

Best Management Practices for Citrus Groves in the



Peace River and Manasota Basins

July 2004

Best Management Practices for Citrus Groves in the Peace River and Manasota Basins

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Publication No. _____

Florida Department of Agriculture and Consumer Services
Tallahassee, FL

July 2004

REGISTRATION

This document is a collection of Best Management Practices (BMPs) that are directed at enhancing and protecting the water resources of the Peace River and Manasota Basins (PRMSB). It is recognized by all the groups that participated in the development of this document, that this collection of BMPs will need to be revisited, reviewed, and modified over time and as new scientific data becomes available. Therefore, all users are encouraged to register their copy of this manual. Registered users will be mailed all addendums and revisions as they become available. A registration form is included in the front of this document. If missing, contact the PRMSB Citrus BMP Steering Committee at the address below to register.

The PRMSB Citrus BMP Steering Committee will meet periodically to act on suggestions for

addendums and/or revisions to the document. To provide input or to obtain the latest addendums to the BMP Manual, contact:

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Table of Contents

INTRODUCTION

| | |
|-----------------------------------|---|
| Committee Structure | 1 |
| Participating Organizations | 2 |
| Background | 3 |
| Implementation of BMPs | 4 |
| BMP Reference Documents | 5 |

WATER RESOURCES

| | |
|--|------|
| A0. Purpose | A-1 |
| A1. Water Table Management | A-2 |
| A2. Scheduling Irrigation and Drainage | A-5 |
| A2.1. Irrigation | A-5 |
| A2.2. Drainage | A-9 |
| A2.3. Managing Salinity | A-12 |
| A2.4. Mobile Irrigation Lab | A-16 |
| A2.5. Irrigation System Maintenance and Evaluation ... | A-17 |
| A3. Moderate Discharge Rate | A-20 |
| A4. Water Furrow Maintenance | A-20 |
| A5. Monitor Soil Moisture | A-21 |
| A6. Drainage Management Plan | A-24 |
| A7. Drainage Rate and Volume | A-26 |
| A8. Discharge Structure | A 26 |
| A9. Detention–Tailwater Recovery and Surface Water Use | A-27 |

EROSION CONTROL AND SEDIMENT MANAGEMENT

| | |
|--|------|
| B0. Purpose | B-1 |
| B1. Riser-Board Water Control Structures | B-3 |
| B2. Sediment Settling Basins in all Ditches | B-4 |
| B3. Ditch Construction | B-5 |
| B4. Stabilize Bare Soils | B-5 |
| B5. Ditch Bank Contours | B-6 |
| B6. Ditch Bank Vegetation Maintenance | B-6 |
| B7. Protect Ditch Banks | B-8 |
| B8. Vegetative Stabilization | B-9 |
| B9. Aquatic Plant Management | B-9 |
| B10. Ditch Maintenance, Cleaning, and Dredging | B-11 |
| B11. Herbicide Applications | B-12 |
| B12. Middles Management (herbicide) | B-13 |
| B13. Grove Development/Renovation | B-13 |
| B14. Settling Basins (Sumps) | B-14 |
| B15. Water Furrow Drain Pipes | B-14 |

| | |
|--|------|
| B16. Water Furrow Maintenance | B-15 |
| B17. Construction Activities and Temporary Erosion Control Measures | B-15 |

PEST MANAGEMENT

| | |
|--|------|
| C0. Purpose | C-1 |
| C1. Integrated Pest Management (IPM) | C-2 |
| C2. Product Selection | C-5 |
| C3. Product Use Training | C-8 |
| C4. Purchase and Transport | C-8 |
| C5. Storage | C-9 |
| C6. Excess Formulation | C-11 |
| C7. Permanent Mix-load Sites | C-11 |
| C8. Non-Permanent Mix-load Sites | C 13 |
| C9. Spill Management | C-15 |
| C10. Excess Mixture | C-16 |
| C11. Protect Water Sources During Mixing | C-17 |
| C12. Handling and Measurement | C-17 |
| C13. Container Management | C-18 |
| C14. Equipment Sanitation and Wash Water Handling | C-19 |
| C15. Application Equipment Calibration and Maintenance | C-20 |
| C16. Environmental Conditions and Timing for Application | C-22 |
| C17. Maintain Soil pH to Avoid Mobility of Copper | C-22 |
| C18. Precision Application of CP Products | C-23 |
| C19. CP Product Use Record Keeping | C-24 |
| C20. Reduce Spray Drift and Off-Target Deposition | C-25 |
| C21. Turn Nozzles Off at Row Ends | C-26 |
| C22. Consider IPM Decisions in the Context of Broader Production BMPs | C-27 |

NUTRIENT MANAGEMENT

| | |
|--|------|
| D0. Purpose | D-1 |
| D1. Education | D-3 |
| D2. Nutrient Management | D-4 |
| D3. Utilization of Waste Resources | D-4 |
| D4. Employ Tissue and Soil Analyses | D-5 |
| D5. Use Appropriate Application Equipment | D-11 |
| D6. Equipment Calibration/Maintenance | D-13 |
| D7. Apply Materials to Target Sites | D-14 |
| D8. Avoid High Risk Applications | D 14 |
| D9. Fertilizer Storage | D-15 |
| D10. Spilled Fertilizer | D-15 |
| D11. Use Caution When Loading Near Ditches, Canals, and Wells | D-16 |
| D12. Alternate Loading Operation Sites | D-16 |

| | |
|---|------|
| D13. Use Backflow Prevention Devices | D-17 |
| D14. Split Applications Throughout Season | D-18 |
| D15. Erosion Control | D-18 |
| D16. Irrigation Management | D-19 |
| D17. Incorporate Organic Materials | D-19 |
| D18. Well Protection | D-20 |
| D19. Use Appropriate Sources/Formulations | D-21 |
| D20. Salinity | D-23 |
| D21. Conservation Buffers and Setbacks | D-25 |

Appendix 1. References

Appendix 2. Important Telephone Numbers

| | |
|---------------------------------------|-----------|
| Emergency Reporting | App.2 - 1 |
| Help Line Numbers | App.2 - 1 |
| Non-Emergency Phone Contacts | App.2 - 1 |
| Assistance Available | App.2 - 4 |
| Web Resources | App.2 - 5 |
| Grove Worker Training Materials | App.2 - 6 |

Appendix 3. Spill Reporting Requirements

Appendix 4. Salt Index of Inorganic and Natural Organic Fertilizer Sources

Appendix 5. BMP Checklist

Appendix 6. PRMSB Citrus BMP Rule

Appendix 7. *Notice of Intent to Implement Application*

Introduction

Due to a sincere desire to sustain and protect our area's natural resources and the viability of our citrus properties, the Peace River Valley Citrus Growers Association initiated Best Management Practices (BMP)'s for the Peace River and Manasota Basin area citrus groves. From the beginning of this process, regulatory, professional and research communities have been tireless, faithful partners to area growers. This document should be viewed as a living document that will adapt to better serve the needs of our growers and our environment. The development and implementation of BMPs is an ongoing process to continually identify and develop improved, science-based BMPs that will enhance and protect the Peace River and Manasota Basins (PRMSB), as shown in Fig. 1, resources and thus the Charlotte Harbor National Estuary Program (CHNEP) study area as shown in Fig. 2. The participating groups recognize this collection of BMPs will need to be revisited, reviewed, and modified, as new information becomes available.

In July 2003, the Florida Department of Agriculture and Consumer Services (FDACS) Commissioner Charles H. Bronson released a document titled "Florida's Agricultural Water Policy". The purpose of this document was to identify those actions needed to ensure agriculture has access to an adequate quantity of water of sufficient quality to remain competitive in an increasingly dynamic and global marketplace. Implementation of the recommendations contained in the FDACS document, as well as this BMP document, will provide protection for the state's environment, water resources, open spaces and wildlife. Success in implementing these agricultural water policy recommendations will require commitment, coordination, and cooperation among elected officials, agricultural producers, other water users, environmental interests, university researchers, and the agencies with water management responsibilities.

It is fully recognized the boundaries of the CHNEP do not exactly match the recognized PRMSB

boundaries. In this document, where the terminology PRMSB/CHNEP is used, we recognize that our watersheds potentially impact the CHNEP STUDY area and the importance of that relationship. That said, the application of these BMP measures is intended for the PRMSB area only.

Due to the environmentally sensitive nature of some recognized "Ridge" soil types present in the PRMSB/CHNEP (shown in Fig. 3), care should be taken by growers to identify and understand the soil types that are present in their groves. If any of these "Ridge" type soils are present, we urge these growers to contact the local University of Florida extension personnel or FDACS to further explore additional BMP measures.

Lastly, we encourage citrus growers to become familiar with any and all water policies applicable to them and to utilize all water management resources available. We also encourage each citrus grower to foster positive relationships with those agencies charged with managing our state's water resources.

Committee Structure

A steering committee was established in May 2003 to guide the development of the BMPs for the PRMSB/CHNEP citrus growing area. The steering committee established immediate and long-term goals directed at improving water quality and reducing water quantity impacts for the PRMSB/CHNEP area. The goals are to:

Immediate Goal: Identify, evaluate, develop and implement BMPs based on the best information available that will protect and enhance the Peace River and Manasota Basin's resources, while maintaining an economically viable citrus industry.

Long-Term Goal: Implement an ongoing process to identify and develop improved, science-based BMPs to enhance and protect the Peace River and Manasota Basin's resources.

Figure 1. Peace River Basin & Manasota Basin Map

July 16, 2004

Intro-2

Figure 2. Charlotte Harbor National Estuary Program Boundary Map

July 16, 2004

Intro-3

Figure 3. Soil Type Characteristics of the BMP Area Map

July 16, 2004

Intro-4

Four subcommittees were formed:

- Water Resource Management,
- Nutrient Management,
- Pest Management, and
- Erosion Control & Sediment Management.

Each subcommittee was charged with the task of creating a comprehensive document that PRMSB citrus growers could utilize to implement BMPs. Individuals on each committee were actual stakeholders in the process and considered knowledgeable in that particular subject. Consistent with the goals set forth by the steering committee, this document outlines a variety of BMPs. These BMPs have the potential to improve water quality, reduce the off-site transport of nutrients and sediments, and provide more suitable timing of surface water discharges into receiving streams within the PRMSB area.

In addition to the BMP subcommittees, a monitoring subcommittee was appointed by the steering committee to evaluate data collected in the past related to the BMP objectives. An additional objective of the monitoring subcommittee is to develop a list of further research necessary to characterize the impacts of citrus production in the PRMSB/CHNEP area, evaluate effectiveness of BMPs presented in this document, and to identify research that should be conducted to scientifically evaluate other potential BMPs.

Participating Organizations

The following is a list of participants in the development of the document. Each of these individuals and organizations made important contributions to the process, and they also be key in assuring proper and successful implementation of the BMPs.

Citrus Growers

Jeff Adams, CMI
Ben Albritton, Albritton Companies
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Jonathan Brown, Bethel Farms
Wes Brumback, TRB Groves, LLC
Steve Farr, Ben Hill Griffin, Inc.

Garvie Hall, Prudential/Citrus Partners
V. C. Hollingsworth, VC Ranch
David Kemeny, TRB Groves, LLC
Clive Morris, Schroeder Manatee Ranch
Jerry Newlin, Orange Co.
Ben Norris, Robert R. Norris, Inc.
Robert Sasser, Villa Citrus, Inc.
Andy Tuck, Elton Crews, Inc.

Citrus Industry

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Keith Davis - Florida Fertilizer Company
Marci Duncan - Duncan Resource Consulting, Inc.
John Roy Gough - UAP
Keith Hollingsworth - Chemical Containers, Inc.
Dave Owens - Bayer Crop Science
Mike Prescott - Monsanto
Gary Sawyer - Syngenta

Charlotte Harbor National Estuary Program

Lisa Beever
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FDACS Office of Agricultural Water Policy

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FDEP

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Peace River Basin Board

Ken Harrison

Peace River Valley River Citrus Growers Association Barbara Carlton

South Florida Water Management District
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Background

Many activities such as urban development, agriculture, industry, and regional water management have all impacted the waters of the PRMSB/CHNEP area. Over the years, efforts have been initiated to address environmental impacts in the PRMSB/CHNEP area. Numerous efforts and activities are underway to improve surface water discharges to the PRMSB area and the CHNEP. There is no single project or effort that will eliminate all human impacts to the PRMSB/CHNEP area. Improvements will come through diligent, incremental program achievements and efforts that reduce the volume of water and loading of constituents that degrade water quality.

These incremental achievements and activities

cover all land uses from agriculture to urban, and include a variety of efforts such as education, water conservation programs, mobile irrigation labs, surface water permit design criteria, regional reservoirs, urban storm water retrofit projects and BMPs. The BMPs developed in this document are for the Peace River & Manasota Basin areas.

The development of these BMPs was enhanced and accelerated by concerns in the CHNEP study area. The Charlotte Harbor National Estuary Program is an environmentally unique, locally-based and federally funded program that was created under Section 320 of the Federal Clean Water Act. The general National Estuary Program is modeled after the success of the Chesapeake Bay Program, which gathered multiple states and local governments to address severe environmental problems in the Chesapeake Bay. This legislation is implemented by the U.S. Environmental Protection Agency and asks states to nominate estuaries for designation as "estuaries of national significance" and eligibility for federal funding. Estuaries accepted into the program are required to develop a "Comprehensive Conservation and Management Plan" for the watershed, develop a public involvement strategy, assess monitoring efforts and base their actions on sound science. Local committees are responsible for implementing the Comprehensive Conservation and Management Plan.

In 1995, Charlotte Harbor was nominated by Governor Lawton Chiles and accepted by EPA into the National Estuary Program, making it one of only 28 NEPs within the United States and Puerto Rico. Water quality, fish and wildlife habitat, and hydrology were designated as the highest priorities facing the Charlotte Harbor watershed along with the related changes in land use and population growth. The Charlotte Harbor "management conference" is composed of four committees of citizens, scientists, resource managers, industry representatives and policy makers, including federal, state and local governments; agriculture; non-profit organizations and citizens. The Charlotte Harbor Comprehensive

Conservation and Management Plan was finalized and approved by the "management conference" in 2000 and approved by U.S. EPA in 2001. For more information, please see the program website at www.charlotteharbornep.org or contact program staff at 239-995-1777.

Requirements for BMP Development

BMPs are production systems and management strategies scientifically shown to minimize adverse water quality and other environmental impacts of agricultural production. BMPs can be defined as those on-grove operational procedures designed to achieve greatest agronomic efficiency in food and fiber production, while limiting the off-site effects of agricultural operations and maintaining an economically viable farming operation. In cases where the economic cost of implementing certain BMPs puts an excessive financial burden on the grower, such practices could only be considered BMPs if external funds were available and the future financial profitability of the farm will be preserved.

There are numerous, significant benefits that can occur with adoption of BMPs in this document. These BMPs were established to ensure water quantity and quality in the PRMSB/CHNEP area is preserved to the benefit of all interests. Not all BMPs are applicable to every citrus operation. Therefore, the overall picture of each citrus operation should be considered prior to adoption of any BMP to ensure each BMP achieves its proper objective.

All BMPs must protect the environment and be economically viable. Recommendations must be based on factual information and science, and must be focused on real problems and real solutions that work. However in some cases, there is no definitive research that applies to a particular BMP. In other cases, available research cannot predict the effectiveness of a BMP. In situations like these, BMPs presented in this document are based upon a combination of available research, best professional judgment, and practical experience. Best professional

judgment should allow modification of a particular practice to field conditions in a specific grove to achieve water quality and quantity objectives. BMPs should be consistent, while providing reasonable flexibility to accommodate local needs and site specific conditions. Most of all, BMPs should not be a barrier to incentive-based programs or to technical innovation.

Implementation of BMPs

These BMP measures are not regulatory or enforcement-based. Landowners are requested to maintain records and provide documentation regarding the implementation of all BMPs utilized and applied on their farm as well as document why certain BMPs are not applicable to their specific situation. Adequate records are very important for documentation of BMP implementation. These records are an integral part of any BMP program.

The priorities for BMP implementation are:

1. To correct any qualified existing water quality/quantity problems.
2. To minimize water quality/quantity problems resulting from land use.
3. To improve effectiveness of applied BMPs.
4. To seek additional improvement of BMPs based on new, quantifiable information.

All growers are encouraged to perform an environmental assessment of their crop production operations. This resource allocation assessment process is a tool that will aid in identifying which BMPs should be considered to achieve the greatest economic and environmental benefit. Among the incentives for adoption of BMPs are:

- Improved crop yield
- Improved crop quality
- Improved worker safety
- Efficient allocation of resources
- Reduced environmental impacts
- Opportunity to receive cost-sharing incentives
- Reduced regulatory requirements
- Opportunity for industry self-regulation

It is fully recognized that additional research is required to establish the effectiveness of some BMPs. The development, advancement, and use of precision agriculture techniques in citrus production are strongly recommended. These technologies have provided cost effective, agronomically sound management alternatives to traditional management methods while providing an increased level of resource protection. The emergence of new precision agriculture technologies occurs rapidly, it is recommended that growers consistently remain abreast of new technology trends. The application of these emerging technologies by growers should be considered on a site-specific basis. The consistent pursuit of precision agriculture technology information can be satisfied using the resources listed in the "Precision Agriculture" reference section at the end of this manual.

Education is a key factor to ensure success of the BMP programs. Training programs are needed to ensure that BMPs are applied and implemented properly. Public participation is needed to provide quality input into the selection and designation of BMPs. Monitoring programs are needed to show that BMPs are effective in protecting water quality/quantity and to provide measurable data for BMP revisions. Incentive programs are needed when a proposed BMP results in adverse economic impact.

BMP Reference Documents

There are several sources of research that have been used to develop BMPs for citrus in the PRMSB/CHNEP area. Primary sources include the NRCS, University of Florida-IFAS, EPA, FDEP and FDACS. This document cites pertinent documentation from these sources that may guide the implementation, evaluation, verification and validation of each and every BMP.

WATER RESOURCE MANAGEMENT

| | Page |
|---|------|
| A0. Purpose | A-1 |
| A1. Water Table Management | A-2 |
| A2. Scheduling Irrigation and Drainage | A-5 |
| A2.1. Irrigation | A-5 |
| A2.2. Drainage | A-9 |
| A2.3. Managing Salinity | A-12 |
| A2.4. Mobile Irrigation Lab | A-16 |
| A2.5. Irrigation System Maintenance and Evaluation | A-17 |
| A3. Moderate Discharge Rate | A-20 |
| A4. Water Furrow Maintenance | A-20 |
| A5. Monitor Soil Moisture | A-21 |
| A6. Drainage Management Plan | A-24 |
| A7. Drainage Rate and Volume | A-26 |
| A8. Discharge Structure | A 26 |
| A9. Detention–Tailwater Recovery and Surface Water Use | A-27 |

A0. Purpose

The drainage systems that have been developed in the Peace River and Manasota Basins (PRMSB) to make productive agricultural and urban land has increased drainage frequency, discharge volumes, and the velocity of water discharged from structures within the watershed compared with the natural condition. Excess rainfall from high intensity thunderstorms, tropical storms, and hurricanes must be drained in order to protect agricultural and urban areas from flooding (Fig. A0.1). The resulting discharges to the PRMSB drainage areas from these events can cause significant environmental impacts (Fig. A0.2) . Under natural conditions, water from these areas would be cleaned by traveling downstream via tributaries before reaching coastal water bodies.

Implementation of the practices and policies in this chapter will improve water quality and maintain natural variability and the aquatic ecosystems in the PRMSB. Salinity issues have become a major area

of concern for both agricultural and urban interests in the PRMSB. Currently, programs are in place through the Florida Department of Environmental Protection (FDEP), Florida Department of Agriculture and Consumer Services (FDACS), Natural Resources Conservation Service (NRCS) and the Southwest Florida Water Management District (SWFWMD) to work with citrus growers and other farmers to reduce salinity problems. A special section, A2.3, has been included in this manual to discuss BMP's for growers with high salinity irrigation water.

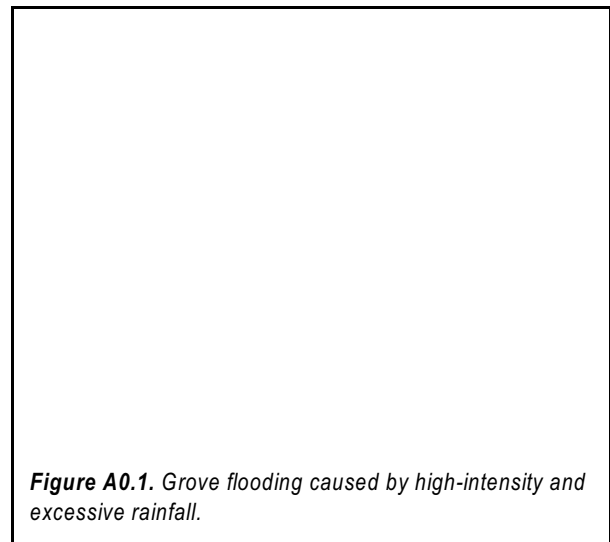


Figure A0.1. Grove flooding caused by high-intensity and excessive rainfall.

Nutrients, pesticides, and sediment in the freshwater inflows in conjunction with tidal dilution involving ocean water directly affect estuarine water quality. Typically, seasonal variation in water quality in the estuary is driven by incoming freshwater flows from within the watershed. Management strategies need to address both freshwater quantity and quality.

All types of land uses within the watershed contribute surface water runoff and pollutant loads to the estuary. Since agriculture is the largest land use type in the PRMSB, the activities associated with agriculture and citrus production are important considerations in the overall health of the estuary. Activities in groves can affect the water resources of

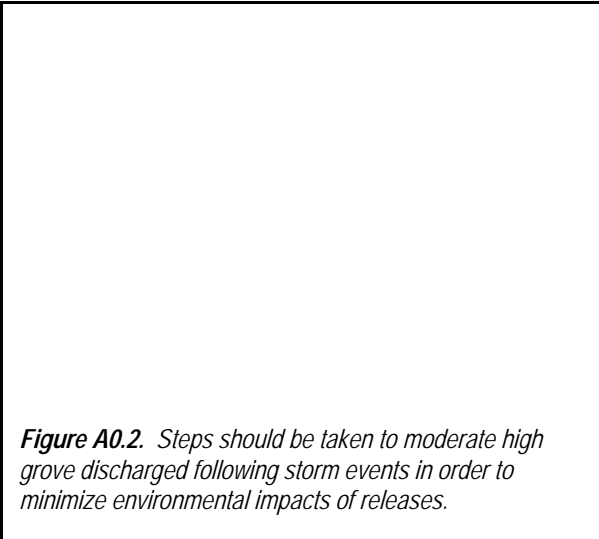


Figure A0.2. Steps should be taken to moderate high grove discharged following storm events in order to minimize environmental impacts of releases.

the watershed. Wherever feasible, citrus growers should consider implementing surface water management strategies that can provide additional storage and reduce the impacts associated with excessive freshwater discharges. These surface water management strategies can range from improved ditch maintenance, water table management to additional on-site canal storage or the construction of detention reservoirs for holding excess rainfall and tailwater recovery systems (Fig A0.3). It is important to conduct site-specific evaluations to determine if additional storage can be provided on-site and to plan long-term water management strategies that will minimize off-site discharges during periods of intense rainfall.

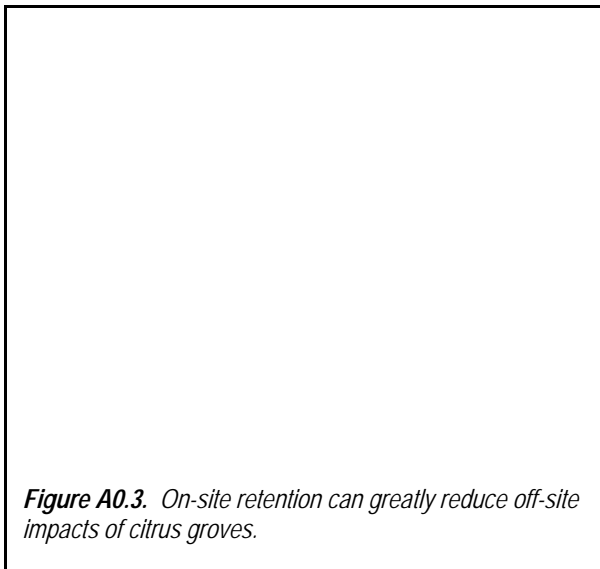


Figure A0.3. On-site retention can greatly reduce off-site impacts of citrus groves.

A1. WATER TABLE MANAGEMENT

Water table control can be managed more efficiently by having sufficient hydraulic capacity in the ditch/canal system, using water control structures on culverts, laser land leveling where appropriate, constructing and maintaining a properly designed drainage system, and actively monitoring the water table.

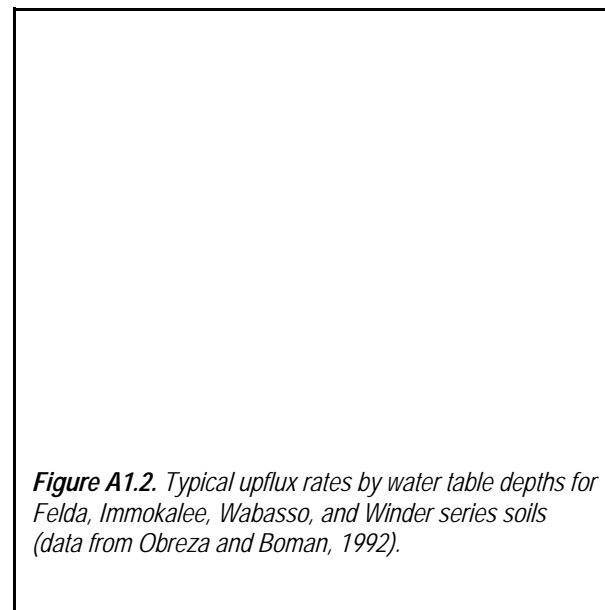
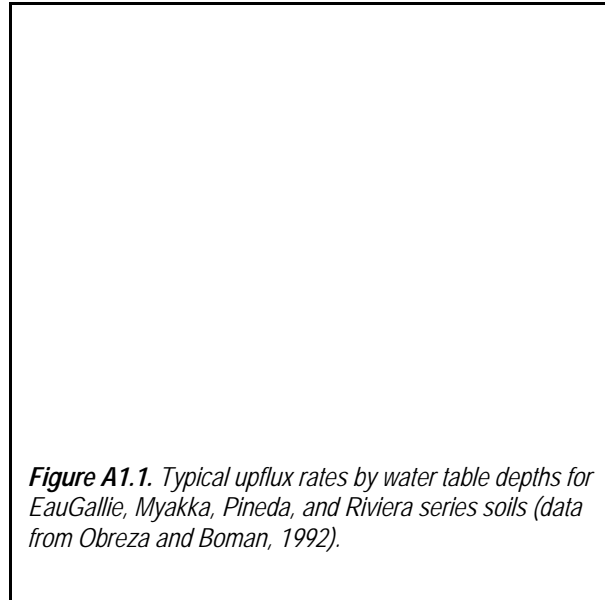
Effective water management of flatwoods soils requires monitoring the water table depth with enough precision to minimize pumping for irrigation and drainage. Knowledge of the water table depth is essential to ensure that adequate drainage can be provided. Since a significant portion of the tree water requirements can come from upward flux from the water table, water table monitoring should be an essential tool in irrigation management. Water table manipulation, and associated supplemental irrigation reductions, can also assist in salinity management by reducing the use of low quality ground water.

Upflux

The movement of water upward within the soil profile from the water table is called "upflux". As water is removed from the soil by the tree roots and by evaporation at the ground surface, water content of the soil decreases. By capillary action, water moves from the water table into the drier soil above. Water tends to adhere to soil particles due to surface tension between adjacent particles. Smaller soil particles have smaller inter-particle voids. The smaller particles provide greater surface areas upon which water can adhere. In addition, the smaller voids allow water to be retained at higher tension or suction. As a consequence, soils with smaller particles have the ability to move water greater distances by capillary action than coarser soils (Figs. A1.1 and A1.2). As a result, the upflux process can move water into the root zone from a much deeper water table in clay soils than it can in sandy soils.

