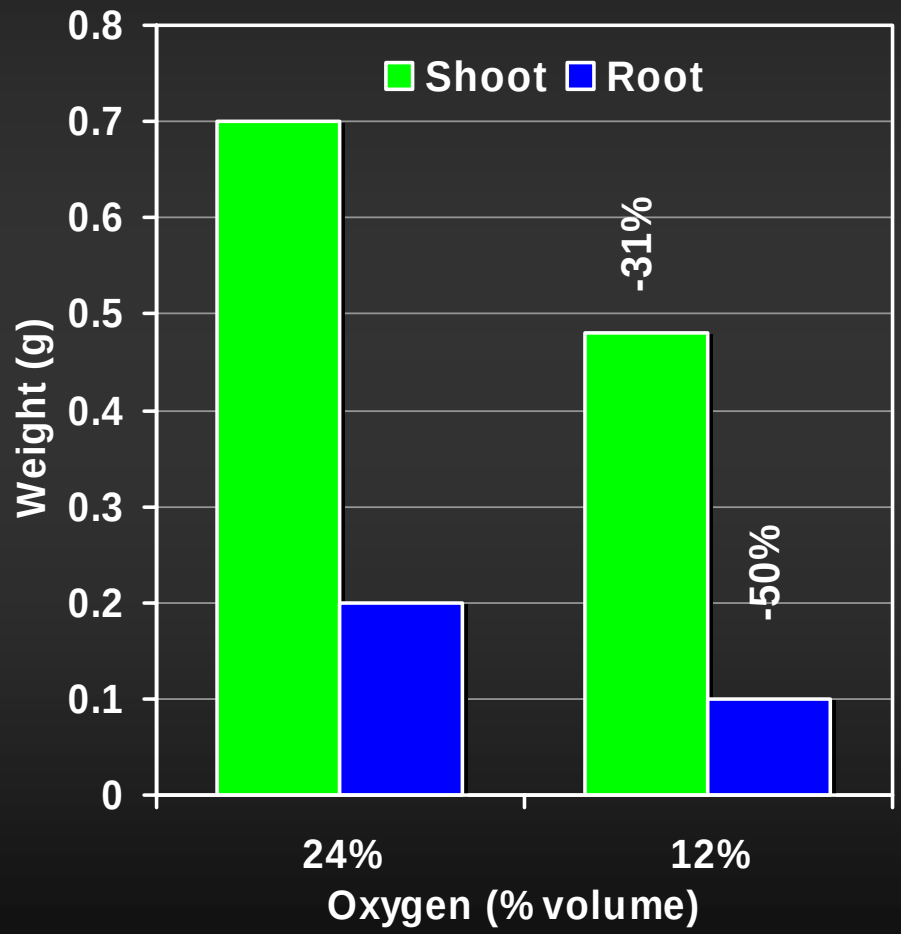
- 2,4-D and DNA types disrupt normal growth processes in non-target plants.
- Label rates based on foliar symptoms however in many cases foliar symptoms are an indicator of root death.

# Oxygen Deficiency

- Raised soil grade , asphalt, waterlogged soils, plastic or clogged weed barriers
- Increase effects of other stresses (e.g. diseases, pests, water, nutrients).
- Deficiency in the root zone is primarily a result of poor site selection, planting technique, and cultural practices.

# Soil Aeration & Nutrient Use



# Take-Home Points

1. Most decline or death of plants in landscapes occurs as a result of abiotic factors – pests and diseases are NOT the primary cause.

2. Root death is natural and is only limiting to plant growth if it occurs without compensatory root growth to meet plant needs.

3. The impact of pre-transplant factors on root death can be minimized by careful inspection and selection and of the best type and quality of stock for specific landscape site.

4. Root murder is usually a result of too little or too much of some factor(s) and increases plant susceptibility to other problems.

5. Symptoms of root death occur above ground before you realize roots are in trouble and mimic symptoms of other problems.