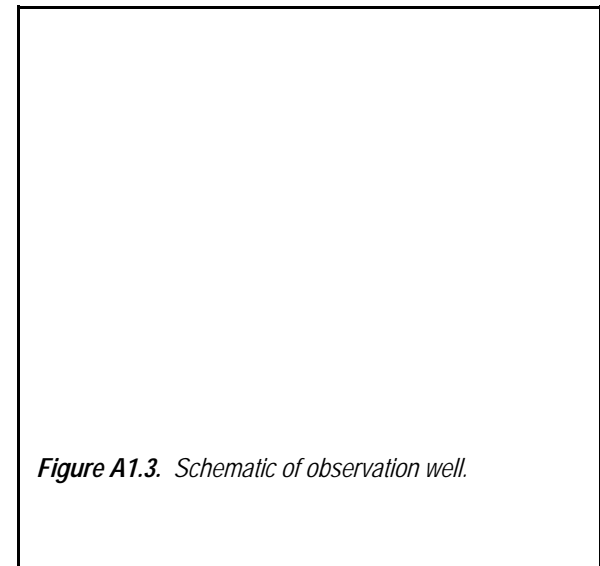
Excess water drains by gravity into the shallow water table after a saturating rain or irrigation cycle. The removal of soil water by evaporation and transpiration results in water movement upwards

(upflux) by capillary action to replace some of the water in the root zone. The deeper the water table is, the farther the water has to travel upwards into the root zone. Therefore, the effectiveness of the water table for providing moisture to the roots decreases as the water table level drops. If the level is allowed to drop too low, capillarity is broken and upflux action ceases until another saturating rain or irrigation cycle refills the soil profile.



Water Table Observation Wells

A water table observation well allows the ground water level to rise and fall inside it as the water level naturally changes. The changing water level moves an inserted float with an attached measuring rod (Fig. A1.3). The float assembly provides a quick visual indication of water table depth. With more precise inspections of the observation well, the information required for more detailed water management can be obtained.



Calibration of Water Table Observation Wells

Calibration is required to determine water table levels that are optimum for flatwoods citrus trees, and to determine when to apply irrigation water to maintain a specific water table level. The measuring rod can be marked with divisions painted at appropriate intervals for the desired maximum and minimum water table depths (Fig. A1.4).

The measuring rod in a water table observation well has marks that indicate critical water table levels. When the water table drops lower than these marks, the soil will not provide sufficient moisture to meet tree demands. If a very slowly permeable spodic and/or argillic horizon is present, it may be necessary to use the depth to the restrictive layer as the lower depth limit. Observations over a period of time will help determine whether water perches on top of the restrictive layer. The upper water table

management level depends on the depths of the water furrows and roots. The upper mark should be selected so that water does not pond in water furrows or cause root pruning.

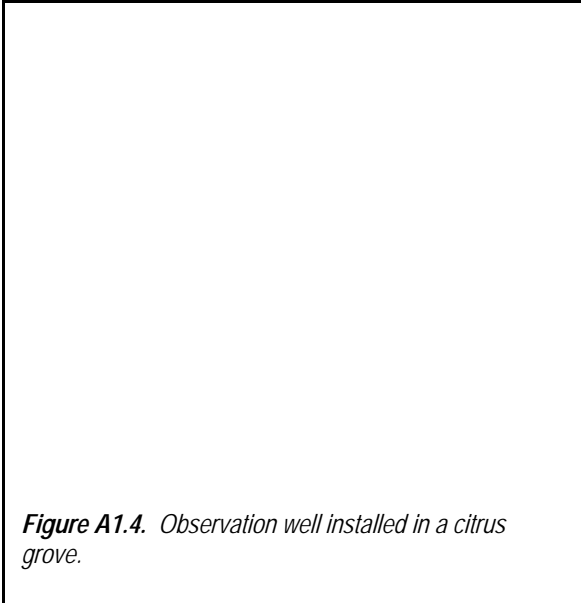


Figure A1.4. Observation well installed in a citrus grove.

For example, in an EauGallie soil (Table A1.1), marks should be made on the measuring rod to show depths of 30 in. (for summer) and 37 in. (for winter months). These will be used to signal the need to start supplemental irrigation throughout the year.

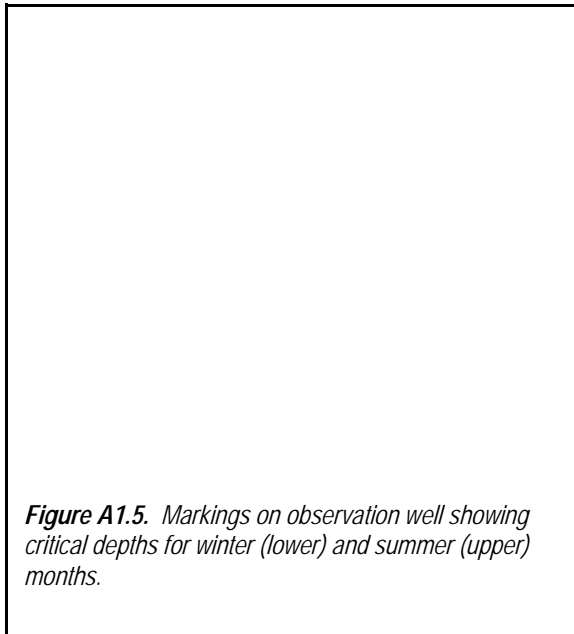


Figure A1.5. Markings on observation well showing critical depths for winter (lower) and summer (upper) months.

These marks should be used as starting points, and confirmed with soil moisture measurements and observation of tree response.

Monitoring water table observation wells can provide adequate information to efficiently schedule irrigation and drainage practices in Flatwoods soils. To incorporate the use of water table observation wells in your operation, contact your local Soil and Water Conservation District.

Table A1.1. Typical water table depths needed to meet tree needs for citrus on EauGallie series soil (calculated from long-term monthly ET and typical upflux data).

| Month | Typical ET (in/day) | Water table depth (in.) |
|-------|---------------------|-------------------------|
| Jan. | 0.07 | 32 |
| Feb. | 0.10 | 29 |
| March | 0.15 | 28 |
| April | 0.16 | 27 |
| May | 0.18 | 26 |
| June | 0.19 | 26 |
| July | 0.19 | 27 |
| Aug. | 0.19 | 26 |
| Sept. | 0.14 | 28 |
| Oct. | 0.12 | 28 |
| Nov. | 0.10 | 29 |
| Dec. | 0.06 | 35 |

References

- Circ. 1188. Simple Water Level Indicator for Seepage Irrigation, <http://edis.ifas.ufl.edu/AE085>
- Obreza and Boman, 1992. Simulated Citrus Water Use from Shallow Groundwater.
- Obreza and Admire, 1985. shallow Water Table Fluctuations in Response to Rainfall, Irrigations, and Evapotranspiration in Flatwoods Citrus.
- Circ. 731. Manual Monitoring of Farm Water Tables, <http://edis.ifas.ufl.edu/AE130>
- Circ. 769. Water Budgeting for High Water Table Soils.
- BUL 251. Water Table Monitoring.
- SP-281. Water and Florida Citrus. Chapt. 20, *Water Table Measurement and Monitoring*.

A2. SCHEDULING IRRIGATION AND DRAINAGE

Drainage and irrigation schedules should focus on optimal crop production and promotion of deep rooting by maintaining a constant water table that minimizes water quantity and quality impacts.

During intense rainfall periods when drainage rates are insufficient to prevent upward fluctuations of the water table, root damage can occur. Therefore, irrigation and drainage practices should be focused on maintaining a well-defined root zone that can be managed during both drought and wet periods. High salinity irrigation water can cause an adjustment to the above-mentioned scheduling.

A2.1. Irrigation

Citrus evapotranspiration (ET) is largely determined by climatic factors. Water requirements vary with soil type, climate, ground cover, cultivation practices, weed control, tree size and age, scion, rootstock, and tree health. Typically, trees only require 1 gal/day during the first 2 years after planting. Large, vigorous, healthy trees require more water than young or non-productive trees. Large trees at low planting densities (60-80 trees/acre) may use twice as much water versus trees planted at a closer spacing that are hedged and topped to control tree size. The water use by typical flatwoods citrus trees planted at a typical spacing (115 to 150 trees per acre) will be on the order of 10-20 gal/day during the winter months and peak at 40-50 gal/day during the summer and should be similar to the rates for developing trees (Fig. A2.1.1).

Studies have shown that efficient use of water and high yields can be obtained by irrigating when 1/3 of the total available water in the soil is depleted during the most critical periods (February through June) and at 2/3 depletion the remainder of the year (Koo et al., 1978). In a flatwoods study, grapefruit trees irrigated at soil tensions of 10-15 cbar (1/3 depletion) yielded 12% more and produced 9% more total soluble solids than those irrigated at 35-45 cbar (1/2 depletion). In addition, irrigation at 1/3 depletion yielded more large-sized fruit (Boman, 1996). Adequate soil moisture is especially important during the bloom period in order to ensure sufficient fruit set. Soil moisture should also

be plentiful throughout the initial fruit enlargement phase to prevent excessive "June drop".

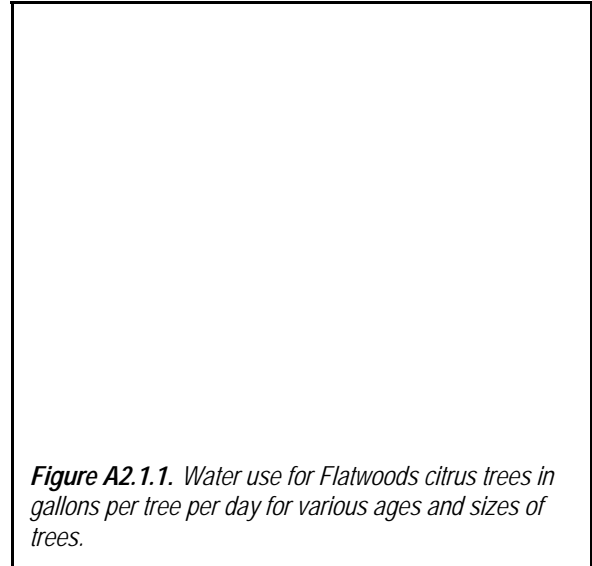


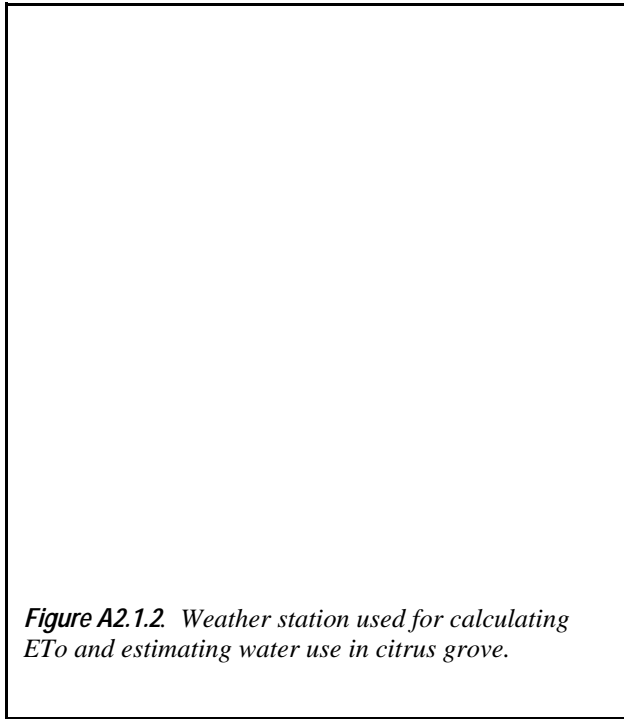
Figure A2.1.1. Water use for Flatwoods citrus trees in gallons per tree per day for various ages and sizes of trees.

Application volumes

Water use rates and irrigation requirements are usually presented in terms of depth. ET rates calculated by the Florida Agricultural Weather Network (FAWN) and many of the private weather stations located within groves (Fig. A2.1.2) use the Penman Reference ET equation (ET_o) and are presented in units of inches per day. Long-term monthly ET_o calculated from data at NOAA Weather Service stations at Tampa and Lakeland are presented in Fig. A2.1.3.

Converting the depths to per-tree volumes is required to manage microirrigation systems that water only a portion of the ground surface. Detailed conversions from irrigation depth to irrigation volume require knowledge of tree planting density and tree size and health. As a rule of thumb, however, evapotranspiration (ET) rates expressed as depths can be converted to volume by:

$$\text{gal/tree/day} = \text{ET (in/day)} \times \text{tree spacing (ft}^2) \times 0.622 \text{ gal/in-ft}^2$$

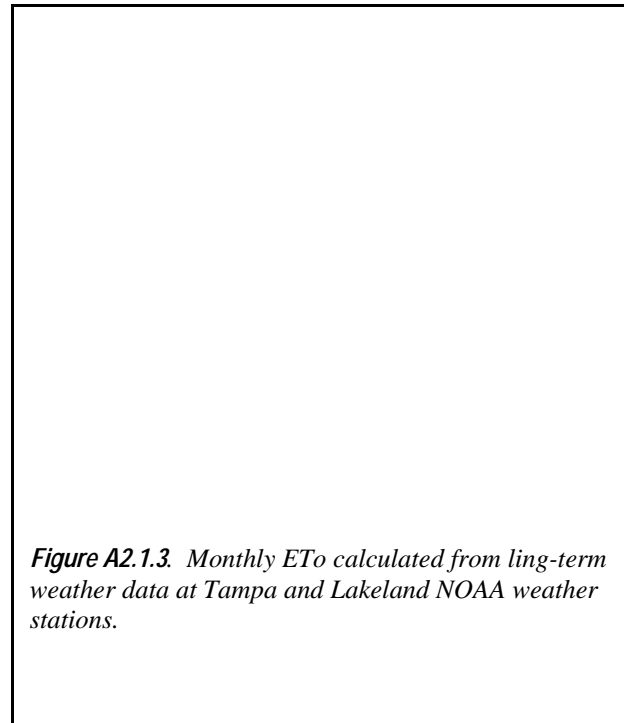


$$0.15 \text{ in/day} \times 12 \text{ ft} \times 25 \text{ ft} \times 0.622 \text{ gal/in-ft}^2 = 28 \text{ gal/day}$$

The conversion should only be used as a starting point, with the actual water estimates based on the size and condition of trees in each block. The water use per tree for mature citrus trees in high-density plantings will be less than that in low-density plantings due to tree size.

The effect of tree density on individual tree water use is illustrated in Table A2.1.1, which assumes that the water used per-acre is equal. During extended dry periods, nearly all of the water used by the trees will come from within the area wetted by the irrigation system. The volume of water that is available in the wetted area depends on the soil texture, organic matter and clay contents, root zone depth, and the emitter design. Typical microsprinklers wet an area of 12-16 feet in diameter, while drip systems frequently wet areas 2½-3 feet in diameter.

The volume of water stored beneath the wetted pattern of a microsprinkler can be estimated if the water holding capacity (WHC) of the soil is known and certain assumptions are made (Fig. A.2.1.2). Table A2.1.2 provides an estimate of the volume of water stored within the area wetted by a 15 ft diameter microsprinkler based on soil texture and root zone depth. Plant available (useable) water is that portion of the total soil water that is held between soil tensions of 0.1 bar (field capacity) and 15 bars (wilting point).



The water use for an ET rate of 0.15 in/day (typical in late March) and a tree spacing of 12 ft x 25 ft can be estimated as:

Table A2.1.1. *Water use in gal/tree for various planting densities assuming equivalent per-acre water use.*

| ET (in/day) | Tree spacing (ft x ft) | Tree area (ft ²) | Tree density (trees/acre) | ET (gal/tree/day) |
|----------------|---------------------------|---------------------------------|------------------------------|----------------------|
| 0.10 | 8 x 22 | 176 | 248 | 11 |
| | 10 x 24 | 240 | 182 | 15 |
| | 12.5 x 25 | 312 | 140 | 19 |
| | 15 x 25 | 375 | 116 | 23 |
| 0.15 | 8 x 22 | 176 | 248 | 16 |
| | 10 x 24 | 240 | 182 | 22 |
| | 12.5 x 25 | 312 | 140 | 29 |
| | 15 x 25 | 375 | 116 | 35 |
| 0.20 | 8 x 22 | 176 | 248 | 22 |
| | 10 x 24 | 240 | 182 | 30 |
| | 12.5 x 25 | 312 | 140 | 39 |
| | 15 x 25 | 375 | 116 | 46 |

Figure A2.1.3. *Procedure for calculating available water in wetted area beneath microsprinkler with 15 ft diameter wetting pattern.*

Table A2.1.2. Gallons of water removed in the 180 ft² area under a microsprinkler with a 15 ft diameter-wetting pattern based on soil type and soil water depletion status.

| Soil Texture* | Available Water | Total available | | | 1/3 depletion | | | 2/3 depletion | | |
|-----------------|-----------------|-----------------|-----|-----|-----------------|-----|-----|-----------------|-----|-----|
| | | Root depth (ft) | | | Root depth (ft) | | | Root depth (ft) | | |
| | (in/ft) | 1.5 | 2.0 | 3.0 | 1.5 | 2.0 | 3.0 | 1.5 | 2.0 | 3.0 |
| Coarse sand | 0.45 | 76 | 101 | 152 | 25 | 33 | 50 | 51 | 68 | 102 |
| Sand | 0.75 | 127 | 169 | 253 | 42 | 56 | 84 | 85 | 113 | 170 |
| FS, LS, LFS, SL | 1.00 | 169 | 225 | 338 | 56 | 74 | 111 | 113 | 151 | 226 |
| Loam | 1.40 | 236 | 315 | 472 | 78 | 104 | 156 | 158 | 211 | 317 |
| CL, SCL | 1.95 | 329 | 439 | 658 | 109 | 145 | 217 | 220 | 294 | 441 |

*FS = fine sand, LS = loamy sand, LFS = loamy fine sand, SL = sandy loam, CL= clay loam, SCL= sandy clay loam.

Typical soils series are: Coarse sand/sands- Tavares, Zolfo; Fine sands: EauGallie, Pineda, Farmton, Wabasso

Irrigation Interval

The optimum interval between irrigation events depends on the design of the irrigation system, ET, time of year, and soil characteristics as well as tree size and condition. Evapotranspiration rates in citrus groves are highly dependent on climatic conditions. Higher evaporation and transpiration rates occur on clear, sunny days with low humidity and high winds compared with cool, damp, overcast winter days. Therefore, irrigation frequency must be adjusted through the year. Table A2.1.3 provides estimates of the irrigation intervals required to replace water lost by evapotranspiration for flatwoods soils (assuming no rainfall or upflux from the water table). Irrigation intervals would be less frequent for trees that use less water due to tree size, tree condition, environmental conditions, or dormancy.

Young Tree Water Use

It takes a number of years (4 to 10, depending on planting density) to achieve maximum ET in a newly planted grove. The amount of water applied to a young grove should take into account the tree canopy size. Newly planted trees require only a fraction of the water that is needed by mature trees.

However, irrigation systems that water grassed areas in row middles and between trees can raise the water requirements considerably. One study found nearly double the water requirement for 2-year-old citrus trees with grass cover compared with trees surrounded by bare soil (Smajstrla, 1985).

In a Florida study, water use for 5-6 year-old Valencia orange trees on Swingle citrumelo rootstock peaked at about 16 gal/day in May. During November through January, ET rates averaged only about half the May rate (Boman, 1993). Water use was found to increase at a rate of about 20% each year from years 4 through 6. Typical spring applications for young trees are 2, 4, 7, 12, and 17 gallons per day from the first to the fifth year, respectively (Boman et al., 1999).

Weather Data for Irrigation Management

Weather is one of the most important factors that affect citrus growth and production. When scheduling irrigation, it is important to have good rainfall and temperature data. In Florida, one of the best sources of up-to-date weather information is the FAWN weather network available on the

Internet. FAWN stands for Florida Automated Weather Network, and is available at <http://fawn.ifas.ufl.edu>. It provides weather information from numerous locations throughout the state at 15-minute intervals.

Decision modules, such as disease prediction, crop phenology, and impacts on crops based on climate forecasts, are also being added to the Web site. Of particular use is the daily summary that gives the daily minimum and maximum temperature, rainfall, total radiation, calculated evapotranspiration (ET), and hours below certain temperatures.

For scheduling irrigation, this daily summary gives much of the information needed to make good scheduling decisions.

Besides giving rainfall, temperature, and ET information that can help with irrigation management, FAWN weather data can be particularly valuable on freeze nights. FAWN provides both temperature and humidity (dew point and wet bulb) data. On predicted frost nights, the wet bulb temperature from FAWN can be particularly useful to estimate how cold it will get.

Table A2.1.3. *Estimated irrigation interval (days) for healthy, mature trees by soil series based on average soil water-holding capacity (WHC) and root zone depth for each series. Citrus trees were assumed to be planted on a 12.5 by 25 foot spacing and hedged to 18 foot canopy width and entire canopy area wetted by the irrigation system. Irrigation interval will be reduced if irrigation system wets a smaller area of the root zone.*

| Month | Average ET | | Allowable depletion % | Myakka 0.54 in/ft, 18-inch | EauGallie 0.64 in/ft, 18-inch |
|-------|------------|--------------|--------------------------|-------------------------------|----------------------------------|
| | in/day | gal/tree/day | | Irrigation interval (days) | |
| Jan | 0.07 | 10 | 67 | 7.8 | 9.2 |
| Feb | 0.10 | 14 | 33 | 2.6 | 3.2 |
| Mar | 0.15 | 21 | 33 | 1.8 | 2.1 |
| Apr | 0.16 | 22 | 33 | 1.7 | 2.0 |
| May | 0.18 | 25 | 33 | 1.5 | 1.8 |
| Jun | 0.19 | 27 | 33 | 1.4 | 1.7 |
| Jul | 0.19 | 27 | 67 | 2.8 | 3.4 |
| Aug | 0.19 | 27 | 67 | 2.8 | 3.4 |
| Sep | 0.14 | 20 | 67 | 3.9 | 4.7 |
| Oct | 0.12 | 17 | 67 | 4.6 | 5.4 |
| Nov | 0.10 | 14 | 67 | 5.5 | 6.4 |
| Dec | 0.06 | 8 | 67 | 9.1 | 10.9 |

A2.2. Drainage

Water table levels vary greatly in flatwoods areas during the rainy season due to the effects of different soil types, non-uniform rainfall, and high intensity rainstorms. Drainage of soil-water is especially important in the wet season since citrus root damage may occur under prolonged high water table conditions. Effective water management, which includes both irrigation and drainage on these poorly drained soils, is essential

for profitable citrus production.

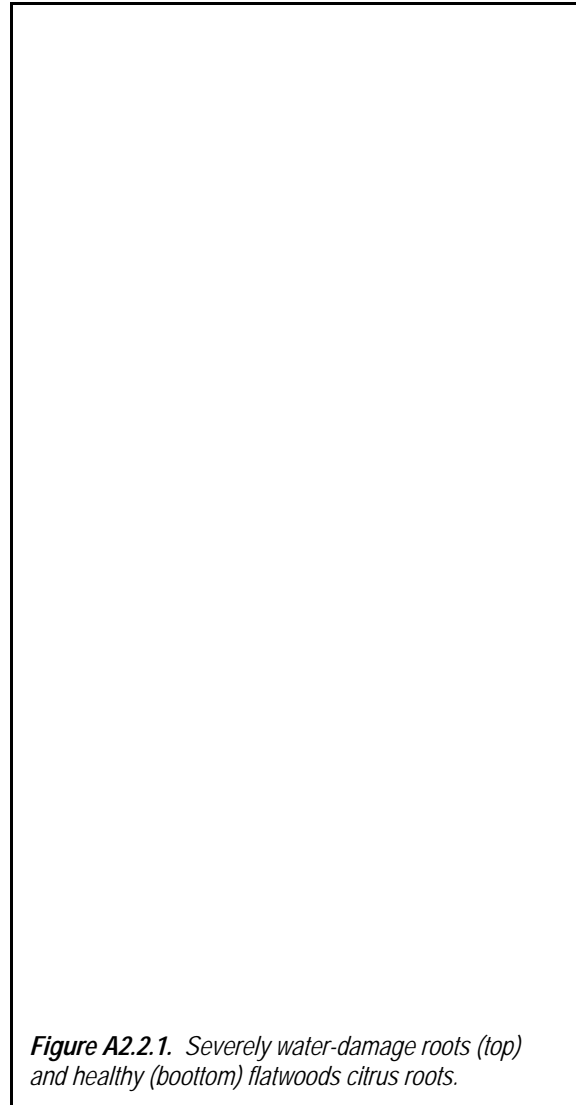
Drainage systems in flatwoods groves consist of canals, retention/detention areas, open ditches, subsurface drains, beds, water furrows, swales, and may include pumps required to move surface water. These systems require continuous maintenance to minimize the chances of root damage from prolonged exposure to waterlogged soils caused by poor drainage, high intensity rains,

and high water tables. Drainage systems should be designed to allow water table drawdown of 4-6 inches per day, a rate that should be sufficient to prevent root damage.

Flooding Damage

Research has shown that there is potential for water damage to citrus roots Fig A2.3.1 if water saturates beds for 4 days or more during extended summer rains. During the cooler months of December-February, citrus trees can tolerate flooded conditions for much longer periods than in the summer. In order to understand how flooding damages citrus, one needs to understand the soil-water dynamics in a grove. In most flatwoods soils, a clay or organic layer within 20-48 inches of the surface acts as a barrier to downward movement of water. As a result, water must move laterally to be drained from saturated soils above these layers. The rate at which water moves through soil expressed in units of distance/time (in/hr or ft/day) is called hydraulic conductivity. Sands typically have saturated hydraulic conductivity of 20 in/hr or more, while the saturated hydraulic conductivity of many flatwoods soils with significant clay content is in the range of 0.1-0.2 in/hr. Hydraulic conductivity also varies tremendously with soil moisture content. For example, when saturated, the hydraulic conductivity of an Oldsmar fine sand soil is about 20 in/hr, but when soil moisture is reduced to a level where a tensiometer reads 85 cbar, the hydraulic conductivity drops to less than 0.05 in/hr.

Porosity is the pore space (air space between soil particles) divided by the total volume of soil. The quantity of water that drains out of the soil as the water table is lowered is directly related to the soil porosity. Gravity is the force that moves water in saturated soils. Therefore, water in saturated soils moves from a higher elevation to a lower elevation. The difference in elevation between two free water surfaces divided by the distance between points is called the hydraulic gradient. The steeper the gradient, the faster water will drain from the higher elevation to the lower elevation. Excessive rainfall will cause a perched water table to develop above



the hardpan in flatwoods soils. Rainfall infiltrates the soil and moves downward to the free water surface (where the soil is saturated), and then must move laterally towards the water furrow for drainage to occur. As a result, a mound in the water table develops in the bed between the water furrows (Fig. A2.2.2).

The time required for this mound of water to recede to a more average depth varies greatly with soil texture and the efficiency of the drainage system. The time may vary from 2 days in coarse textured soils like Pineda, Riviera, and Immokalee series to more than a week in finer textured soils like Winder. If the drainage system is working properly,

water recedes at rates adequate to prevent root damage. Problems occur when heavy rainfall results in elevated water tables for several weeks. Once the soil is near saturation, only a small amount of rainfall is needed to fill the available pore spaces in the soil, saturating the root zone. When the air is excluded (pore spaces are filled with water), root decay can occur with infections by disease organisms.

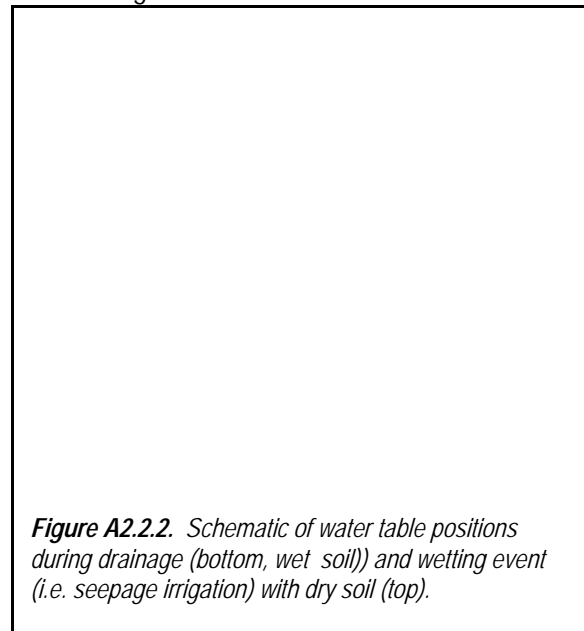


Figure A2.2.2. Schematic of water table positions during drainage (bottom, wet soil) and wetting event (i.e. seepage irrigation) with dry soil (top).

If surface runoff water moves quickly (i.e. slow infiltration rate) following rainfall and the water furrows drain freely, the initial buildup of a perched water table in the beds may be relatively minor. When the difference in elevation between the free water surface in the bed middles and water furrows is relatively large, maximum drainage rates will occur. As the water drains from the beds, the height of the free water surface in the beds decreases, and the mounded water table becomes less pronounced. The rate of drainage from the beds will slow due to a decreased hydraulic gradient.

Water table observation wells (WTOW) are good tools for observing soil-water dynamics. They are a reliable method for evaluating water-saturated zones in sites subject to chronic flooding injury. These wells can also be used to measure the rate

of water table drawdown, which is the key to discovering how long roots can tolerate flooding. Observation wells constructed with measuring rods allow water tables to be visually observed while driving by the well site. The local water conservation district can assist with water table observation well installation and use in scheduling grove irrigation cycles for Hardee and Desoto, Manatee, Sarasota and Charlotte Counties.

Short-term estimates of flooding stress can be obtained by digging into the soil and smelling soil and root samples. Sour odors indicate an oxygen deficient environment. The presence of hydrogen sulfide (a rotten egg odor) is an indication that feeder roots are dying. Anaerobic bacteria (that live in the absence of oxygen) will develop rapidly in flooded soils and contribute to the destruction of citrus roots. In a field survey of poorly drained groves, anaerobic sulfate-reducing bacteria in more than half of the locations formed toxic sulfides. Nitrites, formed by nitrate reducing bacteria, and organic acids that are toxic to roots were also found in these flooded soils.

Good drainage allows air to move into the soil and prevents oxygen-deprived conditions. Citrus tree stress caused by flooding is usually less when soil water is moving than when it is stagnant. A higher subsoil pH may help to delay, for a few days at least, the death of citrus roots under flooded conditions.

With experience, flooding injury can be diagnosed during periods when groundwater levels are high. Even before there are visible tree symptoms, digging into the root zone may give an estimate of future tree response. Indications of problems include high water tables with saturated soils in the root zones, sloughing roots, and sour odors in the soil. When the water table recedes, visible damage to the trees may become more obvious. New feeder roots appear and grow rapidly on trees that have survived and received adequate irrigation.

Symptoms of damage may not occur for several

weeks, depending on the severity of root damage and the frequency of rainfall following the damage. Symptoms usually start to appear after the water table drops and the soil dries out. Symptoms of root damage include leaf yellowing, chlorosis, wilting, fruit drop, leaf drop, and twig dieback. Often root damage is so severe that trees may go into a wilt even though water furrows are still wet. Because the root system was severely damaged by the flooding, the full extent of damage may not be known for several months or until drought conditions occur.

Young trees are often more sensitive to flooding and may develop symptoms resembling winter chlorosis. More subtle symptoms include reduced growth and sparse foliage that can occur at locations only a few inches lower in elevation than the surrounding area. Harvesting operations in a grove after recent flooding may also further damage surface roots that have been injured by the flooding.

Hot, dry conditions following flooding will hasten the onset of stress and symptom expression. The reduced root system resulting from flooding is incapable of supporting the existing tree canopy. When this occurs, irrigation management becomes critical. Irrigation must provide moisture to a depleted (shallow) root system. Excessive water could compound existing problems. If root system damage is extensive and tree canopy condition continues to deteriorate with permanent wilt and foliage dieback, some degree of canopy pruning may be necessary to reestablish a satisfactory shoot/root balance.

Light, frequent irrigations will be required until the root zone has become reestablished. Subsurface moisture should be maintained to promote root growth into the lower root zone. If root damage is severe, frequent irrigation may be required throughout the winter months, especially if dry winds persist.

A2.3. Managing Salinity

It is important that growers understand the issues

related to the quantity and quality of irrigation water used and the potential impacts that the use may have on downstream receiving water bodies. Managing irrigation with high salinity water requires frequent irrigations with excess water applications that leach accumulated salts from the soil. As a result, these salts move off with surface water drainage and impact downstream water users.

Salinity measurement

Saline water is generally defined as water unsuitable for irrigation because of its high content of dissolved solids. Potential problems associated with the use of saline irrigation water and soils can be compounded by fertilization and irrigation practices (Syvertsen et al., 1989). Consequently, the frequency, sources, and methods of application of both fertilizer and water become of important to minimize the effects of salinity.

Electrical conductivity (EC) is a measure of the ability of a solution to conduct electricity and is directly related to the quantity of total dissolved solids (TDS) in solution. The unit of measurement for EC is deci-Siemens per meter (dS/m), which generally ranges from 0-5. If the numbers reported are higher, in the range of 500-5000, the units are typically micro-Siemens per centimeter (: S/cm).

It is recommended that a commercial or certified laboratory analyze each irrigation source annually for EC, TDS, sodium (Na), chloride (Cl), and sulfate (SO₄) concentrations. Specific ion concentrations in relation to overall TDS are important in the assessment of salinity and its effects on citrus. For example, TDS levels may be relatively low (at or near 1,200 mg/l), but chloride concentrations for the same sample may exceed 500 mg/l because chloride is the dominant source of the salinity.

Once laboratory water quality data is obtained, a simple ratio of EC to each dissolved constituent can be used to accurately estimate TDS and concentrations of Na, Cl and SO₄. The conversion from electrical conductance to TDS depends on the particular salts present in the solution. A factor of 700 x EC (in dS/m) for converting EC values to

TDS is suitable for many areas of Florida (Wander and Reitz, 1951).

Salinity in PRMSB

Salinity in some irrigation sources can vary from hour to hour or from day to day. Generally, ground water quality decreases with depth and deep wells may cross-connect multiple water quality zones. These cross-connecting wells may passively contribute to a degradation of local ground water resources due to the intrusion of poor water quality into zones of higher water quality.

In the coastal and southern areas within the PRMSB, it is not uncommon for ground water quality to degrade when wells are pumped at high rates or for prolonged periods. The degradation is generally attributed to "up-coning" of denser, saline water as the fresher water above is pumped out of the aquifer. If these conditions exist, the well may be conducive to back plugging of the highly saline zone to improve water quality. This method of improving ground water quality can be highly effective if the saline source, i.e., fractures of flow zones, can be identified and the flow zone shut off or plugged. However, the sustainability of wells that have been back-plugged is unknown. Therefore, back plugging should be one element of an overall salinity reduction plan and be accompanied by other low salinity irrigation sources such as surface water and/or tailwater recovery and reuse.

In the southern and coastal areas of the PRMSB, many irrigation wells are characterized as flowing artesian wells. If allowed to equilibrate, these wells can exhibit water levels several feet above land surface and can discharge water from several gallons per minute (gpm) to several hundred gpm. If left unchecked, these wells can waste tremendous volumes of water and cause harm to crops and downstream receiving water bodies. If the water is saline, the effects can be deleterious.

Florida Statutes dictate that flowing artesian wells be capped or valved in a manner such that only the volume that is required for an intended use is

released. This also applies to pumping systems that allow water to pass through the pump. Such unchecked flow can allow for a continual discharge through the irrigation system. All flowing artesian wells are required to be valved, even if pumping equipment is installed, unless it can be demonstrated that the pumping equipment prevents discharge.

Effects on citrus

The effects of high salinity can be very detrimental to citrus, especially young trees. The primary responses to salinity in citrus are; reductions in growth, leaf drop, twig dieback, reduced yields, and small fruit. Other considerations include: osmotic stress, toxicity from sodium (Na), chloride (Cl), and boron (B) ions, the tolerance of rootstocks and scions to salinity, fertilizer sources and formulations, frequency of irrigation and nutrient applications, and problems associated saline water used as a carrier for foliar sprays.

Dissolved salts have an osmotic effect that reduces the availability of soil water causing the trees to suffer drought stress-like symptoms. A gradual accumulation of salts in the root zone can reduce root and leaf growth causing visibly thinner tree canopies and lower yields. A sudden shock increase in osmotic stress can be more detrimental than a gradual increase in salinity stress over several irrigation cycles. An osmotic shock can cause leaves to drop within a few days.

Salt stress can occur from fertilizer applied at excessively high rates. If salts do accumulate at the edge of the irrigation-wetted area, a slight rain can move the salts back into solution. If there is insufficient rain (less than 1 inch), the salts may move up back in the root zone resulting in osmotic shock. Salinity can also negatively affect trees through the accumulation of potentially toxic ions, principally Na, Cl and Boron (B) in roots and leaves.

Whether by osmotic stress or by the accumulation of toxic ions, high temperatures and low humidity's can make salinity problems worse. Therefore,

irrigation water with EC values consistently greater than 1,000 uS/cm should be avoided and alternative, low salinity sources employed.

There are differences among citrus rootstocks in their ability to exclude or tolerate high levels of Na and Cl in the soil solution while preventing their accumulation in leaves. Since many common citrus rootstocks can exclude Na, high Cl levels in leaves are usually considered to be more deleterious than high Na. Preliminary ground water quality investigations performed by the SWFWMD indicate that in the southern part of the PRMSB, Cl concentrations are approximately twice the Na concentrations.

The general, decreasing order of salinity tolerance (from best to worse) to high Cl for common citrus rootstocks is Cleopatra mandarin > Rangpur lime > sour orange > rough lemon > Volkamer lemon > Swingle citrumelo > Sweet orange > Carrizo and other citranges > *Poncirus trifoliata* (Levy and Syvertsen 2004). There are also differences in salinity tolerance among scion varieties that may be related to water usage (Syvertsen et al. 1989). The more water a tree uses through transpiration, the more ions can be deposited inside leaves as the water evaporates. For example, grapefruit and lemon trees tend to use more water and are less salt tolerant than orange varieties.

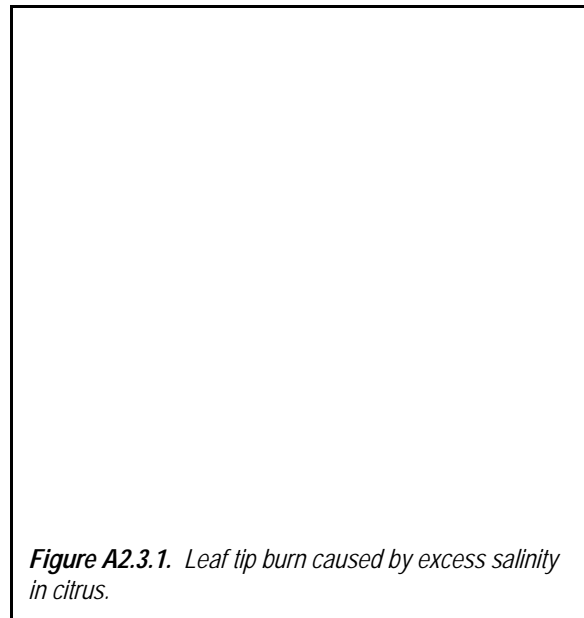
Critical concentrations of leaf Na and Cl can be variable depending on leaf age, duration of salinity stress and the rate at which soil salinity previously increased. High concentrations of Cl in leaves can cause yellowing, bleaching, bronzing and/or tip burn (Figs. A2.3.1 and A2.3.2). At higher salinity levels or longer term drought, leaf drop will occur as leaf Cl levels increase. The thinning canopy will be followed by twig dieback, defoliation, and death of young trees (Fig. A2.3.3).

Leaf tissue analysis should also be used to detect deficient levels of other elements caused by nutrient imbalances from the salt stress. For example, high leaf Na can cause low calcium (Ca) and low potassium (K). Salinity problems can be

minimized if adequate leaf nutritional concentrations are maintained, especially those of N, Ca, and K.

Management

Salinity management should be based on relative concentrations of salts in water, fertilizer solutions



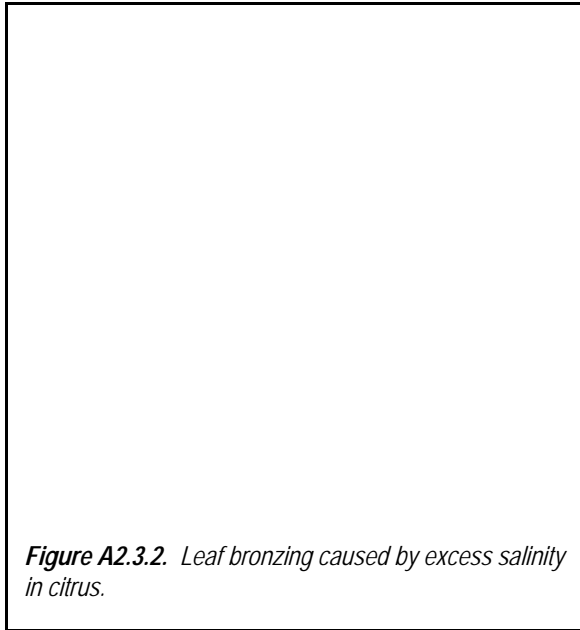
and soils. Therefore, irrigation source water should be regularly tested and when available, low salinity sources should be used to the greatest extent practicable.

Irrigation with high salinity water requires applications to be more frequent and of greater amounts than when good quality water is used. During extended droughts, salinity levels will dictate irrigation scheduling. Salts are concentrated in the soil with the process of plant transpiration and soil surface evaporation, which selectively remove relatively pure water and concentrates the salts. Salt accumulations in the soil are generally only removed by leaching below the crop root zone. Therefore, the key to salinity control is to provide a net downward flow in the root zone.

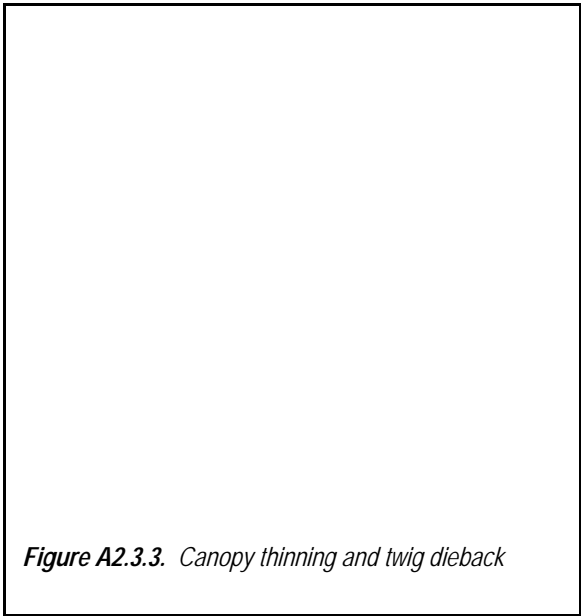
Even in well-managed groves, the soil water will be several times more saline than the irrigation water.

With insufficient leaching and drying out of the soil, this ratio can easily increase ten-fold or more, resulting in injury to the trees. Accumulation of salts over the years is not a problem in most cases due to the abundant rainfall at sufficient rates to leach the salts from the root zones. Salts in typical sandy soils are generally leached out with the first inch of rainfall. However, in some poorly drained heavier soils, salt accumulation can be a problem. These soils require more careful monitoring of salinity-related problems.

If surface water resources are developed, it is important to operate them independently from saline groundwater sources. Mixing of saline ground water into a surface water reservoir may increase the salinity of the reservoir through evaporation. Therefore, water supply withdrawals should be managed independently, if possible. Surface water impounded behind water control structures can also assist in saline water dilution and inhibit off site discharge. This practice, if managed properly, can add to the upflux of soil water, thereby reducing overall irrigation demand and assist in low temperature moderation.



Be aware of the effect of fertilizer use on increasing osmotic stress. Consider selecting fertilizer sources that have the lowest salt index per unit of plant nutrients when using saline irrigation water (Appendix 4, Salt Index table). Increase the frequency of fertilizations by applying lower rates, thereby making it possible to reduce the salt content of each application and aid in preventing excess salt accumulation in the root zone. Maintain optimum, but not excessive, nutrient levels in soil and leaves with rates based on the long-term production potential from each specific grove. Fertilizer rates can usually be lowered for trees with high salinity since production levels will probably be lower than for non-salt stressed trees.



There are numerous programs offered by governmental agencies that will assist in lowering and/or managing high salinity levels in irrigation water. Table A2.3.1 provides information on several of these programs:

Table A2.3.1. Programs aimed at assisting growers with salinity management.

| Program | Program Summary | Contact |
|---|---|--|
| Quality of Water Improvement Program (QWIP) | Provides partial reimbursement to plug abandoned or non-used wells | Southwest Florida Water Management District (SWFWMD) |
| Irrigation Well Back-plugging Program | Provides partial reimbursement to back-plug wells to reduce poor water quality yield | Southwest Florida Water Management District (SWFWMD) |
| Facilitating Agricultural Resource Management Systems (FARMS) Program | Provides funding (up to 75%) for alternative irrigation source development within the Southern Water Use Caution Area (SWUCA) | Southwest Florida Water Management District (SWFWMD) and Florida Department of Agriculture and Consumer Services (FDACS) |
| Environmental Quality Improvement Program (EQIP) | Provides funding (up to 75%) for irrigation related BMPs | Natural Resources Conservation Service (NRCS) |
| Mobile Irrigation Lab | Helps to provide confidential evaluations of irrigation system efficiency and operation. See A-2d below. | Natural Resources Conservation Service (NRCS) and (SWFWMD) |
| County Alliance for Responsible Environmental Stewardship Program (CARES) | Provides increased awareness on positive environmental practices while maintaining profitability | Florida Farm Bureau, IFAS, NRCS |

Summary

BMPs for saline irrigation sources are critical to overall fruit yield and tree health. Consequently, all irrigation sources should be analyzed and monitored frequently. As individual irrigation sources are characterized, the use of high salinity sources should be reduced and low salinity and/or alternative irrigation sources maximized. Practices that reduce salt buildup in the soils offer increased fruit yield, more effective nutrient uptake, and reduce potential water quality impacts to receiving surface water bodies.

References:

- Circ.1411. Managing Salinity in Florida Citrus. <http://edis.ifas.ufl.edu/AE171>.
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- SP-169. Nutrition of Florida citrus trees.
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- FC-81. Management of Microirrigation Systems for Florida Citrus.
- HS-166. Irrigation Scheduling Tables For Florida citrus.
- Circ. 444. Citrus Irrigation Management.
- Boman, 1994. Evapotranspiration from Young Florida Flatwoods Citrus Trees.
- Boman, 1996. Effects of Microirrigation Frequency on Florida Grapefruit.
- Boman, 1999. Water Management, *In* Citrus Health

Management.

- Graser and Allen, 1987. Water Relations of 7-year-old Containerized Citrus Trees under Drought and Flooding Stress.
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A2.4. Mobile Irrigation Lab

An evaluation of an irrigation system by a Mobile Irrigation Lab (MIL) team incorporates site-specific data about the soil, crop and irrigation system to identify problems with system design and operation. The MIL provides recommendations for system improvements and scheduling and shows growers how to use soil moisture measuring devices like tensiometers and water table observation wells. System improvements to increase uniformity and efficient scheduling can help growers conserve significant amounts of irrigation water while still providing the water required to meet crop needs. Increased irrigation efficiency not only saves water, but also reduces the potential for leaching of nutrients and agricultural chemicals. Such leaching may lead to groundwater and/or surface water contamination. A typical MIL evaluation of an irrigation system

begins with a request from a grower for the service. The evaluation is scheduled to accommodate the various grove management operations like spraying, herbiciding and harvesting. The team arrives on-site and works with the cooperating grower to collect information on the system type, design and specifications, tree spacing, canopy size, root depth, wetted area and soils. The grower then begins normal operation of the system. Flow rates and pressures at the pump station and at the ends of the manifolds are measured.

A representative portion of the operating zone fed by one manifold is chosen for intensive study. Flow rates of emitters are measured at 16 locations in a grid pattern throughout the chosen area and pressures are measured at the inlet and closed ends of the laterals. Observations on leaks, clogged emitters and malfunctioning field valves are also noted. MIL operators bring major problems to the immediate attention of the grower for timely repair and provide information on the principles of irrigation water management.

The team calculates emission uniformity, variation in manifold pressures, average emitter discharge rate, water application per irrigation and per tree, average wetted area, and the percent of cropped area. Water samples should be taken to determine pH, total dissolved solids, chlorides, sulfides, iron, calcium, magnesium, total hardness and total alkalinity. The grower can have the samples run at a private lab or contact the local SWFWMD office for assistance. Once the samples have been analyzed the team can provide guidelines on the potential for clogging and recommend treatment methods.

Recommendations

Based on the collected data and the calculated values, the team recommends an irrigation schedule that will help the grower operate the system effectively. This schedule includes recommended run times and frequencies, month by month, reflecting water requirements that will change as a result of growth stages and climatic effects. All the data, calculated information,

problems and recommended improvements in system design, operation and maintenance are presented in a written report to the grower. The team is available to answer questions, discuss problems and recommend improvements, and to pursue further technical assistance through NRCS or the University of Florida, IFAS, Cooperative Extension Service.

Later in the year or the following year, the MIL team follows up with the grower and may re-evaluate the system after improvements are made. Based on this re-evaluation, a new irrigation water management schedule is provided to the grower to ensure increased efficiencies.

NRCS Contacts:

Charlotte County

Ft. Myers Service Center
3434 Hancock Bridge Parkway, Suite 209B
N. Ft. Myers, Florida 33903
Phone: 239-995-5678 ext. 3

Hardee and DeSoto Counties

NRCS Wauchula Service Center
316 North 7th Ave. Suite 101
Wauchula, FL 33873
Phone: 863-773-4764 ext. 3

Sarasota and Manatee Counties

NRCS Sarasota Service Center
6942 Professional Pkwy E., Unit 200
Sarasota, FL 34240-8426
Phone: 941-907-0011

A2.5. Irrigation System Maintenance and Evaluation

Irrigation maintenance and evaluation is a management plan designed to maintain irrigation system components in good condition, so that the entire system can perform according to manufacturer's specifications.

The uniformity of water application and efficiency in water delivery of an irrigation system tends to decrease over time because of aging, weathering and component breakdown unless proper

maintenance is done on the system. The goal of irrigation system maintenance is to maintain and maximize system performance.

Maintenance programs vary according to the type of irrigation system: For example, maintenance of flood or seepage systems may be limited to a pre-season operational check of pump stations and ditches. Likewise, maintenance programs for pressurized pipe irrigation systems generally involve filtration, chlorination/acidification, flushing, repair or replacement of clogged emitters, and observation. Irrigation systems that are managed efficiently help ensure citrus tree uniformity, conserve water, and reduce operation and maintenance costs.

General Irrigation Maintenance

- Determine and record the design operating values. Know the level of irrigation system efficiency defined as the ratio of the volume of water delivered by an irrigation system and available to the crop, compared to the volume of water that this system uses from a source (e.g., well, pond, etc.).
- Periodically check the uniformity, defined as the degree to which an irrigation system can apply equal amounts of water throughout different locations in a field. Improper maintenance can decrease system uniformity.
- Establish a documented maintenance schedule that should include inspection of the mechanical components, irrigation lines, as well as monitoring of the pump and power unit. This can be done by keeping written records of performance and maintenance actions.
- Use flow meters and pressure gages to determine existing operating parameters and to properly manage the irrigation system.
- Test water quality at least once a year; since changes in water quality parameters affect maintenance requirements and frequency. Clean and maintain filtration equipment, so that it

operates at optimum pressure ranges.

- Record the flow rate, pressure delivered by the pump, and energy consumption of the power unit frequently.
- Regularly check control valves, pressure regulators, leaks on seals and fittings, and pressure relief valves for proper operation. Lubricate as necessary.

Microsprinkler Systems

Microirrigation systems are an efficient tool for grower utilization to timely deliver water efficiently to the crop. When properly designed, operated and maintained precise amounts of water, nutrients and other materials are delivered to the target site.

If the microirrigation systems are improperly maintained, problems can occur due to clogged filters and microsprinklers, malfunctioning pressure regulators, damaged lateral lines or connectors. Uniformity of water application is affected by system maintenance and operational pressure. When systems are properly maintained by flushing lines and filters, unclogging emitters and in some cases treating the water to minimize clogging, irrigation efficiency and uniformity is improved, thereby conserving water and improving efficiency which enhance yields.

Microirrigation Maintenance List

- Use proper filters with at least 200 mesh or equivalent.
- Check system prior to injection of fertilizers or chemical to assure even distribution of materials within the grove.
- Flush lines regularly to minimize sediment build up.
- Flush all fertilizers from the lateral lines prior to shutting the irrigation system down when fertigrating to avoid clogging problems.

- If required chemically treat water to prevent emitter plugging due to microbial growth and/or mineral precipitation, inject chemicals prior to filtration.
- Adjust pH of irrigation water to reduce potential for chemical precipitation.
- If water is from surface sources, treat algae blooms in the pond to minimize clogging.

Drip Irrigation Systems

- Use filters compatible with drip irrigation (200 mesh or equivalent) and water source.
- Consider using chemical treatment to prevent emitter plugging due to microbial growth and/or mineral precipitation. Chlorination is the most common method for treating bacterial slimes. If the microirrigation system water source is not chlorinated, it is a good practice to equip the system to inject chlorine to suppress microbial growth. Since bacteria can grow within filters and chlorination may create iron-hydroxide precipitates, chlorine injection should be done before filtration.
- Acid can be used to lower the pH of irrigation water to reduce the potential for chemical precipitation and to enhance the effectiveness of the chlorine injection. Acid can be injected in much the same way as fertilizer; however, extreme caution is required.
- Scale inhibitors, such as chelating and sequestering agents are available for use in microirrigation systems to prevent plugging.
- Flush the drip irrigation lines regularly to minimize sediment build up. A regular maintenance program of inspection and flushing will help significantly in preventing emitter plugging.
- Flush all fertilizer (when fertigating) prior to shutting the irrigation system down. Flushing can be accomplished manually by opening the

end of each lateral, or by using automatic flushing end-caps on the laterals.

Mobile Irrigation Lab (MIL)

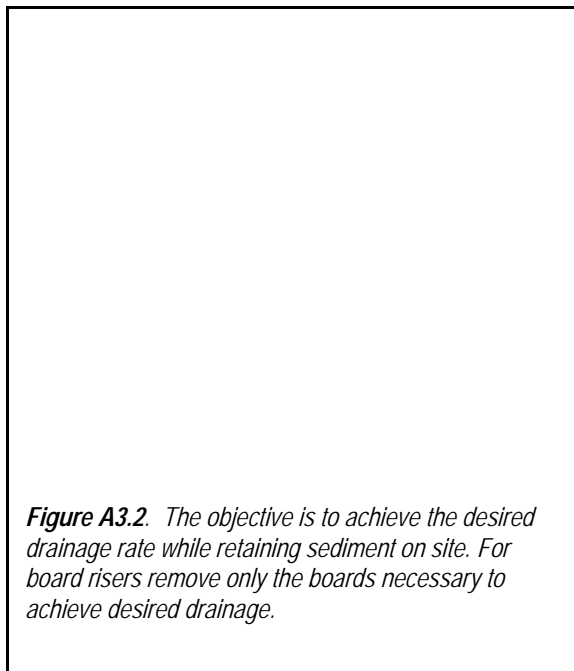
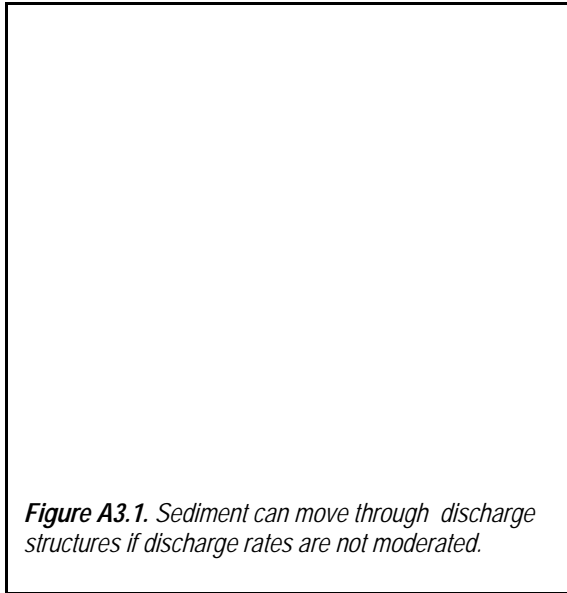
- MILs are available free of charge and provide a confidential irrigation system evaluation with recommendations regarding system upgrades, irrigation scheduling, and other maintenance items. Contact your NRCS District Conservationist for the MIL closest to your location.

References:

- AE-73. Potential Impacts of Improper Irrigation System Design, <http://edis.ifas.ufl.edu/ae073>
- Bul 258. Causes and Prevention of Emitter Plugging in Microirrigation Systems, <http://edis.ifas.ufl.edu/AE032>
- Bul 247. Efficiencies of Florida Agricultural Irrigation Systems, <http://edis.ifas.ufl.edu/ae110>
- Bul 248. Backflow Requirements When Using Public Water Supplies, <http://edis.ifas.ufl.edu/bul248>
- Bul 294. Design of Agricultural Irrigation Systems in Florida, <http://edis.ifas.ufl.edu/ae064>
- Code 441. NRCS Conservation Practice Standard, Irrigation System, Microirrigation.
- SP-281. Water and Florida Citrus.

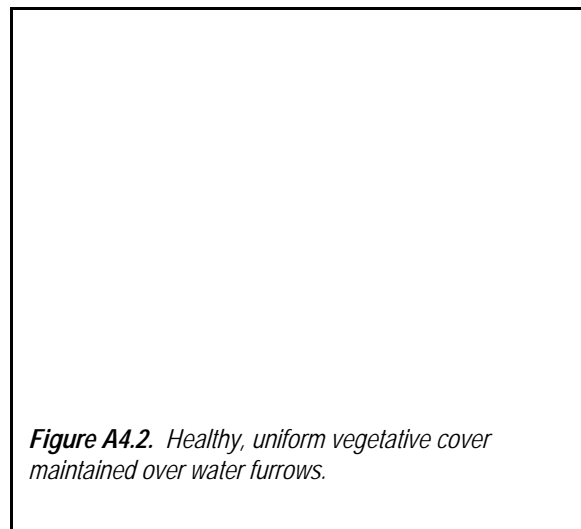
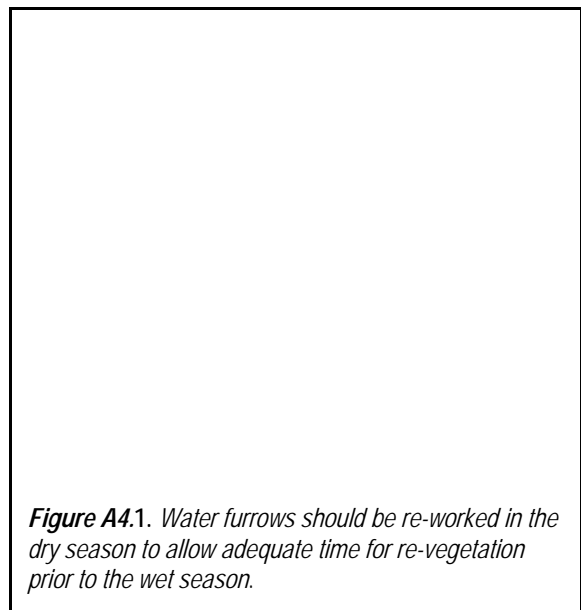
A3. Moderate Discharge Rate

Adjust the rate of discharge proportionate to the rate of lateral movement of water through soils. Slowing the discharge rate will lessen the turbulence, reduce sediment movement, reduce erosion, and moderate the impacts on the receiving water body.



A4. Water Furrow Maintenance

Maintain a consistent bottom slope on water furrows between beds to achieve uniform drainage. Avoid rutting and sloughing of water furrow areas. Where possible, maintain vegetation management programs that minimize soil movement in the event of heavy rains by keeping a grass or vegetation cover on the soil surface in between tree rows. For additional information refer to the Erosion Control and Sediment Management chapter in this manual.



A5. Monitor Soil Moisture

Use Tensiometers, capacitance sensors or other soil water monitoring devices along with water table observation wells for irrigation and drainage management to avoid excess soil moisture depletion and minimize water volume requirements during irrigation cycles.

Good irrigation management requires that the status of soil water be accurately evaluated. There are direct and indirect methods to measure soil water content and several alternative ways to express it quantitatively. There is no universally recognized standard method of measurement and no uniform way to compute and present the results. The most commonly used sensor is the tensiometer, however; capacitance sensors are rapidly gaining in popularity.

Tensiometers

Tensiometers are devices that indicate the water status of a soil. They do not directly measure the amount of water in the soil, but measure the energy a plant must exert to extract water from the soil. The amount of energy a plant exerts to extract water is directly related to the soil water content. A diagram of a commercial tensiometer is shown in (Fig. A5.1). It consists of a porous ceramic tip sealed to the base of a water-filled tube, usually plastic, which is sealed at the top with a removable airtight cap. A vacuum gauge is connected to the upper part of the tube.

Soil moisture tension (SMT) values are periodically read from the vacuum gauge. Soil moisture tension is a direct measurement of the energy that holds water in the soil. When the relationship between SMT and available soil water are known, the tensiometer can be used to determine the amount of available water present in the soil at any time and therefore, it can be used to schedule irrigations.

The vacuum gauges available on most commercial tensiometers are calibrated in units called centibars (cbar) with readings on the gauge ranging from 0 to

100. Some tensiometers may read in kilopascals (KPa) units, with the conversion of 1 cbar = 1 KPa. The useful range of the tensiometer is from 0 to 80 cbar. At SMT values greater than 80 cbar, air enters the porous tip and the tensiometer no longer functions properly. Essentially all of the water available for plant growth can be detected between gauge readings of 0 and 80 for coarse textured soils. Less can be measured with a tensiometer in medium-textured soils, while only a small amount of the available water can be detected with a tensiometer in fine textured soils. Therefore, tensiometers are most applicable to coarse and medium-textured soils.

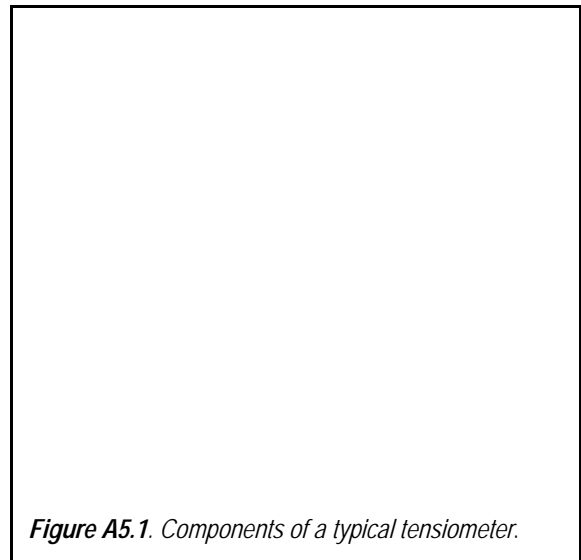
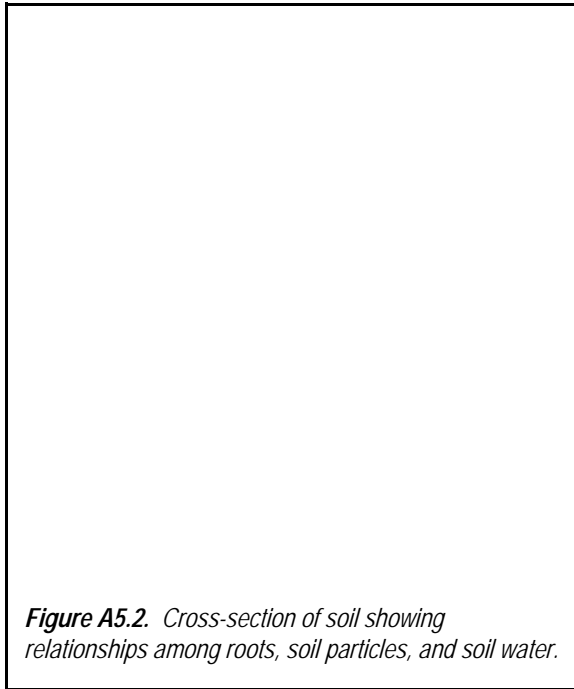


Figure A5.1. Components of a typical tensiometer.

When a tensiometer is filled with water and properly installed with the porous tip in the root zone of a growing crop, movement of water into or out of the porous tip occurs in order to maintain equilibrium between water in the soil and water in the tensiometer (Fig. A5.2). As the soil dries, water moves from the porous tip into the soil and a higher tension is registered on the gauge. Conversely, when irrigation or rainwater wets the soil surrounding the tip, water moves from the soil into the tensiometer with a resultant decrease in tension. Thus, the tensiometer indicates the soil water status for soils as they become drier in response to crop use and as they receive water from rainfall or irrigation.



Tensiometer Installation

Tensiometers must be properly prepared prior to their insertion in the soil. This servicing process requires the following steps. Remove the threaded cap from the tensiometer and submerge the ceramic tip in a bucket of water and allow it to soak overnight. Water will move through the tip and accumulate in the tube. A hand-held suction pump (sold by the tensiometer supplier) should be used to remove entrapped air from the porous cup. Allow the tensiometer to soak a few more hours and repeat the process of removing entrapped air. Fill the hollow tensiometer tube with water and seal the cap firmly. The tensiometer is now ready for insertion into the soil.

Installation of tensiometers in the soil is a simple process requiring only a hammer and a piece of steel rod having the same diameter as the body of the tensiometer. The steel rod, which should have a tapered point, is driven to the desired depth and extracted. In coarse, moderately coarse and medium textured soil, pounding the tapered rod into the soil and extracting the rod from the soil is easily done. An alternative method of installation is to make the tensiometer hole using a soil-sampling

probe (coring tools are sold by tensiometer manufacturers) or a soil auger of the required diameter.

After inserting the body of the tensiometer into the hole, the tip should be forced gently into the soil at the base of the hole. In order to establish good contact between the porous tip and the soil (good contact must be established for the tensiometer to function properly), pour about one fourth cup of water down the hole prior to inserting the tensiometer. The bottom of the gauge should be about one inch above the soil surface. Get a snug fit between the body of the tensiometer and the soil surface by compacting the soil around the tensiometer so that water will not run down along the body of the tensiometer. Minimal disturbance of the soil adjacent to the tensiometer is essential. Allow the tensiometer to remain overnight before taking the first reading.

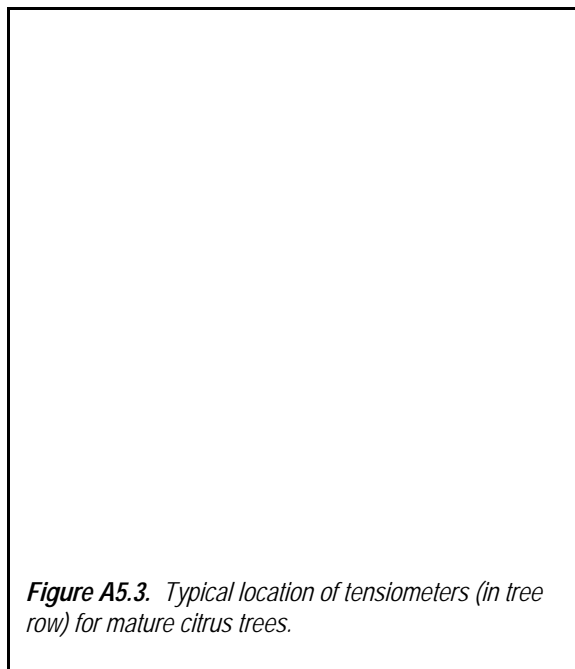
Maintenance

Service each tensiometer frequently when air bubbles accumulate in the tensiometer tube. This involves recording the tension, removing the cap, adding water to refill the instrument, removing entrapped air bubbles with the hand-held suction pump, and replacing the airtight cap. If the gauge indicates an unexpectedly low (or zero) reading following a previous high gauge reading, the tensiometer is probably not broken, but the tension is broken. Tensiometers are not intended to operate above a reading of 80 cbar. One can correct this seemingly erratic behavior simply by servicing the tensiometer as indicated above. Servicing the tensiometer before irrigating the soil will be of no benefit because the soil is so dry that the tension will break again.

Location

Tensiometers should be placed at representative sites or stations in a field (Fig. A5.3). Since many groves have several different soil types, a specific recommendation on the number of tensiometers required per block is difficult to provide. More tensiometers per block mean a better characterization of the grove soil water status, and

a grower should invest in as many tensiometers as he can reasonably afford, read, and maintain. Tensiometers should be placed in the root zone where water uptake is most rapid. Since citrus roots are more abundant near the soil surface, and because upper soil layers usually dry out sooner than the deeper soil layers, placement within the root zone is ideal.



There are various opinions on best depths for tensiometer placement. Tensiometer stations should consist of at least two tensiometers of different lengths, preferably 6 and 12 inches. Tensiometers must be placed at stations where they will not be damaged or broken during normal cultural operations. Typically, they should be installed in the tree row near the drip line of the tree. Tensiometers need to be in an area wetted by the microirrigation system to provide meaningful information. On typical flatwoods soils, springtime irrigation can start at 15 cbar and fall and winter irrigation can start at 20-30 cbar (Table A5.1).

Capacitance Sensors

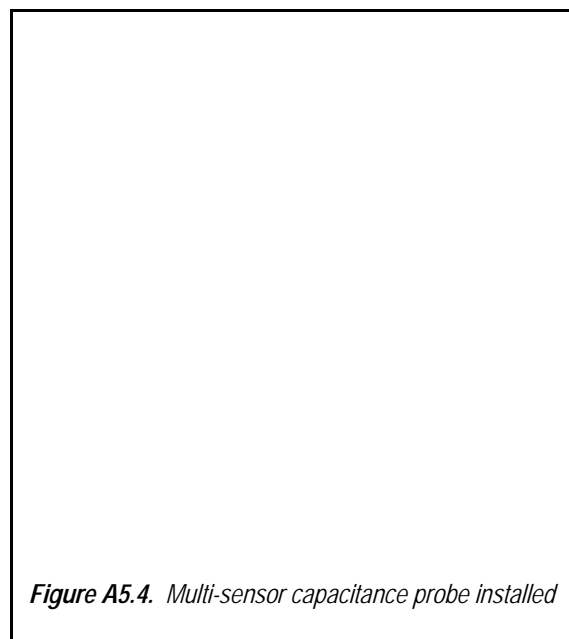
Capacitance methods measure the dielectric constant of the soil using an electric circuit arrangement in which the soil is the dielectric

media of one capacitor in a circuit. Capacitance-based sensors rely on the fact that water has a much higher dielectric constant than air or dry soil. Hence, changes in the water content of the soil are reflected in capacitance changes of the soil near the sensor. Soil water content is determined by measuring the capacitance between two electrodes implanted in the soil.

Table A5.1. Tensiometer readings for starting irrigation in flatwoods soils (Boman, 1996).

| Period | Tensiometer Reading (cbar or Kpa) |
|---------------|-----------------------------------|
| February-June | 15 |
| July-January | 30 |

Capacitance sensors provide a near instantaneous measure of volumetric soil water content. Two types of devices are available: one is a portable sensor that is lowered into the soil through an access tube and the other is more permanently installed with numerous sensors connected to a data logger (Fig. A5.4). Theoretically, capacitance sensors can provide absolute soil water content. They also can provide water contents at any depth.



An advantage of capacitance-type sensors is their high accuracy, the availability of excellent software for interpreting data, the speed data can be formatted and delivered and the fact that there are no known hazards associated with their use. Figure A5.6 shows an easy to read graph reflecting moisture content relative to fill (high moisture) and refill (low moisture) lines.

This type of information is available in a matter of minutes on the Internet transmitted via radio waves from a probe, which expedites a grower's decision-making process on operating and irrigation system. Commercial systems are operating and are available in the PRMSB. For more information contact your local NRCS office or agricultural extension agent.

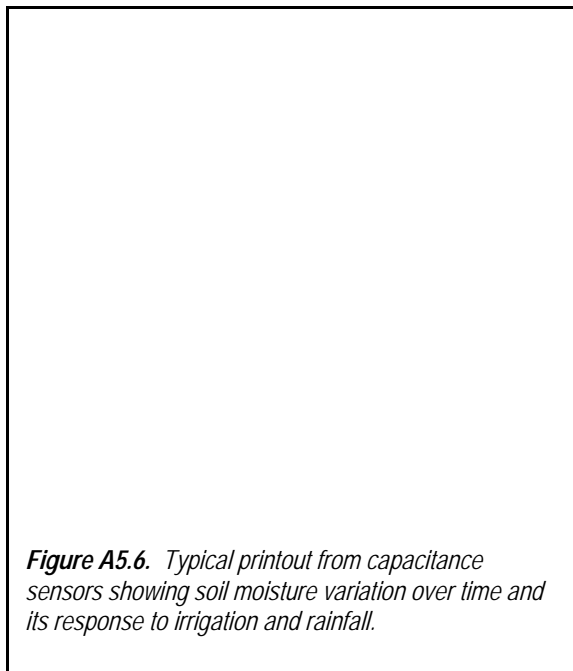


Figure A5.6. Typical printout from capacitance sensors showing soil moisture variation over time and its response to irrigation and rainfall.

References

- Bul. 319. Tensiometer Service, Testing and Calibration.
- Circ. 487. Tensiometers for Soil Moisture Measurement and Irrigation Scheduling Calibration.
- Circ. 532. Measurement of Soil Water for Irrigation Management.
- SP-281. Water and Florida Citrus, Chapt. 15. *Soil Water Measuring Devices.*

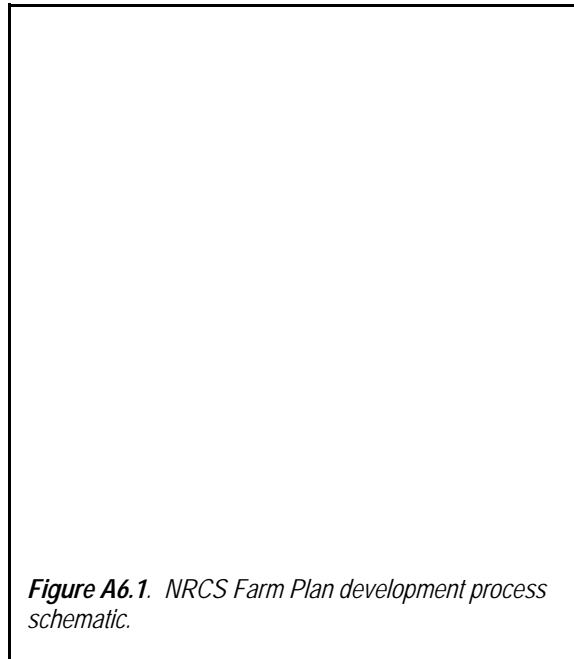
A6. Drainage Management Plan

Implement and maintain a written drainage management plan that provides specific responses to various types and levels of rainfall. The goal of the plan should be a reduction in volume of off-site discharge while maintaining a healthy rooting environment for citrus trees thus maximizing fruit production. The plan should include target water table levels and pump or drainage structure operating procedures that will be used for typical and extreme rainfall events. Consideration should be given to the use of existing canals and ditches for temporary water storage.

The United States Department of Agriculture-Natural Resource Conservation Service (USDA-NRCS) has conservation planning to help develop this BMP.

Conservation planning is a natural resource problem solving and management process. The process integrates economic, social (cultural resources are included with social), and ecological considerations to meet private and public needs. A conservation plan is developed by the NRCS to assist growers in developing, implementing, and evaluating conservation practices for their groves. The process is used regardless of the expected outcome, scope, size of planning area, complexity of natural resource problems or source of funding to be used for implementation.

This approach, which emphasizes desired future conditions, helps improve natural resource management, minimize conflict, and address problems and opportunities. The success of conservation planning and implementation depends on the voluntary participation of clients. The planning process used by NRCS is based on the premise that clients will make and implement sound decisions if they understand their resources, natural resource problems and opportunities, and the effects of their decisions.



Conservation planning helps clients, conservationists, and others view the environment as a living system, of which humans are an integral part. Conservation planning enables clients and planners to analyze and work with complex, natural processes in definable and measurable terms. The conservation planning process consists of the following nine steps divided into three phases (Fig. A6.1). It is a process that considers people and the resources they use or manage. Conservation planning is based on a desired future condition that is developed by the grower for an individual conservation plan.

Collection and Analysis

- Identify resource problems, opportunities, and concerns in the planning area.
- Identify and document the client's objectives.
- Inventory the natural resources and their condition, and the economic and social considerations related to the resources. This includes on-site and related off-site conditions.
- Analyze the resource information gathered to clearly define the natural resource conditions along with economic and social issues related to the resources. This includes both problems and opportunities.

Decision Support

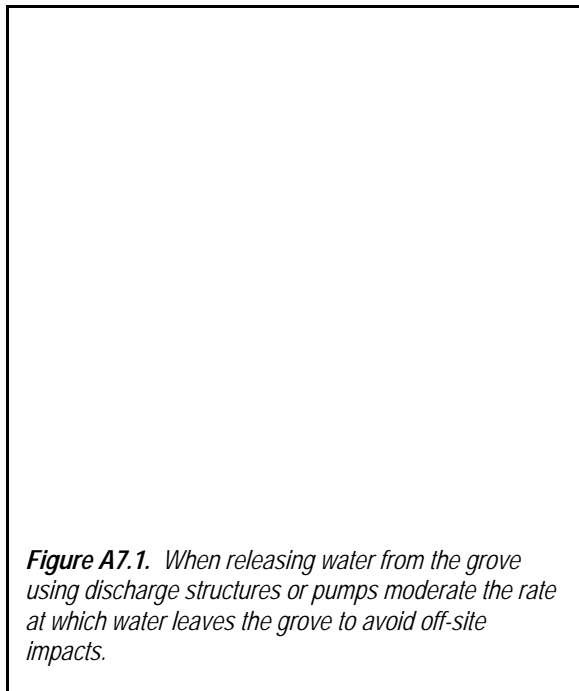
- Formulate alternatives that will achieve the client's objectives, solve natural resource problems, and take advantage of opportunities to improve or protect resource conditions.
- Evaluate the alternatives to determine their effects in addressing the client's objectives and the natural resource problems and opportunities. Evaluate the projected effects on social, economic, and ecological concerns. Special attention must be given to those ecological values protected by law or Executive Order.
- Make decisions based on selected alternatives and work with the planner to schedule conservation system and practice implementation. The planner prepares the necessary documentation.
- Implement the conservation plan and the selected alternatives. The planner provides encouragement to the client for continued implementation.
- Evaluate the effectiveness of the plan if it is implemented and make adjustments as needed.

To provide conservation planning direction and help ensure a balance of natural resource issues with economic and social needs, NRCS employees will work with conservation districts to establish objectives that reflect current resource issues in the district. The process should include meetings with stakeholders interested in resource issues. These objectives will help define some desired future condition of these resources in terms of what the local people desire regarding resource management.

A7. Drainage Rate and Volume

Drainage rates and the volume of water released or discharged following intense rainfall events should provide an adequately drained root zone while minimizing off-site impacts.

When the water table approaches the target level, off-site discharges should be moderated. Depending on the grove design, this may require reducing pump speed, adjusting the discharge structure, or pulse drainage (discharging for short periods of time and then allowing for recharge in the ditches). If adequate drainage in one portion of a grove results in water tables that are below target levels in another area, ditch cleaning, drainage system redesign, or auxiliary pumps may be needed to achieve more uniform drainage.



References:

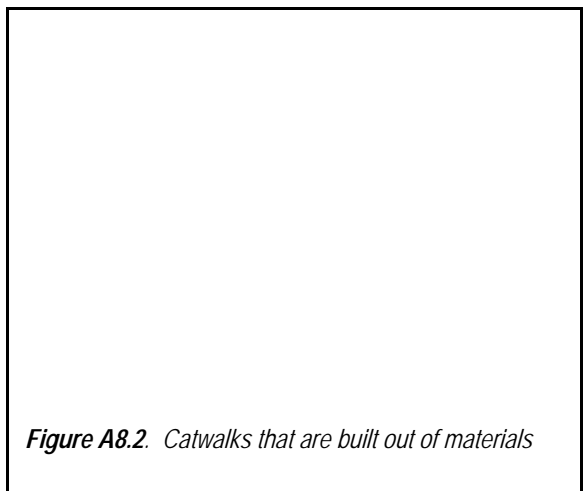
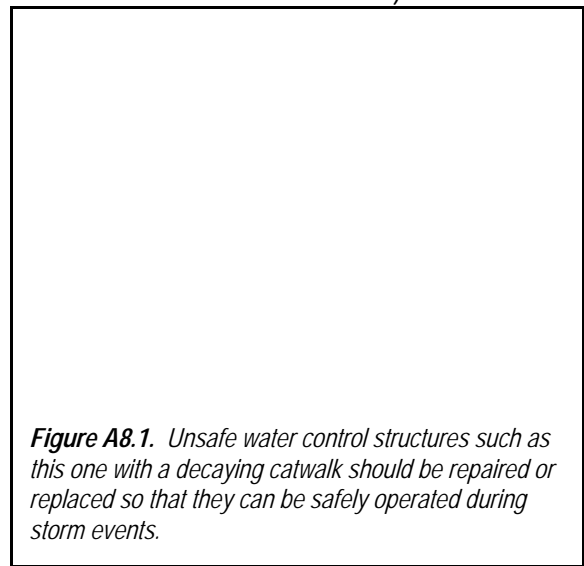
- Circ. 661 A Guide for Plastic Drain Tile in Florida Citrus Groves.
- SP-281. Water and Florida Citrus, Chapt. 19. Drainage.

For additional information see your local NRCS and SWFWMD Ag-Team representative.

A8. Discharge Structures

Structures and/or pumps that regulate off-site water discharge should be adequately designed, constructed, and maintained so that target water table levels within the grove can be achieved.

If safety or operational concerns prevent structures from being adjusted to regulate discharges during storm drainage events, they should be rehabilitated or replaced. (e.g. modifying riser-board structures to allow easier water level control).

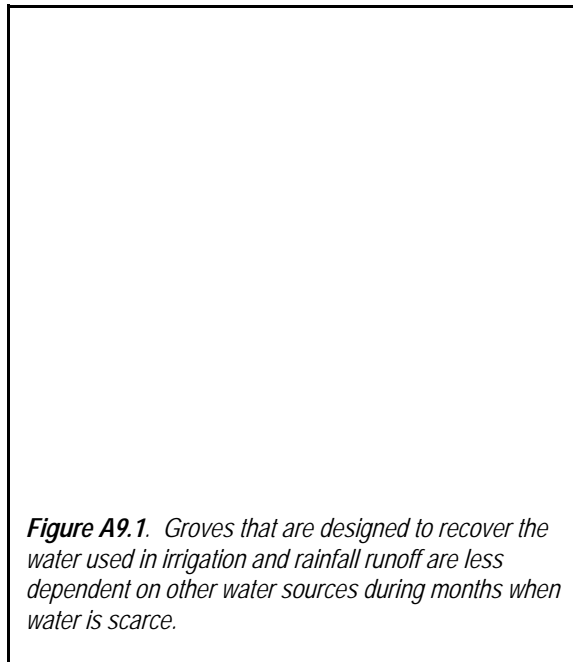


For additional information see your local NRCS and SWFWMD Ag-Team representative.

A9. Detention- Tailwater Recovery and Surface Water Use

Where possible, on-site detention should be considered to reduce both the rate and volume of off-site discharges following heavy rains.

Detention areas allow all or a portion of the drainage water to be temporarily stored on-site. The excess water can be stored for tailwater recovery or released later at low flow rates. The size, type, and location of proposed tailwater recovery ponds are variables considered when determining the need for an Environmental Resource Permit. Growers should contact their local SWFWMD Ag-Team for guidance on the issue.



Working definition:

Tailwater recovery is the practice of collecting, storing, and re-using water for irrigation.

Tailwater Recovery

- A tailwater recovery system typically consists of collection and storage components (ditches, ponds), and also delivery components (pump stations, pipes).

- Consider the runoff volume and rate in addition to the water control level in the tailwater pond when determining the proper size of the storage facility.
- Also consider the size of the tailwater recovery system, including variables such as land available, gravity drainage, number of fields and their acreage, and the source and quality of the irrigation water.
- Consider tailwater recovery systems for seepage, flood irrigation systems, and low-volume irrigation systems.
- Locate the tailwater recovery system at the low end of the grove so that water can be collected by gravity.
- Contact an Agricultural Engineer to determine if your grove is suited for a tailwater recovery system.
- Consider "rainwater harvesting" to collect significant water quantities from storm water runoff.

Water Quality Considerations

- Tailwater recovery and/or surface water reservoir systems may require additional filtering and purification infrastructure, depending on the quality of the water, the type of irrigation system being used.
- Offsite seepage from the tailwater recovery system should be controlled and managed properly, especially if the system is expected to receive chemical-laden waters. Control may be in the form of dike compaction, natural-soil liners, soil additives, commercial liners, drain tile, or other approved methods.

Technical Criteria

- Equip tailwater recovery ponds with inlets designed to protect the collection and storage facilities from erosion. Additional sediment sumps should be installed as needed.

- The capacity of tailwater recovery systems should be determined by analysis of the expected runoff rate, the planned storage pond capacity, and the irrigation application rate if the recovery pond is to supply irrigation water.
- Tailwater recovery systems should be designed for structural integrity, using the appropriate, 24-hour storm frequency design if the system will be directly accepting rainfall.

Operation and Maintenance:

- Clean and re-grade all collection components periodically to maintain structural integrity and functionality.
- Check and remove debris as necessary from trash racks and structures to assure proper operation.
- Remove sediment from traps and/or storage facilities to maintain design capacity and efficiency.
- Inspect or test all pipeline and pumping station components and appurtenances, as applicable, to ensure their long-term operation.
- Implement routine maintenance of all mechanical components in accordance with the manufacturer's recommendations.
- Maintain proper vegetative cover and re-grade dikes and berms as necessary to maintain structural integrity and insure proper functioning of the system.

Other Considerations:

- Irrigation scheduling and related management practices should be reviewed once tailwater recovery systems are implemented.
- The stored tailwater should be analyzed for nutrient content and the fertilization program should be adjusted accordingly.
- Nutrient and pest management measures should be planned to limit chemical laden tailwater as

much as practical. Chemical laden water can create a potential hazard to wildlife, and especially to any waterfowl that are drawn to the impounded water.

- Protection of system components from large storm events and excessive sedimentation should be considered.
- The effect on downstream flows and/or wetland hydrology should be analyzed.
- Monitor the EC of tail water, especially in areas that have irrigation water with high salinity.

In the southern and coastal areas of the PRMSB, poor ground water quality may dictate the incorporation of tailwater recovery and/or surface water reservoirs. Tailwater recovery systems can be installed to conserve water and improve runoff water quality by collecting and re-using irrigation water. Since these systems intercept subsurface lateral flow above a spodic or clay horizon, swales or ditches may have to be added to increase the area captured and increase the efficiency of the recovery system.

Where groundwater is highly mineralized, surface water reservoirs may be the only viable source of irrigation water. These reservoirs typically extend 10 to 15 feet below land surface and are recharged by the surficial aquifer system. Some of these reservoirs are often made from old shell borrow pits. Water levels in shell pits may recover quickly and can offer sustainable quantities for irrigation. Shell pits can also be incorporated into a tailwater recovery system. Please check local ordinances and the SWFWMD Ag-Team representatives regarding the construction and/or modification of tailwater or surface water irrigation systems, prior to construction.

Both tailwater recovery and surface water reservoirs can offer improved irrigation water quality in regard to dissolved constituents, i.e. TDS. However, they can cause problems in low volume irrigation systems due to high levels of total suspended solids (TSS) which include algal and

vegetative debris. The development of algae can occur in both tailwater recovery and surface water systems, as well as within the irrigation pipelines and valves. This can result in reduced output and eventual clogging of the emitters.

Increased filtration, in addition to water purification through chlorination, may have to be added to the tailwater recovery and/or surface water irrigation system to reduce or eliminate clogging. Other, less hazardous compounds are currently being marketed for the same purpose. Please check with the NRCS or the University of Florida - IFAS Extension Service for technical assistance.

If a chlorination system is incorporated, care must be taken in both the handling and storage of the chlorine, as well as the rate and concentration used. If chlorine is used for purification, the residual chloride concentration of the irrigation water should be kept to an absolute minimum so as to not harm the crop or cause impacts to downstream receiving waters.

EROSION CONTROL AND SEDIMENT MANAGEMENT

| | Page |
|--|------|
| B0. Purpose | B-1 |
| B1. Riser-Board Water Control Structures | B-3 |
| B2. Sediment Settling Basins in all Ditches | B-4 |
| B3. Ditch Construction | B-5 |
| B4. Stabilize Bare Soils | B-5 |
| B5. Ditch Bank Contours | B-6 |
| B6. Ditch Bank Vegetation Maintenance | B-6 |
| B7. Protect Ditch Banks | B-8 |
| B8. Vegetative Stabilization | B-9 |
| B9. Aquatic Plant Management | B-9 |
| B10. Ditch Maint., Cleaning, and Dredging | B-11 |
| B11. Herbicide Applications | B-12 |
| B12. Middle Management (herbicide) | B-13 |
| B13. Grove Development/Renovation | B-13 |
| B14. Settling Basins (Sumps) | B-14 |
| B15. Water Furrow Drain Pipes | B-14 |
| B16. Water Furrow Maintenance | B-15 |
| B17. Construction Activities and Temporary Erosion Control Measures | B-15 |

B0. Purpose

Sediments or suspended solids are recognized forms of water pollution and often result in the loss of ditch or canal capacity. Unlike many chemical pollutants, sediment is a natural component of water bodies and the resources they support. Excessive amounts of suspended solids or sediments are often a product of erosion from un-stabilized or disturbed land areas. These solids originate from four primary sources:

- Soil-particles eroded into ditches
- Soil-particles eroded from ditches
- Plant material washed into the ditches
- Plant and biological material growing within the ditches and canals.

Excessive sediments deposited on stream bottoms and suspended in the water column can harm fish

spawning and impair fish food sources, reduce habitat complexity, potentially harm public water supply sources, and reduce water clarity. Reduction in water clarity can harm natural resources, such as seagrasses and oysters, in the receiving estuary. Studies have shown one of the major causes for reduction in water clarity in Charlotte Harbor is suspended solids.

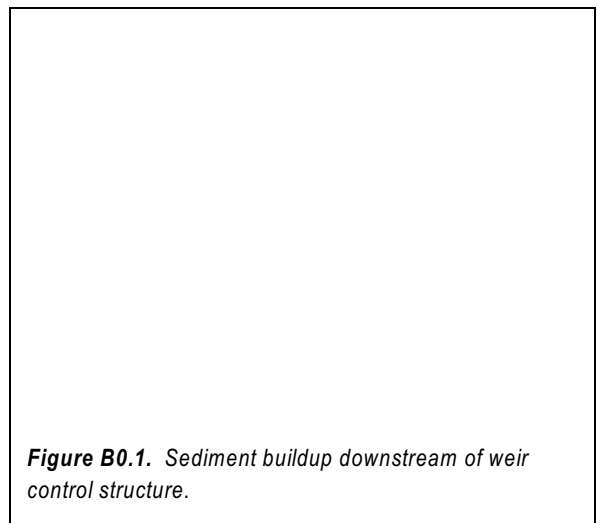


Figure B0.1. Sediment buildup downstream of weir control structure.

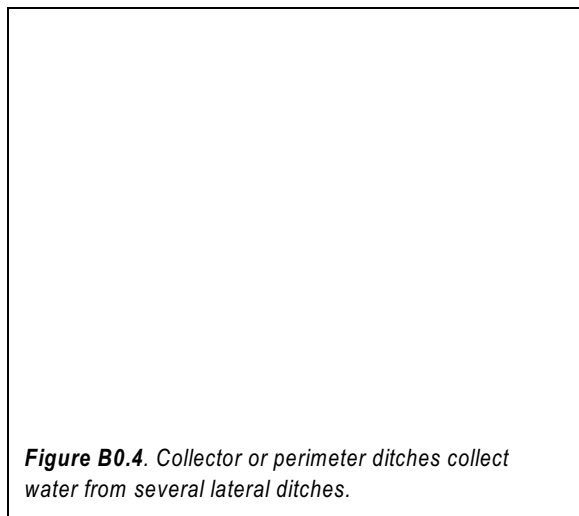
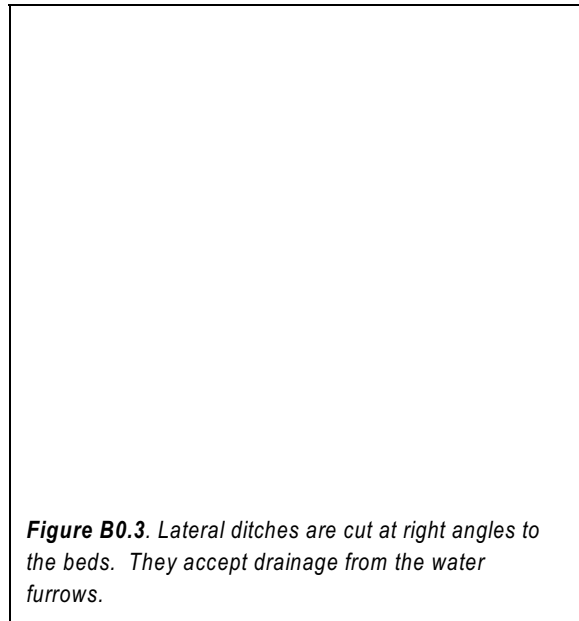
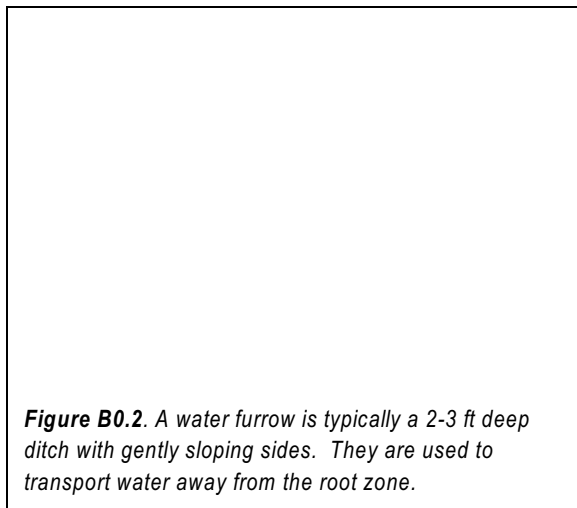
In addition to potential downstream water quality impacts, the build-up of silts and sediments in the grove/farm-level, secondary, and primary drainage canals reduces ditch and canal cross-section. This reduction in cross-sectional area results in higher water velocities, as compared to an unfilled ditch or canal. This higher water velocity (compared to unfilled ditches/canals) may induce greater amounts of erosion of fine and coarse particles from ditch and canal banks. The presence of shoals and sandbars are good indicators of soil losses. Field erosion also results in site degradation resulting in increased costs for ditch-cleaning and reshaping of beds and furrows. In order to minimize effects of sediment transport in surface water, efforts should focus on keeping soils in the fields and along canal

and ditch banks.

Minimizing downstream transport of sediments from groves and canal/ditch banks requires an integrated approach of managing erosion at the grove-level, the secondary canal system level and primary canal system level. Erosion control measures for the secondary and primary canal systems are beyond the scope of this document. This document focuses on practices that can help reduce sediment losses at the grove-level. However, many of these practices may be applicable for the primary and secondary canal systems. It should be noted that maximum sediment losses from groves are expected during construction of new groves or renovation of older ones. Losses from mature, well managed groves will be much lower.

The following sections describe BMPs that are applicable for water conveyances within citrus groves. The selection and implementation of particular BMPs must be based upon site-specific circumstances and management styles.

NOTE: Water conveyances within citrus groves are defined as follows:



B1. RISER-BOARD WATER CONTROL STRUCTURES

Place and maintain culverts with riser-board control structures at locations where runoff is discharged off-site.

Water discharge structures are used to control water table levels and surface water levels in drainage ditches within flatwoods citrus groves. The type of structure selected can significantly influence the quality of water discharges.

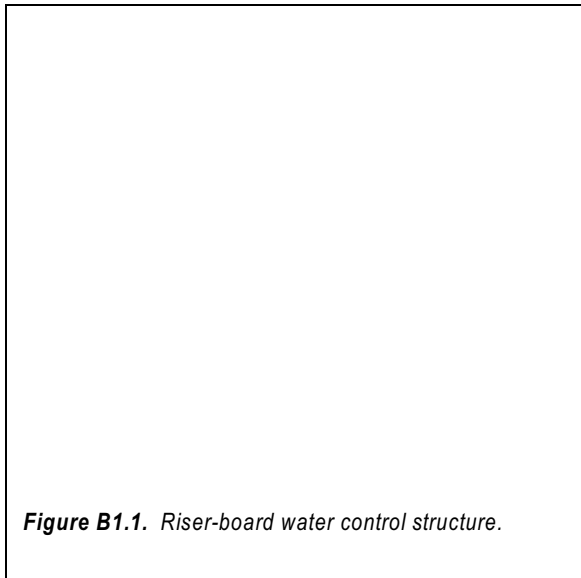


Figure B1.1. Riser-board water control structure.

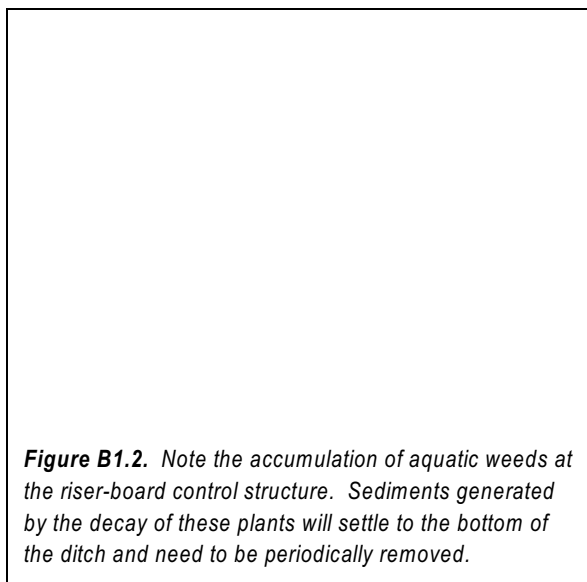


Figure B1.2. Note the accumulation of aquatic weeds at the riser-board control structure. Sediments generated by the decay of these plants will settle to the bottom of the ditch and need to be periodically removed.

With riser-board control structures, water is forced to flow over the top of the boards. This flow path creates a low current area towards the bottom of the structure, which facilitates the deposition of sediments and their accompanying nutrients or pesticides, essentially removing them from the discharges. Conversely, screw-gates structures do not create this dead-current zone. Since they open from the bottom, sediments and their accompanying load are swept out along with the discharge water.

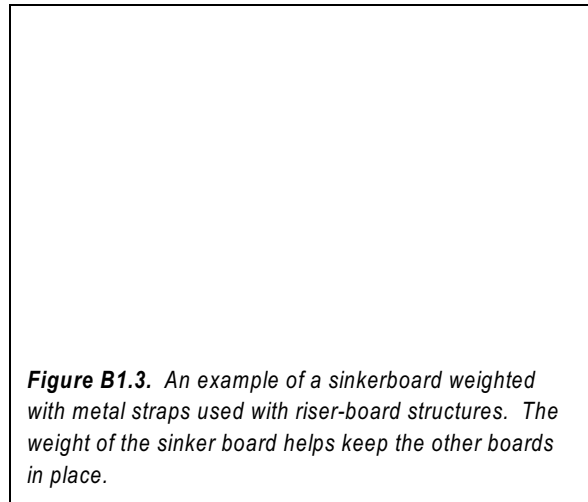


Figure B1.3. An example of a sinkerboard weighted with metal straps used with riser-board structures. The weight of the sinker board helps keep the other boards in place.

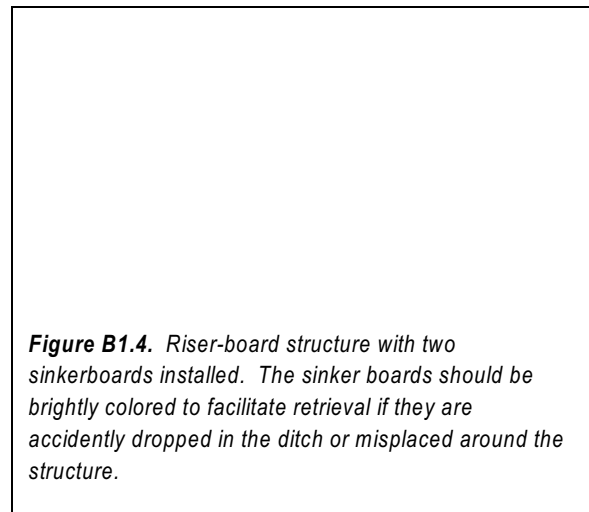


Figure B1.4. Riser-board structure with two sinkerboards installed. The sinker boards should be brightly colored to facilitate retrieval if they are accidentally dropped in the ditch or misplaced around the structure.

References

- Code 537. NRCS Conservation Practice Standard.
- SS-409. Flatwoods Citrus Best Management Practice: Riser-board Structures, <http://edis.ifas.ufl.edu/SS409>

B2. SEDIMENT SETTLING BASINS IN ALL DITCHES

Create and maintain localized settling basins (sump) to trap sediments at field ditch connections to lateral canals, at lateral and collector ditch connections, and prior to water discharge points from the grove.

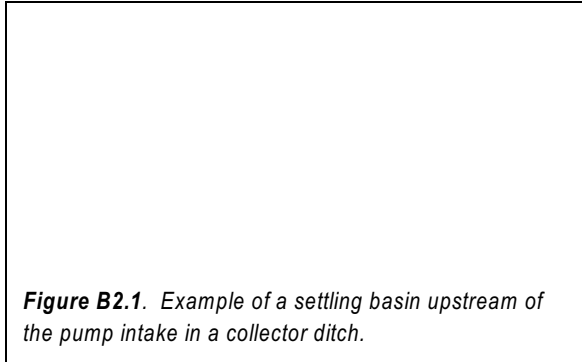


Figure B2.1. Example of a settling basin upstream of the pump intake in a collector ditch.

Successful sediment traps require site-specific designs, with the following points to consider:

- Determine runoff volume and intensity.
- Determine transport and settling rates for sediments of concern.
- Size traps to allow adequate residence time for natural settling to occur - include considerations for allowable storage (fill-up) of trapped sediments.
- Make provisions for materials removed from the ditches.
- Maintenance access to settling basin area should be provided.
- When sediments are removed, materials need to be placed in a manner that prevents material from sloughing back into the waterway.
- Sediment excavation and removal should be conducted during low stage conditions or during the dry season. This will reduce the likelihood of increasing turbidity and suspended solid loads.

Settling basins or settling ponds are a quick and simple way to remove sediments out of runoff water. Settling basins simply slow down the water, allowing sediments to settle out of the water before the water returns to the receiving water body.

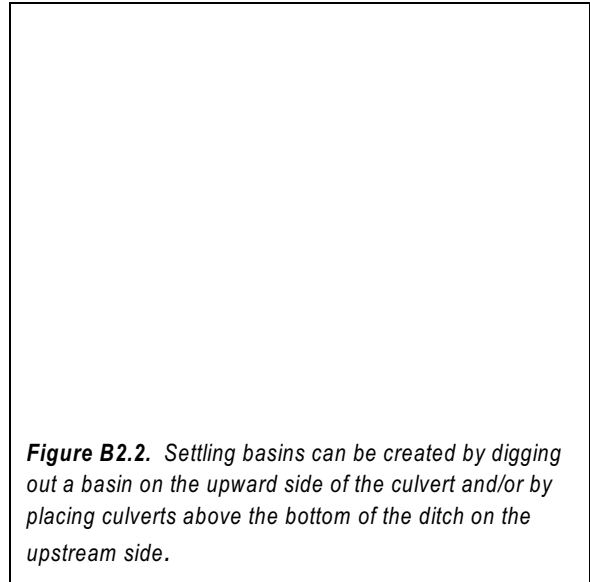


Figure B2.2. Settling basins can be created by digging out a basin on the upward side of the culvert and/or by placing culverts above the bottom of the ditch on the upstream side.

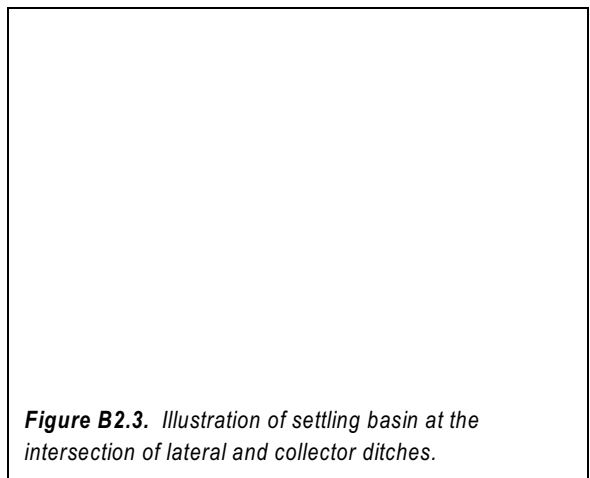


Figure B2.3. Illustration of settling basin at the intersection of lateral and collector ditches.

NOTE: Existing detention impoundments may function as sediment settling basins.

B3. DITCH CONSTRUCTION

Construct ditches and canals with side-slopes consistent with soil types.

Refer to Engineering Tables in local County Soil Surveys for information on preferred side slopes for specific soil types.

Table B3.1. Side slopes for open channels.

| Soil | Side Slopes | |
|-------------------|-------------------------------|---------------------------|
| | Shallow channels (up to 4 ft) | Deep channels (over 4 ft) |
| Peat and muck | Vertical | 0.25:1 |
| Heavy clay | 0.5:1 | 1:1 |
| Clay or silt loam | 1:1 | 1.5:1 |
| Sandy loam | 1.5:1 | 2:1 |
| Loose sandy | 2:1 | 3:1 |

Reference: Land Drainage and Flood Protection, by Etcheverry, copyright, 1931, McGraw-Hill Book Co.

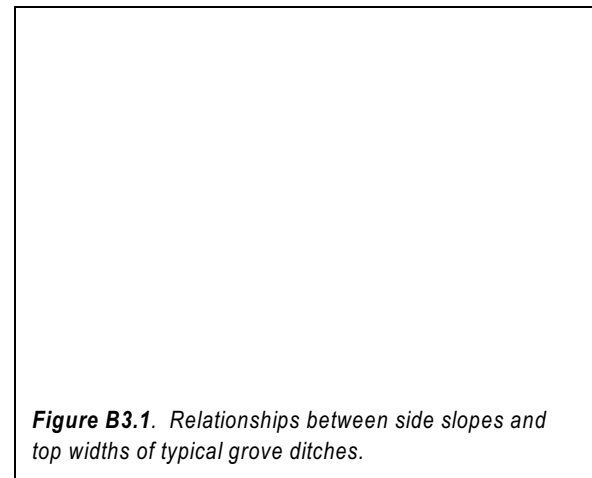


Figure B3.1. Relationships between side slopes and top widths of typical grove ditches.

References

- NRCS engineering tables & local county soil survey manuals.

B4. STABILIZE BARE SOILS

Stabilize bare soils and canal or ditch banks by encouraging coverage by noninvasive vegetation.

Vegetation types selected should be adapted to grove conditions and should provide maximum stabilization by roots and foliage. Vegetative buffer strips can also serve to reduce the erosion of soil particles. Whenever practical, plant or encourage establishment of native species.

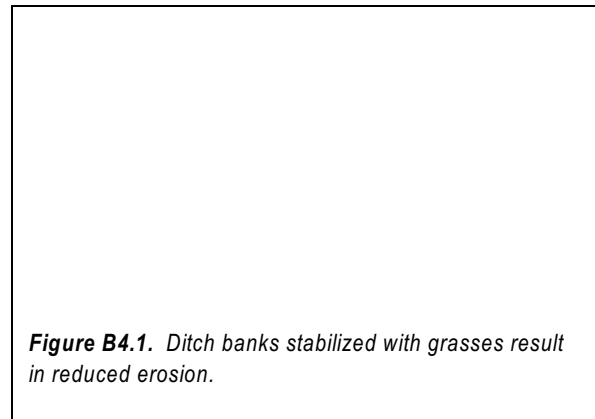


Figure B4.1. Ditch banks stabilized with grasses result in reduced erosion.

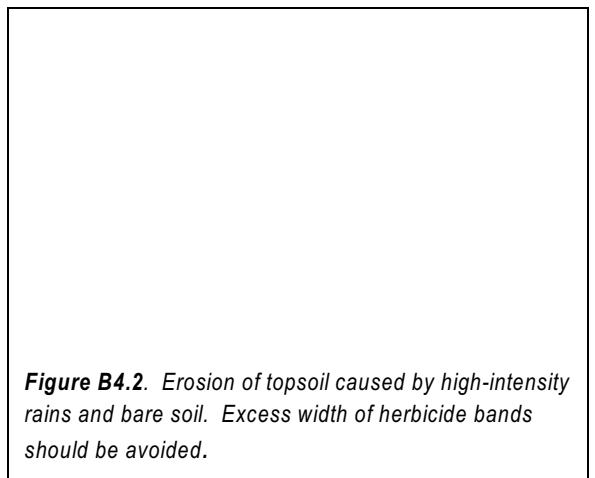


Figure B4.2. Erosion of topsoil caused by high-intensity rains and bare soil. Excess width of herbicide bands should be avoided.

References

- Code 342.NRCS Conservation Practice Standard, Critical Area Planting.
- Code 391a. NRCS Conservation Practice Standard, Riparian Forest Buffer.
- Code 393. NRCS Conservation Practice Standard, Filter Strip.
- HS-802. Weed Control in Subtropical Conditions in Florida Citrus.

B5. DITCH BANK CONTOURS

Contour ditch bank top edges or berms to divert water away from the drainage ditch.

This practice will minimize overland flow of stormwater directly down the banks.

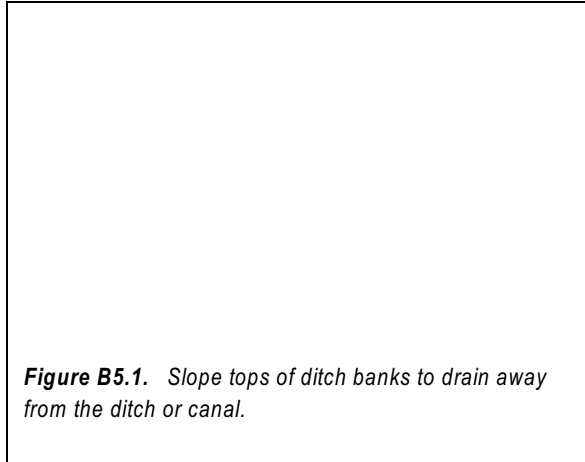


Figure B5.1. Slope tops of ditch banks to drain away from the ditch or canal.

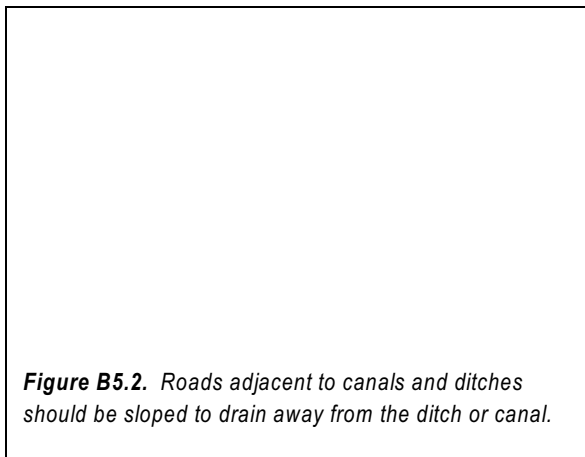


Figure B5.2. Roads adjacent to canals and ditches should be sloped to drain away from the ditch or canal.

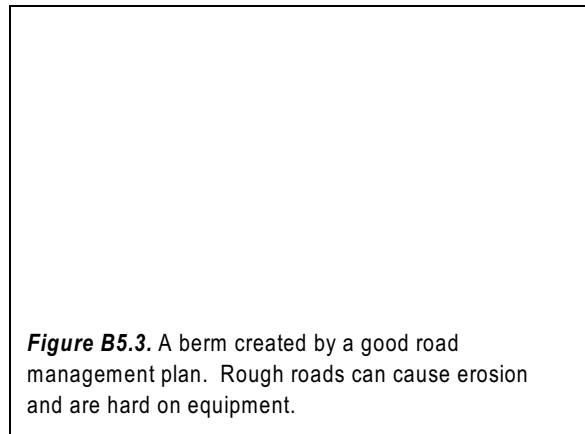


Figure B5.3. A berm created by a good road management plan. Rough roads can cause erosion and are hard on equipment.

B6. DITCH BANK VEGETATION MAINTENANCE

Broadleaf weed control using herbicides or maintenance mowing of slopes and ditch banks increases grass cover and decreases the proliferation of shade-producing shrubs and weeds, thus reducing erosion from wind and rainfall.

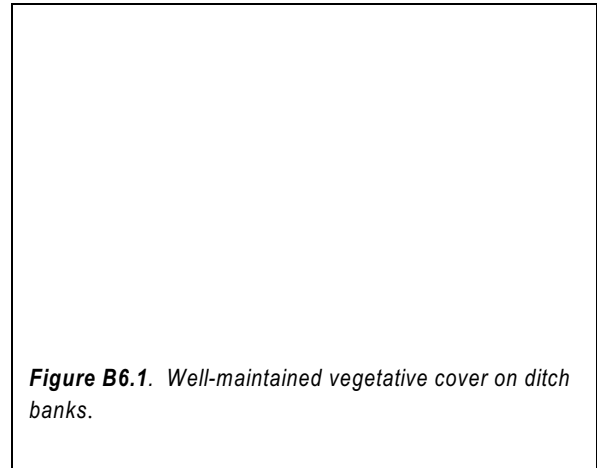


Figure B6.1. Well-maintained vegetative cover on ditch banks.

Points to Consider:

- Mechanical mowing does not uproot vegetation and expose soil.
- The use of herbicides should be conducted with caution and precision to avoid excessively large areas of bare soil.
- Selective herbicides should be used in order to maintain desired vegetation (e.g. remove broadleaf vegetation while maintaining grasses).

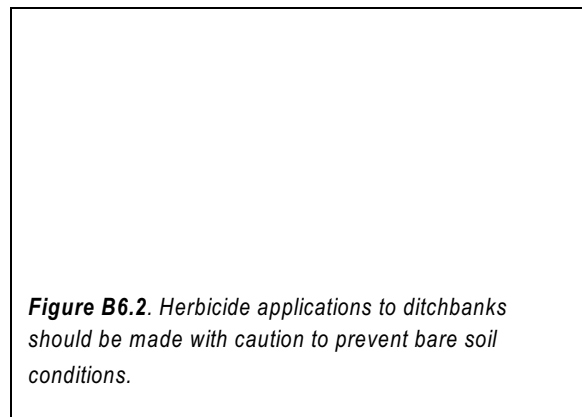


Figure B6.2. Herbicide applications to ditchbanks should be made with caution to prevent bare soil conditions.

Ditch Bank Brush Identification and Control

The following describes several common plants that may be in or around ditches and canals within citrus groves. The reader is directed to IFAS Publication SP-168 and Circular 707 for further information and recommendations for control.

Brazilian Pepper (*Schinus terebinthifolius*)

Description: An extremely fast growing shrub found predominantly in disturbed areas of south Florida. This aggressive nonnative species produces large quantities of seeds contained in a red fruit usually about 1/4-inch in diameter. Reproduction is by seed.

Wax Myrtle (*Myrica cerifera*)

Description: Shrub or small tree usually 10 feet tall. Leaves are alternate, pale green, and lance-shaped. When crushed, leaves emit a pleasant aroma. Close inspection of the leaves will reveal numerous small dark scales on top and bright orange scales below. Reproduction is by seed.

Water primrose (*Ludwigia species*)

Description: Small shrub attaining height of up to 6 feet with multiple branching stems. Leaves are lance-shaped with small soft hairs on both sides. Flowers are yellow with four symmetrical petals. Reproduction is by seed and underground stems.

Willow (*Salix species*)

Description: Fast growing shrub, which can become a tree in a short period of time. Leaves are alternate and lance-shaped with finely toothed margins. The fruit capsule contains many small hairy seeds, which drift in air currents.

References

- CH-181. Aquatic Weed Management in Citrus Canals and Ditches, <http://edis.ifas.ufl.edu/CH181>

Brazilian Pepper

Wax Myrtle

Water Primrose

Willow

B7. Protect Ditch Banks

Protect canal and ditch banks from erosion in areas subject to high water velocities.

In areas where water is constricted (usually at discharge points) or at ditch intersections where velocities are high, rip-rap, concrete, headwalls, or other materials that buffer turbulence should be used to protect ditch banks and reduce sediment transport.

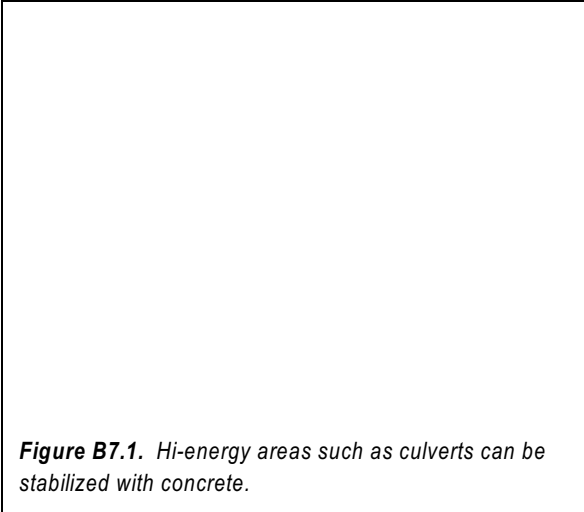


Figure B7.1. *Hi-energy areas such as culverts can be stabilized with concrete.*

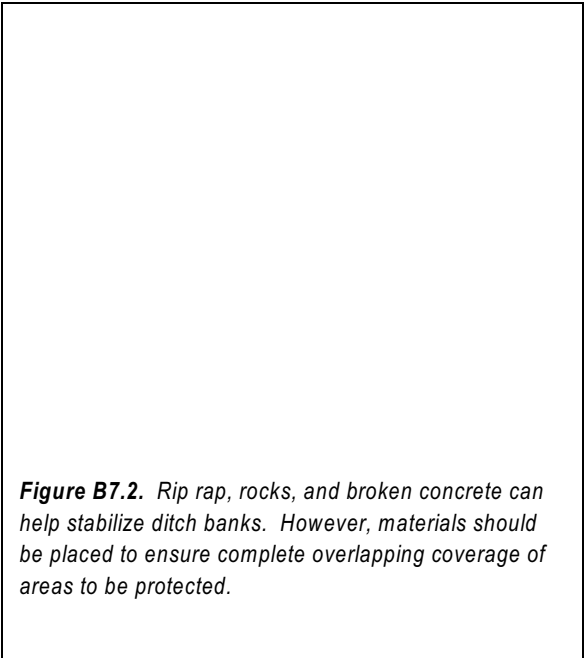


Figure B7.2. *Rip rap, rocks, and broken concrete can help stabilize ditch banks. However, materials should be placed to ensure complete overlapping coverage of areas to be protected.*

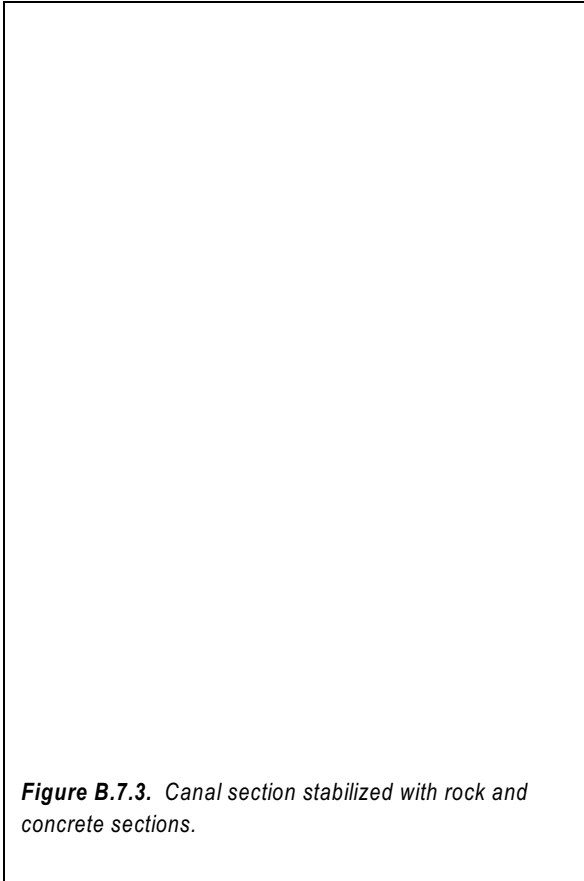


Figure B.7.3. *Canal section stabilized with rock and concrete sections.*

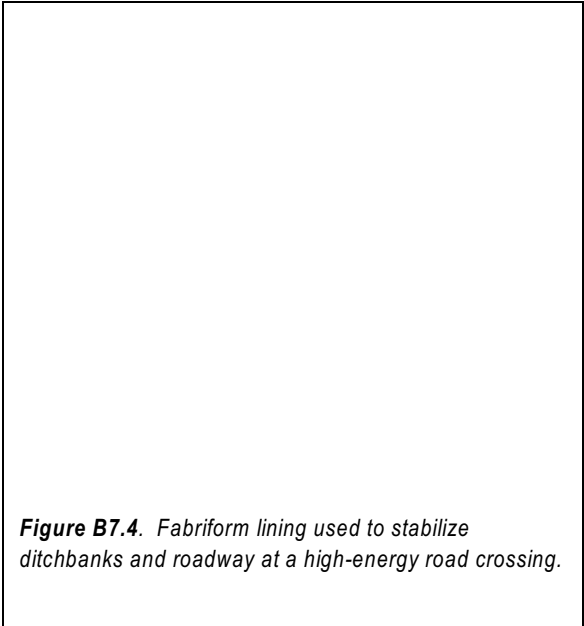


Figure B7.4. *Fabriform lining used to stabilize ditchbanks and roadway at a high-energy road crossing.*

B8. VEGETATIVE STABILIZATION (WATER FURROWS)

Plant noninvasive vegetation and/or maintain desirable vegetation within all water furrows to prevent/minimize erosion and trap sediments that may result from stormwater runoff or irrigation drainage.



Figure B8.1. Healthy, uniform vegetative cover maintained over water furrows.

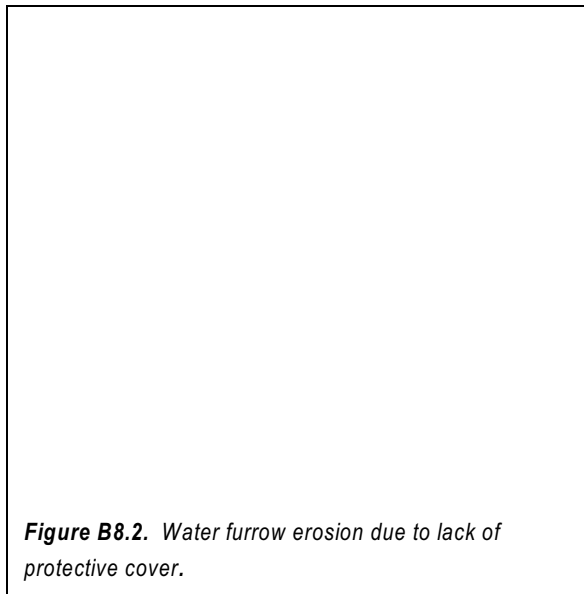


Figure B8.2. Water furrow erosion due to lack of protective cover.

B9. AQUATIC PLANT MANAGEMENT

When removing vegetation from ditch bottoms, avoid disrupting side slopes.

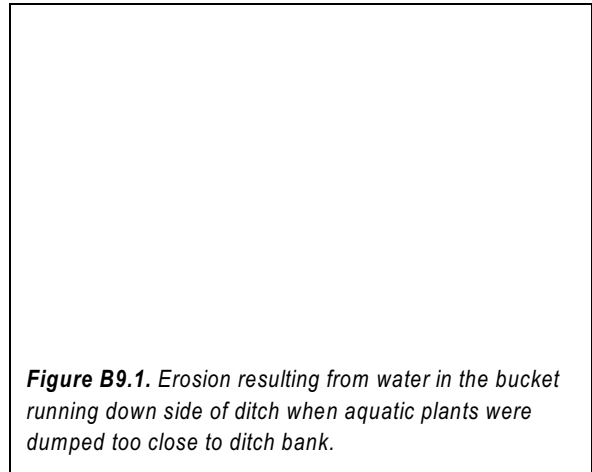


Figure B9.1. Erosion resulting from water in the bucket running down side of ditch when aquatic plants were dumped too close to ditch bank.



Figure B9.2. Preferred buckets for ditch cleaning are slotted or are cross-drilled to allow water to seep out before materials are placed on ditch banks.

If a backhoe without a vented bucket is used to remove aquatic plants from grove ditches, special precautions should be taken to prevent washouts. Once a bucketful of vegetation is picked up, the bucket should be raised to allow most of the water to drain out over the deeper part of the ditch. The boom should be swung far enough over the ditch bank so that when the vegetation is dumped, remaining water will flow away from the ditch.

Aquatic Plant Identification and Control

The following describes several common plants that may be in ditches and canals within citrus groves. The reader is directed to IFAS Publication SP-168 and Circular 707 for further information and recommendations for control.

Cattail (*Typha species*)

Description: Erect perennials (up to 9 feet) that can reproduce by seed or creeping rootstalk. Grasslike leaves are flat and smooth to the touch. Flowers look like a "cat's tail" and can be found in a tightly packed spike usually 6-8 inches long.

Hydrilla (*Hydrilla verticillata*)

Description: Long stemmed, branching plant that is rooted to the bottom and often forms large surface mats. Leaves grow in a whorl with toothed margins that feel rough. Hydrilla can spread by plant fragments, underground stems, seed, leaf buds, or buds located on the underground stems.

Torpedograss (*Panicum repens*)

Description: Narrow leaves (less than 1/4-inch wide), with stems often several feet in length. Torpedograss creeps horizontally by underground stems and forms large floating mats. Reproduction is by seed and creeping stems.

Waterhyacinth (*Eichhornia crassipes*)

Description: Plants several inches to two feet in height. Smooth leaves attached to spongy bulb-shaped stalks. Reproduction is primarily through the production of daughter plants.

References

- CH-181. Aquatic Weed Management in Citrus Canals and Ditches.

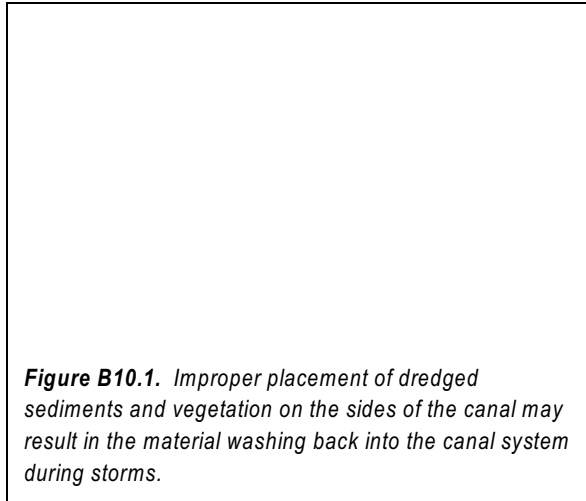
Cattail

Hydrilla

Torpedograss

Water hyacinth

B10. Ditch Maintenance Cleaning and Dredging
Develop and implement a systematic management plan for removing sediments from canals and farm ditches on a regular basis.

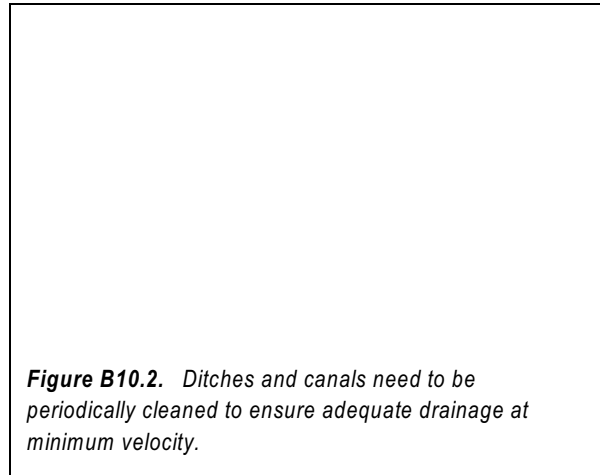


Maintenance dredging of existing ditches, canals, and intake and discharge structures should include the following:

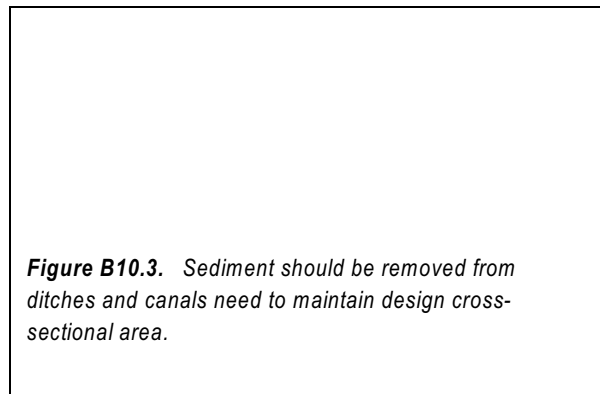
- Spoil material should be removed and deposited on a self-contained, upland spoil site and not placed in a delineated floodplain. This will prevent the movement of the water and excavated spoil material into wetlands or other surface waters.
- Do not remove any more material than is necessary to restore the original design specifications or configurations.
- No significant impacts should occur to previously undisturbed natural areas.
- Erosion and sedimentation control devices (e.g., turbidity screens) should be used to prevent bank erosion, scouring, and to prevent turbidity from discharging into adjacent waters during maintenance dredging.

Removal of excess sediment to the originally designed and constructed cross-sectional area generally increases the canal cross-sectional area and reduces water velocities (compared to same water volume in filled-in systems), thus reducing the potential for bank scouring. Caution should be

considered as ditch maintenance, cleaning and dredging beyond the originally designed and constructed cross-sectional area may result in upstream and/or downstream adverse water resource impacts.



In order to reduce the potential for misunderstandings with regulatory agencies and adjacent property owners, growers are highly encouraged to initially schedule a site visit with the SWFWMD local service office Ag-Team prior to conducting routine ditch maintenance activities. If an agreement is reached, this approach will result in a formal SWFWMD letter confirming that the activities are indeed exempt.

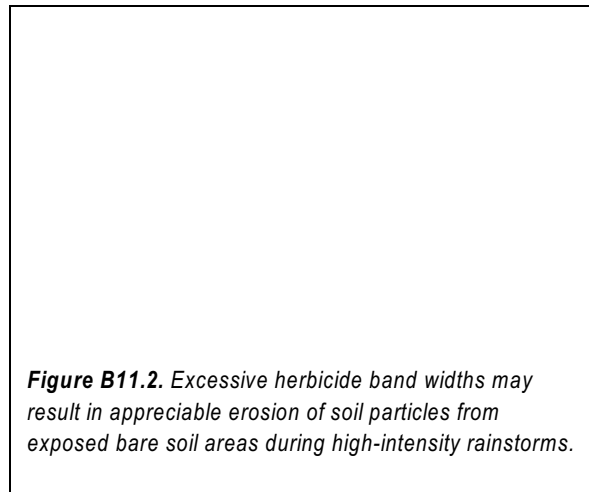
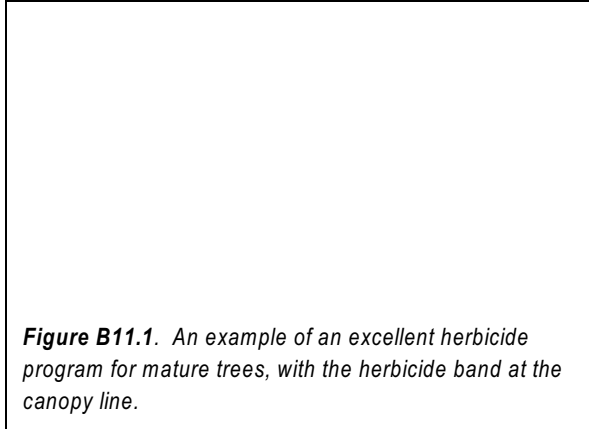


References:

- Chapter 403.813, Florida statutes.
- Rule 40D-4.051, Florida Administrative Code.

B11. HERBICIDE APPLICATIONS (WATER FURROWS)
Restrict the area of tree-row applied herbicides to within the canopy dripline of the citrus trees.

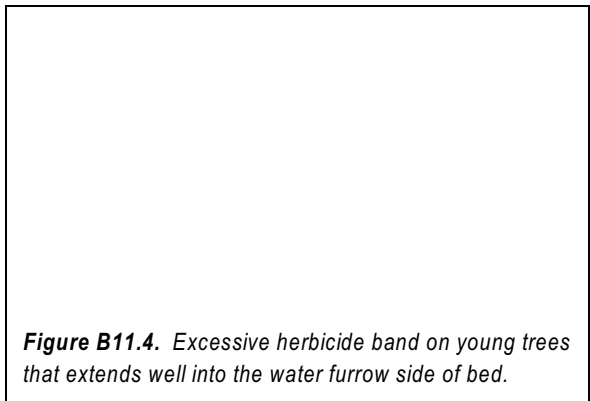
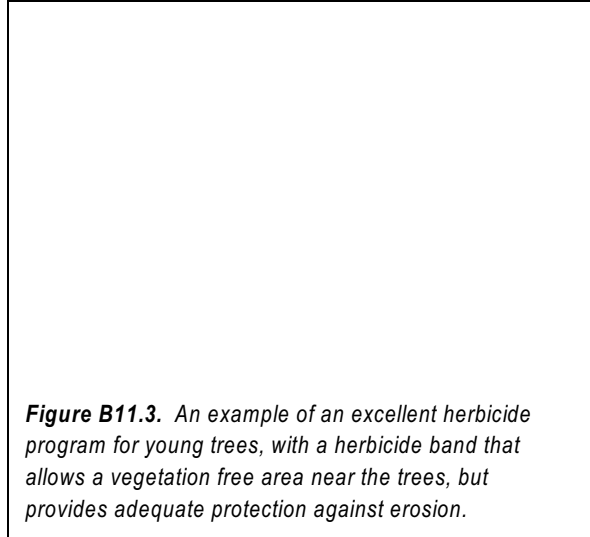
The restricted herbicide band width will maximize the width of grassed water furrow slopes. Grassed water furrows serve as filters, preventing sediment movement from the fields into the drainage systems.



See Section C12 for proper handling and application of herbicides.

For young plantings, minimize the width of tree-row applied herbicides and establish vegetation in the water furrows. Smaller band widths will reduce the quantity of herbicides applied, thereby reducing material costs while minimizing potential of soil

erosion into the drainage systems. As the trees increase in canopy width, the herbicide band width can be increased to match canopy size.

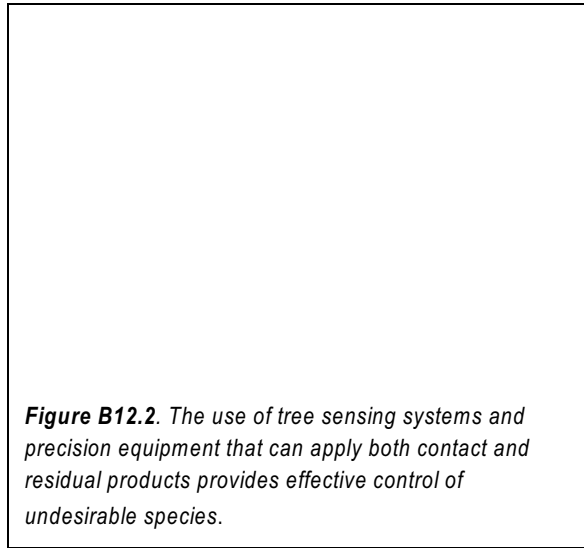
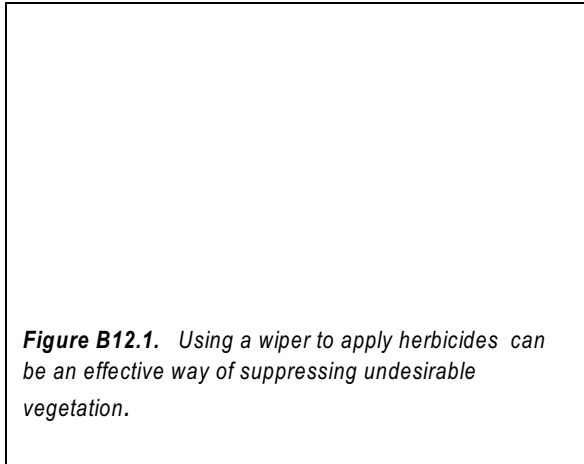


References

- SP-43. Florida Citrus Pest Management Guide: Weed Management, Section HS-107.
- HS-802. Weed Control in Subtropical Conditions in Florida Citrus.

B12. MIDDLES MANAGEMENT (HERBICIDE)

Suppress undesirable vegetation on bed tops and in water furrows.



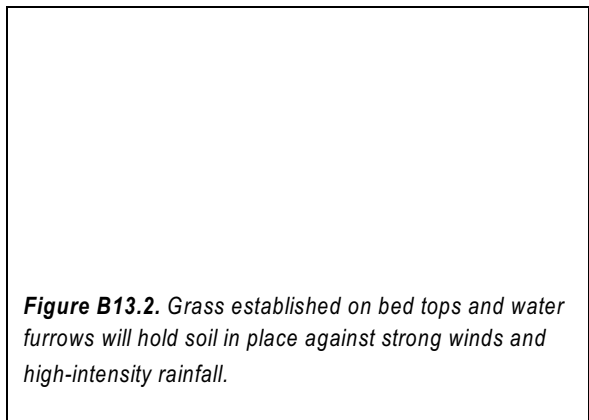
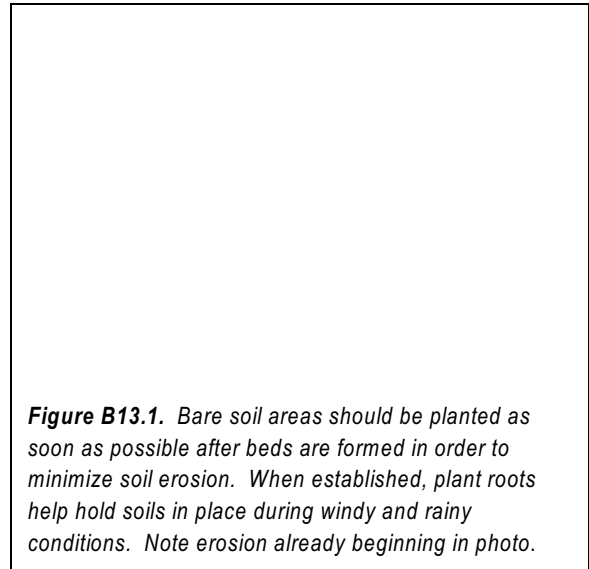
References

- SP-43. Florida Citrus Pest Management Guide: Weed Management, Section HS-107.
- HS-869. Vegetation Management in Row Middles in Florida Citrus.
- HS-802. Weed Control in Subtropical Conditions in Florida Citrus.

B13. GROVE DEVELOPMENT/RENOVATION

Upon completion of the soil bedding process within citrus groves, all bare soil areas (except tree rows) should be planted with grass or other vegetation species to minimize soil movement from rain and/or wind.

Bare soil surface, during windy conditions, can provide sufficient soil to blast the bark of young trees and allow movement of soil into water furrows and other drainage systems.



B14. SETTLING BASINS (SUMPS)

Dig out and maintain small settling basins in front of the drainage inlets within water furrows.

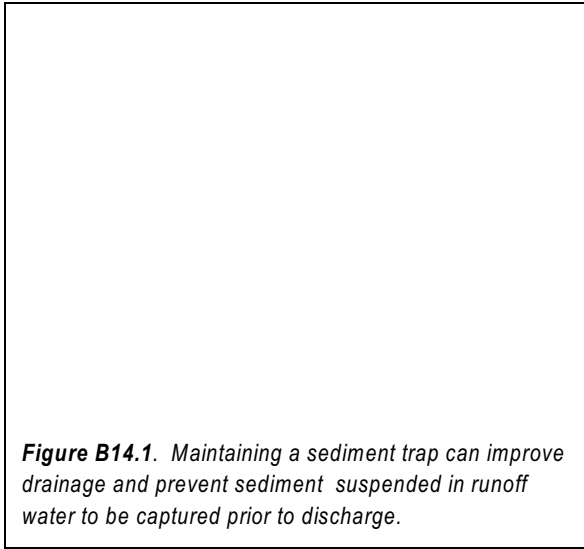


Figure B14.1. Maintaining a sediment trap can improve drainage and prevent sediment suspended in runoff water to be captured prior to discharge.

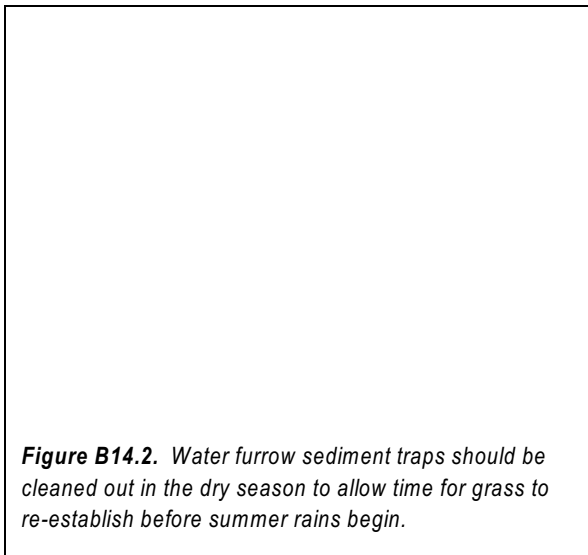


Figure B14.2. Water furrow sediment traps should be cleaned out in the dry season to allow time for grass to re-establish before summer rains begin.

B15. WATER FURROW DRAIN PIPES

Use PVC drain pipe or flexible pipe to connect all water furrows or field ditches to lateral ditches. Extend the pipe on the downstream side away from the ditch bank to prevent bank scouring.

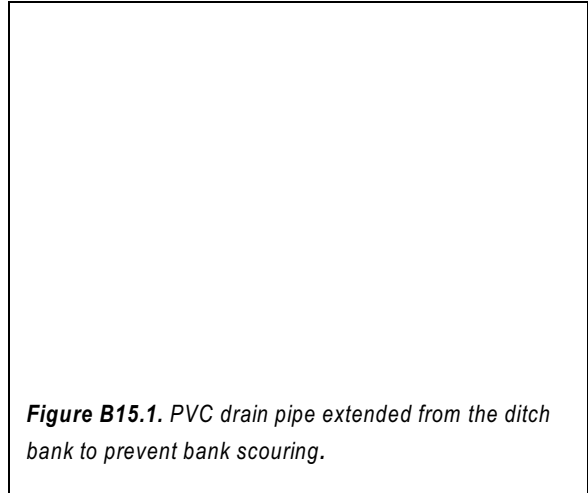


Figure B15.1. PVC drain pipe extended from the ditch bank to prevent bank scouring.

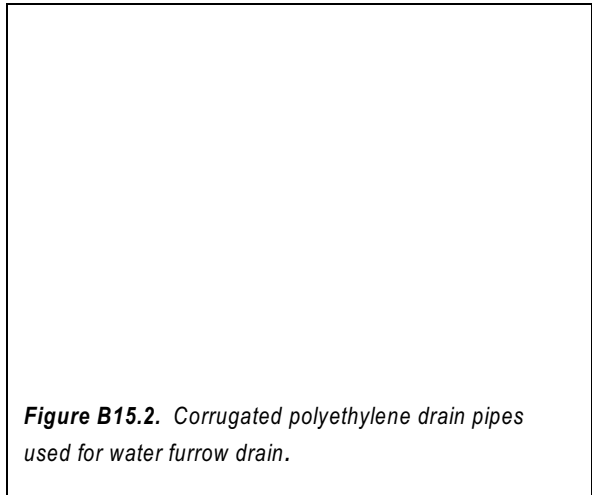


Figure B15.2. Corrugated polyethylene drain pipes used for water furrow drain.

B16. WATER FURROW MAINTENANCE

Use water furrow drain pipes with managed vegetation in furrows to reduce surface water transfer velocity from the furrows to the drainage ditches and canals.

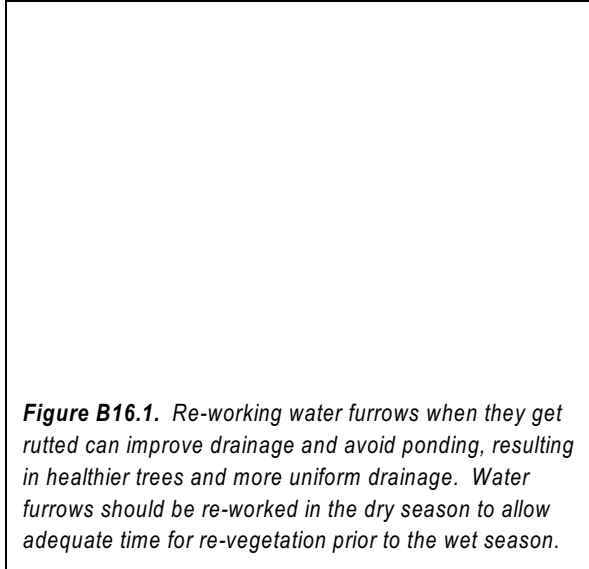


Figure B16.1. Re-working water furrows when they get rutted can improve drainage and avoid ponding, resulting in healthier trees and more uniform drainage. Water furrows should be re-worked in the dry season to allow adequate time for re-vegetation prior to the wet season.

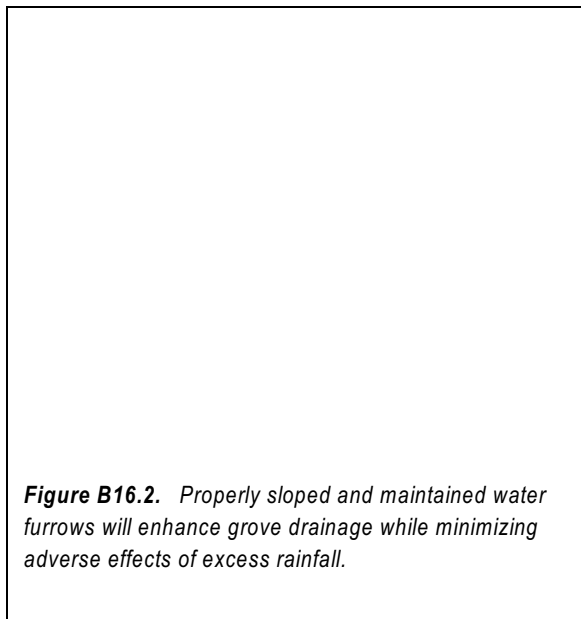


Figure B16.2. Properly sloped and maintained water furrows will enhance grove drainage while minimizing adverse effects of excess rainfall.

B17. CONSTRUCTION AND TEMPORARY EROSION CONTROL MEASURES

Special measures and/or temporary erosion control measures should be taken during construction and renovation of groves, when culverts and control structures are replaced or repaired, and when there is a major disruption of established vegetation such as during irrigation system installation or when buried water lines are repaired.

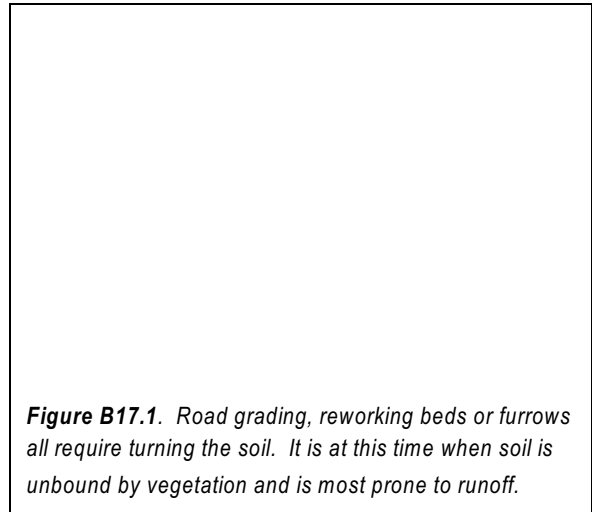


Figure B17.1. Road grading, reworking beds or furrows all require turning the soil. It is at this time when soil is unbound by vegetation and is most prone to runoff.

Erosion control measures are used to minimize sediment transport and protect the quality of water bodies that receive runoff from disturbed areas. The most common temporary erosion control tools include straw or hay bale barriers, silt screens, and silt fences; however, more permanent control can be obtained through the use of specialized blankets and mats, gabions, and other systems used for soil stabilization.

The cost of erosion control options are highly variable and agricultural producers are encouraged to consider economics and site-specific conditions when selecting the most appropriate erosion control system for a particular action. When selecting an erosion and sediment control method, it is recommended that a NRCS representative, engineer, and/or a SWFWMD Ag-Team member be consulted.

Straw or Hay Bale Barrier: A temporary sediment barrier consisting of a row of entrenched and anchored straw or hay bales.

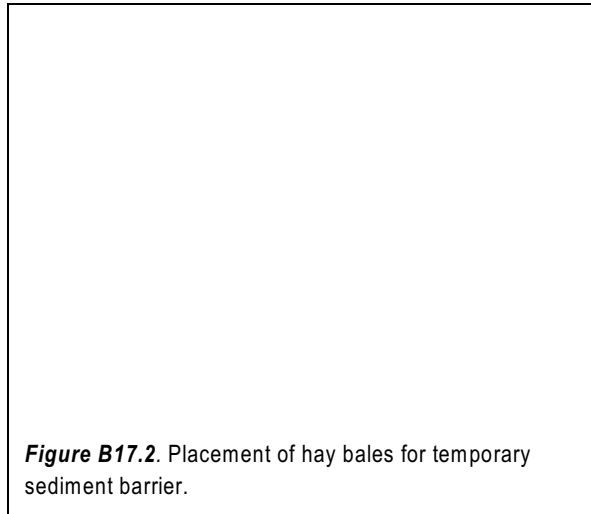


Figure B17.2. Placement of hay bales for temporary sediment barrier.

Installation Considerations:

- Install bales below disturbed areas that are subject to sheet or rill erosion.
- Use bale barriers when effective control is needed for less than 3 months.
- Install bales in a continuous row, perpendicular to the direction of water flow, and place bales tightly together to prevent water from passing between the bales.
- Entrench bales approximately 4 inches, and secure by driving two stakes through each bale.
- Use double rows spaced a minimum of five feet apart when the disturbed area is within 50 feet of a receiving water body.
- If bales are used in conjunction with silt screens, bales should be placed adjacent to the silt screen on the upslope side.

Things to Avoid:

- Do not construct straw or hay bale barriers in streams or swales where hydraulic forces will cause a washout.
- Do not use straw or hay bale barriers for sediment control when site conditions exceed the application specifications identified below.

- Avoid bare ground situations during construction, and sod, seed and protect as necessary to minimize adverse impacts from erosion.

Applicable Technical Criteria:

- Drainage area should not exceed ¼ acre per 100 feet of barrier length.
- Slope length behind barrier should not exceed 100 feet, and slope gradient behind barrier should not exceed 5%.

Operation and Maintenance:

- Inspect barriers after all significant rainfall events and replace bales as needed.
- Remove sediment deposits if they reach one half the height of the barrier.

Silt Fence: A temporary barrier consisting of a filter fabric (burlap or synthetic material) stretched across and attached to supporting posts and, in some cases, wire fence material. Small silt fences, which are designed with lighter materials and without the use of supporting wire, are often referred to as “filter barriers”.

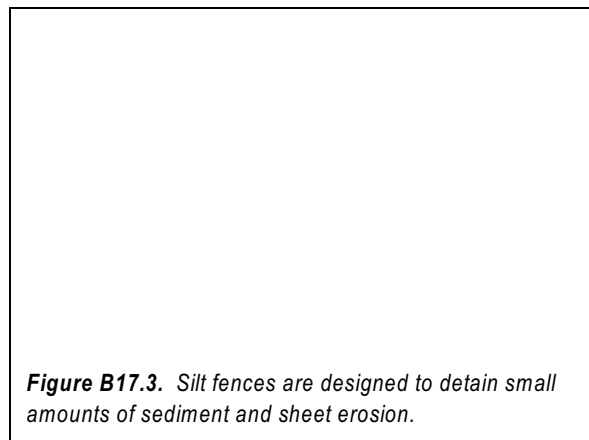


Figure B17.3. Silt fences are designed to detain small amounts of sediment and sheet erosion.

Installation Considerations:

- Install silt fences perpendicular to the direction of water flow, below disturbed areas that are subject to sheet or rill erosion.
- Use filter barriers when effective control is needed for less than 3 months, and use silt fences when longer application periods are needed.

- Drive posts or stakes securely into the ground (minimum depth of 12 inches for posts and 8 inches for stakes).
- Excavate a 4-inch by 4-inch trench along the line of posts and on the upslope side.
- If wire fence material is used to provide extra support, fence should extend 1 inch into the trench, be securely attached to the posts using heavy gauge wire staples, and should not extend more than 36 inches above the original land surface.
- Securely fasten filter fabric to the posts or fence material with 8 inches of the fabric extending into the trench.
- Backfill the trench and compact over the filter fabric.
- Install two parallel silt fences (located at least three feet apart) if needed to provide additional sediment control. When within 50 feet of surface waters, utilize two rows of silt fences spaced at least 5 feet apart.

Things to Avoid:

- Do not install silt fences in streams or swales where the contributing drainage area exceeds 2 acres or where flows will exceed one cubic foot per second.
- Avoid bare ground situations during construction, and sod, seed and protect as necessary to minimize adverse impacts from erosion.

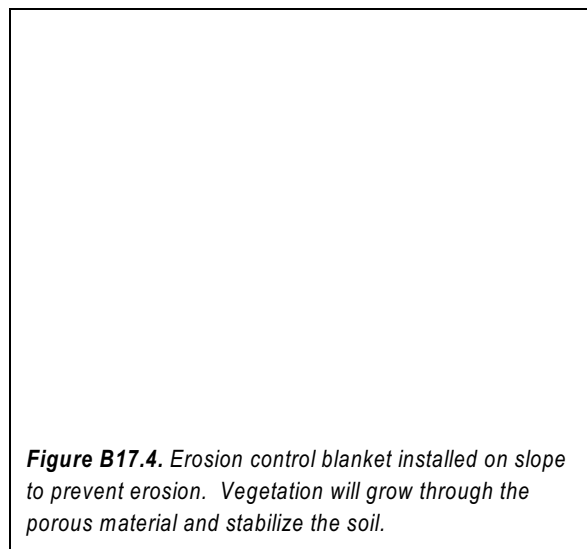
Applicable Technical Criteria:

- Drainage area should not exceed ¼ acre per 100 feet of barrier length.
- Slope length behind barrier should not exceed 100 feet, and slope gradient behind barrier should not exceed 5%.
- Silt fences should not exceed 36 inches in height, and filter barriers should be between 15 and 18 inches in height.
- Posts (4 inch diameter wood or equivalent) for silt fences should be spaced a maximum of 10 feet apart. When extra strength fabric is used without wire support, post spacing should not exceed 6 feet.
- Stakes (1-inch by 2-inch wood or equivalent) for filter barriers should be spaced a maximum of 3 feet apart.

Operation and Maintenance:

- Inspect silt fences after significant rainfall events, and make repairs as needed.
- Remove sediment deposits if they reach one half the height of the barrier.

Erosion control blankets: Erosion control blankets and mats are made of natural and/or synthetic fibers that are woven to form a highly permeable material. These blankets, which are often photodegradable and/or biodegradable, are commonly used to provide permanent erosion control on ditch banks, berms, levies and other areas with excessive slope. Erosion control blankets protect soils prior to vegetative establishment and encourage vegetative growth by capturing sediment and providing soil reinforcement.

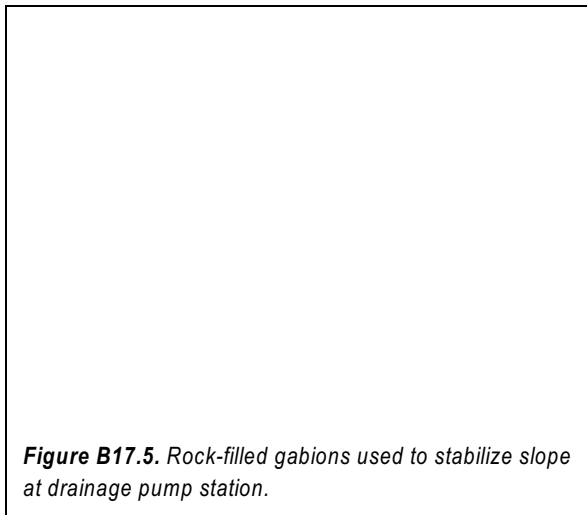


Erosion Control Blankets can be utilized in association with other types of erosion control methods where the feasibility of utilizing sodding is cost prohibitive because of the area of application. Mulches are generally utilized to retard erosion by protecting bare earth areas where sheet and rill erosion are likely to occur by reducing the velocity of overland flow and enhancing the effectiveness of turbidity and erosion controls installed down slope. In addition, mulches can enhance the effectiveness of seeded areas by retarding the transport of seeds down slope. Mulches should be

free from weeds and/or nuisance and exotic plant material. The recommended application rate for broadcasting hay/straw is 1.5 to 2 tons per acre or 70 to 90 lbs per 1000 sq. ft. Mulches such as wood chips need to be anchored (i.e., netting, etc.).

For further information regarding the applicability and usage of specific products in this category, please contact your local Soil and Water Conservation District, or USDA-NRCS.

Gabions: Gabions are partitioned, wire meshed containers that are filled with stone or concrete rubble to form flexible, permeable, monolithic structures such as retaining walls, weirs, and channel linings. Gabions can provide effective long-term erosion control within water conveyance features especially around water control structures. For further information regarding the applicability and usage of gabions, please contact your local Soil and Water Conservation District, USDA-NRCS, or refer to information provided by product manufacturers, distributors and/or dealers.

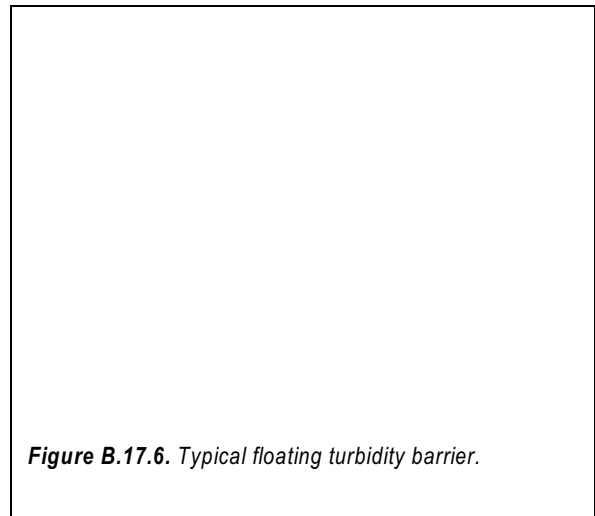


Floating Turbidity Barriers.

Turbidity barriers or "curtains" are designed to minimize sediment transport from a disturbed area adjacent to or within a water body. Turbidity barriers are commonly used in addition to other sediment controls to provide additional water quality protection. These barriers are designed to trap

sediment in low to moderate flow conditions. Turbidity barriers should not be installed across channel flows where higher water velocities can occur.

The standard practice in installing barriers is to keep the lower edge of the barrier about 12 inches above the bottom as shown in Fig. B17.6. When the lower edge of the barrier is long enough to drape on the bottom, silt will build up as shown in Fig. B17.7. If the build-up is allowed to collect over a long period of time, the barrier may be pulled beneath the surface of the water. The build-up also makes it difficult to remove the barrier without stirring up the silt and sending it back in to the water course. For further information regarding the applicability and usage of floating turbidity barriers, please contact your local Soil and Water Conservation District, USDA-NRCS, or refer to information provided by product manufacturers, distributors and/or dealers.



Key Terms:

Sheet Erosion: Sheet erosion is caused by shallow sheets of water flowing over the land. These broad moving sheets of water are seldom the cause of erosion, but the flow transports sediments detached

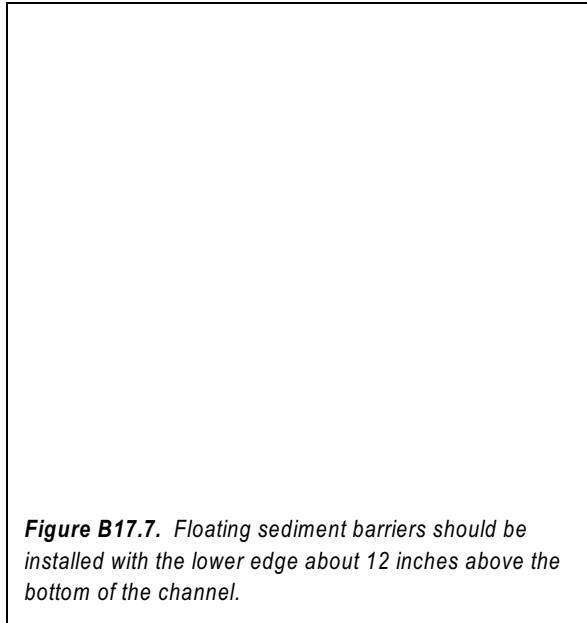


Figure B17.7. Floating sediment barriers should be installed with the lower edge about 12 inches above the bottom of the channel.

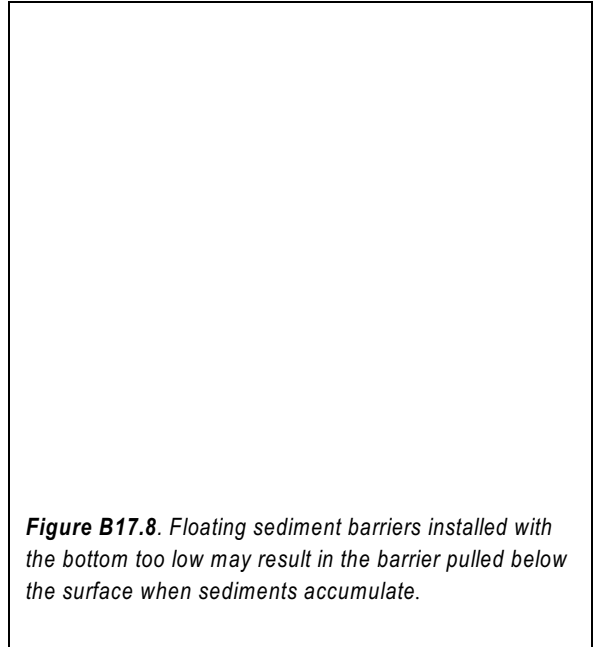


Figure B17.8. Floating sediment barriers installed with the bottom too low may result in the barrier pulled below the surface when sediments accumulate.

by raindrop impact and splash. The shallow surface flow rarely moves as a uniform sheet for more than a few feet before concentrating due to topographic irregularities.

Rill Erosion: Rill erosion develops as the shallow surface flow begins to concentrate in low spots. The concentrated flow increases in velocity and turbulence, which in turn causes the erosion and transport of more sediments. This action cuts tiny well-defined channels called rills, which are usually only a few inches deep.

References

- The Florida Stormwater, Erosion, and Sediment Control Inspector's Manual.
- FDEP Storm Water Inspection Course.
- SL-195. Flatwoods Citrus Best Management Practice: Soil Stabilization.

Table B17.1. Potential temporary erosion control practices for use during grove construction and renovation and when major land disturbances are made during repair operations.

| Practice | Definition | Purpose | Where Applicable |
|---|--|---|--|
| Straw Bale Dike | Temporary sediment barrier constructed from a row of entrenched and anchored straw bales. | To catch and retain sediment on the construction site and prevent sedimentation. | May be used below disturbed areas subject to sheet and rill erosion where temporary sedimentation control is needed. |
| Turbidity Barrier (staked or floating) | Temporary sediment barrier consisting of an impermeable material stretched across a surface water body. | To catch and hold sediment plumes and floating debris in surface waters. | May be used across ditches and canals and in retention/detention areas or reservoirs adjacent to shores. |
| Temporary Sediment Trap | A small temporary ponding basin formed by excavation or by an embankment. | To detain sediment-laden runoff and to trap the sediment and to protect receiving water bodies from sedimentation. | May be used at the outlets of drains, diversions, ditches, and other runoff conveyances. |
| Temporary Seeding | Planting fast-growing vegetation to provide temporary erosion control. | To provide stabilization of bare soil areas that will not be brought to final form for a period of more than 30 days. | May be used on cleared, un-vegetated areas where temporary erosion control is needed. |
| Mulching | Use of a protective blanket of straw, residue, gravel, or synthetic material on soil surface. | To protect soil surface from forces of raindrop impacts and overland or sheet water flow. | May be used on beds for temporary or permanent seeding and on areas of bare soil when seeding or planting must be delayed. |
| Outlet Stabilization Structure | Structure designed to control erosion at the outlet of a channel or conduit. | To prevent erosion by reducing water velocity from the outlet of a channel or conduit. | May be used at locations where water velocity from a conduit or open channel exceeds permissible velocity of the receiving canal. |
| Fabric Drop Inlet | Temporary fabric barrier placed around inlets to ditches or canals. | To prevent sediment from entering canals during construction activities; allows use of the drainage system during construction. | May be used where drain inlets are to be operational before permanent stabilization of the drainage area occurs. This method is used in areas that are nearly level, with slopes less than 5%. |
| Temporary Graveled Entrance/Exit | A gravel driveway or pad located at a point where vehicles enter and exit a construction site. | Provides a suitable location for vehicles to drop mud and sediment before entering public roads; controls erosion from surface runoff and helps control dust. | May be used whenever traffic leaves a construction site and enters a public road or other paved areas. |
| Silt Fence | Temporary sediment barrier consisting of filter fabric or burlap stretched across supporting posts and entrenched. | To catch and hold small amounts of sediment from disturbed areas by reducing the velocity of sheet flow to allow sediment deposition. | May be used below small disturbed areas less than 1/4 acre per 100 ft of fence, and where runoff can be stored behind the fence without damaging the fence or the area behind the fence. |

PEST MANAGEMENT

| | Page |
|--|------|
| C0. Purpose | C-1 |
| C1. Integrated Pest Management (IPM) ... | C-2 |
| C2. Product Selection | C-5 |
| C3. Product Use training | C-8 |
| C4. Purchase and Transport | C-8 |
| C5. Storage | C-9 |
| C6. Excess Formulation | C-11 |
| C7. Permanent Mix-load Sites | C-11 |
| C8. Non-Permanent Mix-load Sites | C 13 |
| C9. Spill Management | C-15 |
| C10. Excess Mixture | C-16 |
| C11. Protect Water Sources During Mixing | C-17 |
| C12. Handling and Measurement | C-17 |
| C13. Container Management | C-18 |
| C14. Equipment Sanitation and Wash Water Handling | C-19 |
| C15. Application Equipment Calibration and Maintenance | C-20 |
| C16. Environmental Conditions and Timing for Application | C-22 |
| C17. Maintain Soil pH to Avoid Mobility of Copper | C-22 |
| C18. Precision Application of CP Products | C-23 |
| C19. CP Product Use Record Keeping | C-24 |
| C20. Reduce Spray Drift and Off-Target Deposition | C-25 |
| C21. Turn Nozzles Off at Row Ends | C-26 |
| C22. Consider IPM Decisions in the Context of Broader Production BMPs | C-27 |

and implementation of responsible farm management practices that promote the proper handling of these products also has contributed significantly to reducing the risk of environmental problems and protecting water resources, pesticide handlers and agricultural workers.

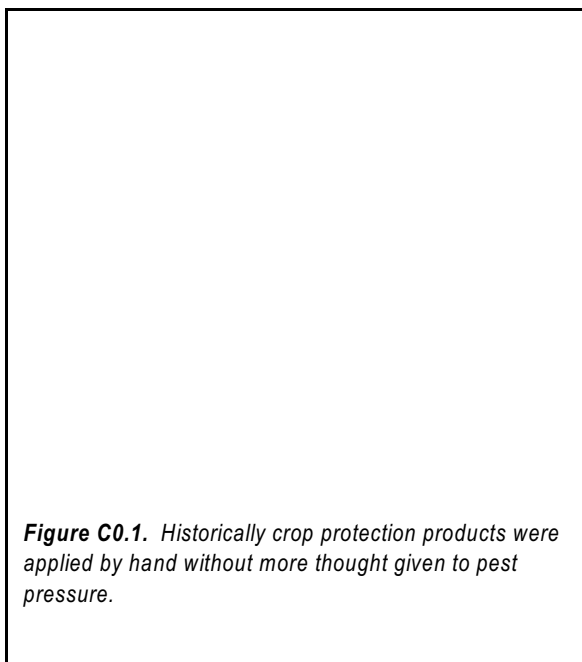


Figure C0.1. Historically crop protection products were applied by hand without more thought given to pest pressure.

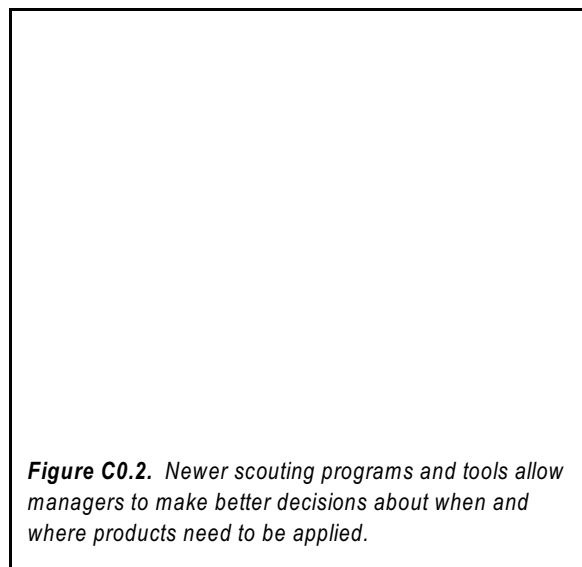


Figure C0.2. Newer scouting programs and tools allow managers to make better decisions about when and where products need to be applied.

Purpose

Over the past 50 years, many lessons have been learned about the use of agrichemicals and synthetic pesticides (herein described as crop protection products or CP products) and the unintended environmental consequences that may have resulted from these older products. Over the last 20 years, great strides have been made in the development of CP products that are more target specific, less harmful to the environment and safer to those who handle and apply these products. The development

C1. Integrated Pest Management (IPM)

Adopt an Integrated Pest Management (IPM) program. IPM is an integrated system using a combination of mechanical, cultural, biological, and chemical approaches to best meet the goals of the program. This approach provides better and more economical management of most pests.

What is IPM?

- A philosophy of managing pests that aims to reduce farm expenses, conserve energy, and protect the environment.
- A broad, interdisciplinary approach using a variety of methods to systematically manage pests which adversely affect people and agriculture.

IPM does not, as many believe, mean that no CP products are used. Rather, it means that CP products are only one weapon against pests and they should be used judiciously, and only when necessary.

The goals of an IPM program are:

1. Improved control of pests, through a broad spectrum of practices that work together to keep pest populations below economically significant thresholds.
2. More efficient CP product management through less frequent and more selective use of CP products.
3. More economical crop protection from reduced chemical costs and more efficient protection.
4. Reduction of potential hazards to farmers, workers, consumers, and the environment through reduced CP product exposure.

IPM accomplishes these goals using resistant plant varieties, cultural practices, parasites and predators, other biological controls such as *Bacillus thuringiensis* (BT), and other methods including chemical CP products as appropriate.

The basic steps for an IPM program are:

1. Identify key pests and beneficial organisms and

the factors affecting their populations.

2. Select preventative cultural practices to minimize pests and enhance biological controls. These practices may include soil preparation, resistant rootstocks/scions, modified irrigation methods, cover crops, augmenting beneficials, etc.
3. Use trained "scouts" to monitor pest populations to determine if or when a control tactic might be needed.
4. Predict economic losses and risks so that the cost of various treatments can be compared to the potential losses to be incurred.
5. Decide the best course and carry out corrective actions.
6. Continue to monitor pest populations to evaluate results and the effectiveness of corrective actions. Use this information when making similar decisions in the future.

See your county extension agent or independent crop consultant for help in setting up an IPM program for your farm. Factors to consider when selecting pest management strategies are listed in Table C1.1.

What are Pests?

The pests associated with citrus IPM include insects, mites, nematodes, fungi, bacteria, viruses and weeds. It is important to recognize that not all organisms found in citrus groves are considered pests. Many species in the diverse ecosystem of the citrus grove are neutral they do not cause injury or loss to citrus, while other species are actually beneficial to the production of citrus. Thus, only a small proportion of the organisms should be considered as pests, and only under certain circumstances, when their level of existence threatens the health or productivity of citrus trees.

In addition to pests that are known to occur in Florida and for which IPM tactics are available, there is a continuing threat of the introduction and establishment of exotic pests. Establishment and spread of exotic mites, insects, nematodes,

Table C1.1. Issues to consider when selecting pest management strategies.

| Problem | Reference | Timing/Season | |
|---|---|--|--|
| Citrus Rust Mite (CRM) Spider Mites Other Mites | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Resistance management 2. Biological controls and Predator populations (Beneficials) 3. Pest Populations (i.e.; citrus leafminer) 4. Environmental Hazards (See CP product label environmental hazards section) | <ol style="list-style-type: none"> 5. <i>Hirsutella thompsonii</i> fungus (CRM) 6. Other increased pest populations associated with certain sprays 7. Phytotoxicity 8. Fresh or processed fruit 9. Rainfall 10. Temperature |
| Scale Insects | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Natural Predator Populations 2. Pest location - Interior or Exterior <ol style="list-style-type: none"> a. Trunk b. Leaves c. Fruit d. Limbs | <ol style="list-style-type: none"> 3. Trunk run-off 4. Type of seal (armored or soft) 5. Emulsifiable oil control 6. Environmental Hazards (See CP product label) 7. Timing of sprays |
| Thrips Aphids Mealy Bugs Leafminer | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Environmental hazards (see CP product label) 2. Timing of sprays 3. Natural predator population (beneficials) | <ol style="list-style-type: none"> 4. Area of the canopy receiving spray coverage (periphery) 5. Resistance factor |
| Root Weevils Nematodes | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Mode of action (i.e. aduaticide, ovicide, etc.) 2. Weeds and ground applications 3. Partition coefficient (SP-43) 4. Population timing 5. Application equipment | <ol style="list-style-type: none"> 6. Proper calibration for ground applied materials 7. Area to receive application (tree trunk to canopy drip line) 8. Weather (adequate moisture, temperature, rainfall, wind) 9. Erosion from application site |
| Other Insects | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Resistance 2. Biological Predators | <ol style="list-style-type: none"> 3. Population Build-Up 4. Timing/Season |
| Fungal Pathogens | SP-43, Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Resistance 2. Fresh or processed fruit 3. Biological Predation | <ol style="list-style-type: none"> 4. Alternative compounds 5. Soil toxicity 6. Soil pH |
| Citrus Canker | IFAS SP-182 FDACS Plant Pathology Circular No. 377 | Decontamination | |
| Terrestrial Weeds | SP-43 Annual Citrus Pest Management Guide | <ol style="list-style-type: none"> 1. Soil/Type 2. Partition Coefficient (SP-43) 3. Types and modes of action for herbicides 4. Types of weeds to control 5. Growth stage of weeds 6. Season/Timing | <ol style="list-style-type: none"> 7. Band width/Canopy dripline 8. Erosion/Ground Cover/Buffer Strips 9. Root System/Size of tree 10. Good Calibration 11. Rainfall/Moisture 12. Temperature/Wind |
| Aquatic Weeds | SP-168, Aquatic Weed Manual | <ol style="list-style-type: none"> 1. Water level 2. Irrigation water usage intervals 3. Rainfall 4. Method of control 5. Biological Predators 6. Surface or underwater weed control 7. Good calibration (Surface area or volume) | <ol style="list-style-type: none"> 8. Application site (label) 9. Timing/season 10. Temperature 11. Sunlight 12. Wind 13. Mowing vs. Chemical 14. Wiping vs. Spraying 15. Ditch bank erosion 16. Downstream effects |
| Fertilization of Bedded Groves | SP-169, Nutrition of Florida Citrus Trees | <ol style="list-style-type: none"> 1. Leaching potential 2. Salt index 3. Cation exchange capacity 4. Soil type 5. Timing/season 6. Volatilization | <ol style="list-style-type: none"> 7. Foliar 8. Rainfall capacity 9. Application site 10. Proper calibration 11. Spillage 12. Root zone location |

diseases or weeds exert additional pressure on the citrus production system, often leading to the need for additional chemical intervention in order to prevent injury or tree loss. New introductions of pests are destabilizing features of IPM systems and must be treated carefully to avoid disruption of the established pest management system.

Approaches that can be used in IPM vary from those that prevent development of damaging levels of the pest to those that reduce the pest below levels of concern. Among the tactics that are available that prevent development of pest injury are sanitation and exclusion. When these tactics fail, eradication can be attempted to eliminate the pest organism from the system and prevent repeated injury or damage. Finally, suppression tactics are used to reduce populations or infection below the level that would compromise tree health or fruit yield.

Informed decisions are an important aspect of citrus IPM. As pest populations are encountered in the grove, proper identification of the pest organisms involved is a crucial step in making appropriate responses. Following identification of the pest(s) involved, implementation of the appropriate cultural practices or other tactics should occur. When it is deemed that CP products are necessary, targeted application of pest control products should be made so as to maximize suppression of the target pest populations while minimizing non-target impacts. Inappropriate choice of tactics can lead to undesirable outcomes. The presence of a long history of biological control of numerous pests in Florida citrus makes the system vulnerable to upset through misuse or overuse of CP products. Elimination of parasites or predators through multiple applications of CP products can lead to disruption of the balance between pests and their natural enemies, resulting in higher pest populations and increased damage.

Pest Monitoring and Economic Assessment: Scouting procedures are a very effective and efficient tool for the grower. Scouting allows the grower or production manager to visually formulate

recommendations that can be very cost effective for the crop being grown. It gives the grower the decision-making ability to properly apply CP products and nutrients.

By scouting the crop, past, current and future problems can be seen, and scouting allows growers to address them in the proper manner. When scouting for insects, for example, growers should also be watchful for other problems that could be present. For instance, when scouting for mites growers could find an increasing problem with weed control or an increasing insect population. When practiced properly, scouting can be a valuable management tool for all growers.

Pest monitoring results should be subjected to an economic assessment before reactive measures are taken. The mere presence of a pest or disease is not sufficient to warrant treatment expense. Assessing the potential loss if the pest goes unchecked versus the cost and financial return preserved through various treatments should assist the pest manager in making decisions that are biologically and economically sound. While cost of suppression compared to savings in yield, quality or tree health is of primary importance, the costs associated with disruption of other pests by the treatment also should be considered.

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- CPMG-02. Approaches to Processed and Fresh Fruit Management.
- CPMG-03 Florida Citrus Integrated Pest Management Guide: the Use of Pesticides in Citrus IPM.
- EDIS UF/IFAS. <http://edis.ifas.ufl.edu/>
- ENY-624. Pesticide Resistance and Resistance Management.
- HS-107. Florida Citrus Integrated Pest Management Guide: Weeds.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-53. Private Applicator Agricultural Pest Control.
- SM-63. Agricultural Tree Crop Pest Control.
- SP-176. Identification of Mites, Insects, Diseases, Nutrition Symptoms, and Disorders of Citrus.

C2. Product Selection

Select target-specific active ingredients that complement natural systems in epidemiological cycles and modes of action (i.e. insect growth regulators, botanicals, and biologicals).

Be aware of CP product leaching- and/or runoff-potential with each soil type within the grove. Select CP products that have the least potential for impacting water quality.

Agricultural use of CP products should be part of an overall pest management strategy, which includes biological controls, cultural controls, pest monitoring and other applicable practices, referred to altogether as Integrated Pest Management or IPM. When a CP product is needed, its selection should be based on effectiveness, toxicity to non-target species, cost, and site characteristics, as well as its solubility and persistence.

While the focus of the IPM program is for field populations of mites, insects, nematodes disease pathogens and weeds, CP products also are prescribed for post-harvest maintenance of fruit quality. Some of these situations require pre-harvest applications as part of the overall management strategy. Due consideration needs to be given to these treatments in the overall crop BMPs.

Half-lives and partition coefficients (K_{oc}) are particularly important when the application site of a CP product is near surface waters or is underlain with permeable subsoil and a shallow aquifer. Short half-lives and intermediate to large K_{oc} are best in this situation. The K_{oc} for a compound is a measurement of its tendency to tightly bind to organic materials.

Many areas of Florida have impermeable sub-soils which impede deep leaching of soluble CP products. Where impermeable sub-soil exist, soluble CP products (low K_{oc}) and moderate long half-lives may be rapidly transported in drainage water to nearby surface waters. Non-erosive soils are common in much of Florida and CP products

with large K_{oc} remain on the application site for a long time. However, the user should be cautious of CP products with long half-lives as they may build up in the soil.

In addition to CP product solubility and soil permeability, it is important that the CP product's toxicity to non-target species be considered. Some of the CP products listed in Table C2.1 have severely restricted use due to acute toxicity or long half-life.

An important purpose of the CP product container label is to instruct users to apply the CP products safely and with minimum threat to non-target species, both on and off the application site. CP product users assume responsibility to follow label instructions. Table C2.2 shows the potential movement of CP products into ground and surface water based on persistence and sorption. Table C2.3 shows potential for surface runoff and/or leaching based on common soil types within the Peace River and Manasota Basin (PRMSB) citrus production areas.

Adapted from SL-40;
Behavior of Pesticides in Soils and Water

CP Product Leaching and Runoff Potential

Resource soil scientists with the Natural Resources Conservation Service have rated the soils delineated by map units for their potential for leaching and runoff of CP products (Table C2.3). The rating criteria are given in a publication entitled "Soil Ratings for Selecting CP products for Water Quality Goals." These soil ratings have been developed to help CP product users determine the potential for CP products to be lost to groundwater or surface water bodies.

Table C2.1. Persistence and sorption in soils for selected CP products used on citrus.

| Common Name | Trade Name(s) | K_{oc}^1 (mg/gOC) | $T_{1/2}$ (days) |
|--|----------------------|------------------------|---------------------|
| Non-persistent (half-life 30 days or less) | | | |
| dicamba | Banvel | 2 | 14 |
| acephate | Orthene | 2 | 3 |
| dimethoate | Cygon | 20 | 7 |
| oxamyl | Vydate | 25 | 4 |
| aldicarb | Temik | 30 | 30 |
| carbaryl | Sevin | 300 | 10 |
| iprodione | Rovral | 700 | 14 |
| norflurazon | Solicam | 700 | 30 |
| azinphos-methyl | Guthion | 1,000 | 10 |
| fluridone | Sonar | 1,000 | 21 |
| malathion | Cythion | 1,800 | 1 |
| chlorpyrifos | Lorsban | 6,070 | 30 |
| Moderately-persistent (half-life greater than 30 but less than 100 days) | | | |
| bromacil | Hyvar | 32 | 60 |
| metalaxyl | Ridomil | 50 | 70 |
| simazine | Princep, Simazine | 130 | 60 |
| dichlobenil | Casoron | 400 | 60 |
| diuron | Karmex, Direx | 480 | 90 |
| diazinon | Basudin, Spectracide | 1,000 | 40 |
| benomyl | Benlate | 1,900 | 67 |
| dicofol | Kelthane | 5,000 | 45 |
| trifluralin | Treflan | 8,000 | 60 |
| endosulfan | Thiodan, Endosan | 12,400 | 50 |
| glyphosate | Roundup | 24,000 | 47 |
| Persistent (half-life greater than 100 days) | | | |
| Formetanate Hydrochloride | Carzol, Dicarzol | 1,000,000 | 100 |

¹ K_{oc} is octanol-water partition coefficient; the higher the number, the more fat soluble the chemical.

Table C2.2. Potential pesticide impact on ground and surface waters based on persistence and sorption.

| Persistence | Sorption | Potential Impact | |
|--------------------------------------|-----------------|---|---------------|
| | | Groundwater | Surface Water |
| Non-persistent | Low-moderate | Low | Low |
| Non-persistent | Moderate-high | Low | Moderate |
| Moderately persistent | Moderate-high | Moderate | Moderate |
| Moderately persistent | Low-moderate | High | High |
| Persistent | Moderate - high | Moderate | High |
| Moderately persistent and persistent | Low - high | Site-specific conditions determine groundwater or surface water impacts | |

Adapted from SL-40; Behavior of Pesticides in Soils and Water

Table C2.3. Leaching and surface runoff potential from the most common soil types within the Peace River Valley and Manasota citrus producing areas.

| Soil Series | Leaching potential | Runoff potential |
|-------------|--------------------|------------------|
| Basinger | Very High | Low |
| EauGallie | Low | Medium |
| Farmton | Low | Medium |
| Immokalee | High | Medium |
| Malabar | Low | Medium |
| Myakka | High | Medium |
| Oldsmar | Low | Medium |
| Pineda | Low | High |
| Pomello | High | High |
| Pomona | Low | Medium |
| Smyrna | High | Medium |
| Wabasso | Low | High |
| Waveland | High | High |

NOTE: The user may discover that one or more map unit names in Table C2.3 have been updated from names given in the legend of the soil survey report. For example, a soil map unit may be listed in the survey report with a single soil series name, whereas the same soil map unit is shown as comprising two or more soil series in the list below (sequence numbers 1, 2, 3, ...). Whenever this occurs, the user should

use the multi-named map unit given and make CP product selections based on the most limiting condition to be found on the land in question. If necessary, the local Natural Resources Conservation Service office should be contacted to perform an onsite evaluation of the land in question. See "Soil Ratings for Selecting Pesticides for Water Quality Goals" (IFAS Extension Circular 959) for explanations of the criteria used to develop soil ratings.

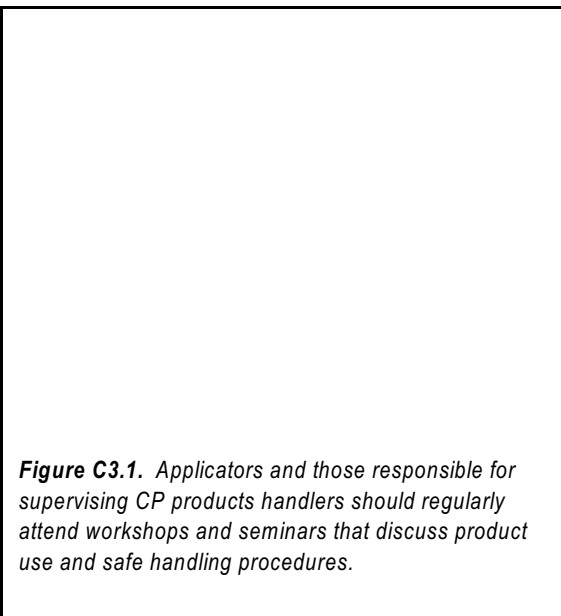
References

- Circular 959. Soil Ratings for Selecting Pesticides for Water Quality Goals.
- Circ. 974. Citrus: Managing Pesticides for Crop Production and Water Quality Protection.
- ENY-601. Florida Citrus Pest Management Guide: Pesticides Registered for Use on Florida Citrus.
- HS-107. Florida Citrus Pest Management Guide: Weeds
- RF-WQ-107. Factors Influencing Pesticide Movement to Ground Water.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SL-40. Behavior of Pesticides in Soils and Water
- SL-65. Charlotte County: Soil Ratings For Selecting pesticides, <http://edis.ifas.ufl.edu/SS059>
- SL-73. DeSoto County: Soil Ratings for Selecting Pesticide, <http://edis.ifas.ufl.edu/SS067>
- SL-75. Hardee County: Soil Ratings for Selecting Pesticides, <http://edis.ifas.ufl.edu/SS069>
- SI-86. Manatee County: Soil Ratings for Selecting Pesticides, <http://edis.ifas.ufl.edu/SS080>
- SL-108. Sarasota County: Soil Ratings for Selecting Pesticides, <http://edis.ifas.ufl.edu/SS102>
- SM-53. Private Applicator Agricultural Pest Control.
- SM-63. Agricultural Tree Crop Pest Control.
- SP-43. Florida Citrus Pest Management Guide.

C3. Product Use Training

Proper training of field operators responsible for handling, loading, and operating spray machinery can minimize the potential for misapplication of agricultural chemicals.

It is essential that information learned at continuing education classes be transferred to individuals of the application staff. Special efforts should be taken to ensure that non-English-speaking field personnel understand proper handling, loading, and operating techniques.

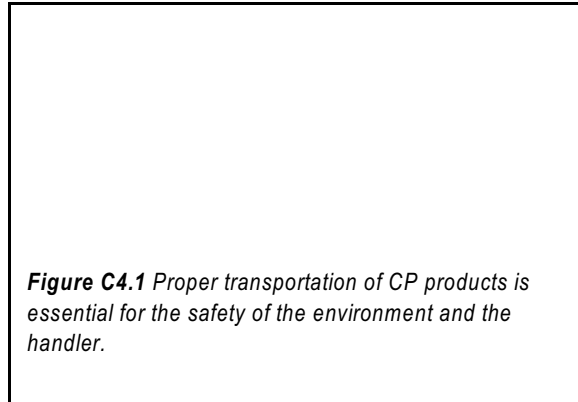


References

- AE-259. Florida Citrus Pest Management Guide: Pesticide Application Technology - Foliar.
- ENY-601. Florida Citrus Pest Management Guide: Pesticides Registered for Use on Florida Citrus.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-2. Aerial Applicator Training Manual.
- SM-3. Aquatic Pest Control Training Manual.
- SM-53. Private Applicator Agricultural Pest Control.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.
- SM-63. Agricultural Tree Crop Pest Control.

C4. Purchase and Transport

Appropriately planned and timed purchase of CP products can avoid risks associated with protracted storage.



Adherence to instructions provided by product manufacturers relating to transport of CP products can minimize risks of spillage and contamination in the event of accident or other container failure.

Follow directions for transport provided on product label, taking into consideration exposure to temperature, moisture, UV light and other variables.

Ensure packages and containers are properly closed and secured prior to transport, and are retained in original containers and with original product label attached.

Consider restrictions imposed by manufacturers or transportation agencies on transport within enclosed spaces and or by personal vehicle.

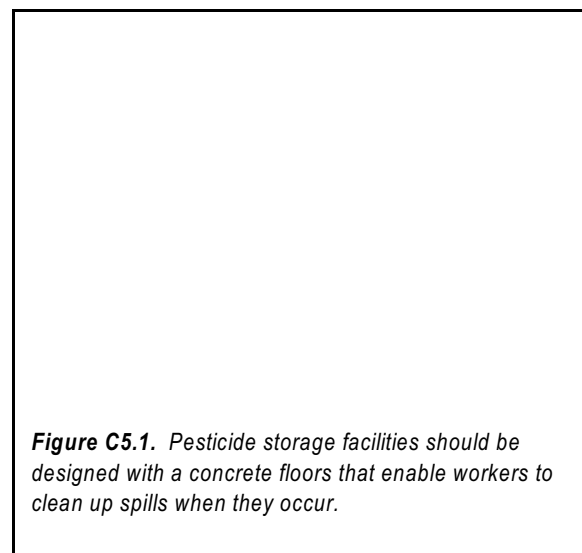
Appropriate spill response materials should always be transported along with CP products to ensure that immediate spill response can be accommodated. (See Pest Management BMP C3.9, Spill Management.)

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.

C5. Storage

Design and build CP product storage structures to keep CP products secure and isolated from the surrounding environment. Store CP products in a roofed concrete or metal structure with a lockable door. Locate this building at least 50 feet from other structures (to allow fire department access) and 100 feet from surface water and from direct links to ground water. Keep CP products in a separate facility, or at least in a locked area separate from areas used to store other materials, especially fertilizers, feed, and seed.



Do not store CP products near burning materials, hot work (welding, grinding), or in shop areas. Avoid storage of CP products in spaces occupied by people or animals. Do not allow smoking in CP product storage areas.

Store personal protective equipment (PPE) where it is easily accessible in the event of an emergency, but not in the CP product storage area to avoid contamination and since that may make PPE unavailable in time of emergency. Check the label and the Material Safety Data Sheets (MSDS) for the safety equipment requirements. Keep a written CP product inventory and the MSDS file for the chemicals used in the operation on site. Do not store this information in the CP product storage room.

Depending on the products stored and the quantity, you may need to register the facility with the Department of Community Affairs and your local emergency response agency. Check with your dealer about Community Right-to-Know laws for the materials that you purchase. An emergency response plan should be in place. All farm personnel should be familiar with the plan before an emergency occurs. Individuals conducting emergency CP product cleanups should be properly trained under the requirements of the Occupational Safety and Health Administration (OSHA). For reporting chemical spills, see Appendix 2.

Do not store large quantities of CP products for long periods of time. Adopt the "first in - first out" principle, using the oldest products first to ensure that the product shelf life does not expire.

Store CP products in their original containers. Do not put CP products in containers that might cause children and others to mistake them for food or drink. Keep the containers securely closed and inspect them regularly for splits, tears, breaks, or leaks. Arrange CP product containers so that labels are clearly visible and make sure labels are legible about the contents of the container.

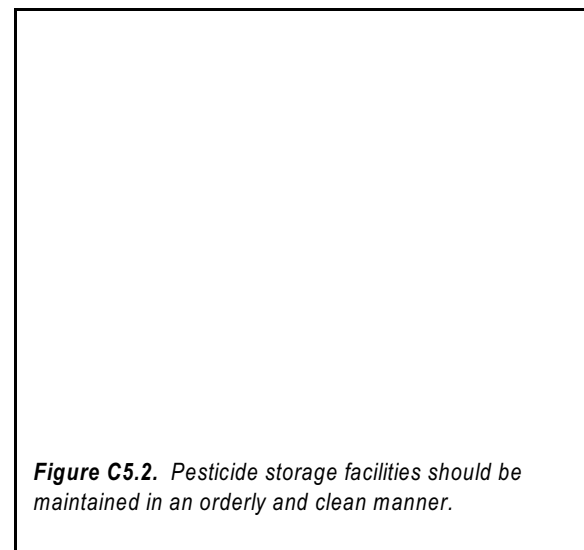
All CP product containers should be labeled. Refasten all loose labeling. Use non-water-soluble glue or sturdy transparent packaging tape to refasten loose labels. Do not refasten labels with rubber bands (these quickly rot and break) or non-transparent tapes such as duct tape or masking tape (these may obscure important product caution statements or label directions for product usage). If a label is damaged, immediately request a replacement from the CP product dealer or formulator. As a temporary supplement to disfigured or badly damaged labels, fasten a baggage tag to the container handle. On the tag write the product name, formulation, concentration of active ingredient(s) and the date of purchase.

Dry bags should be stored on pallets and covered with plastic to ensure they do not get wet. Do not

store liquid materials above dry materials. Store flammable CP products separately from non-flammable CP products.

Segregate herbicides, insecticides and fungicides to prevent cross-contamination and minimize the potential for misapplication. Cross-contaminated CP products often cannot be applied in accordance with the labels of each of the products. This may make it necessary to dispose of the cross-contaminated materials as wastes and could require the services of a consultant and hazardous waste contractor.

Use shelving made of plastic or reinforced metal. Keep metal shelving painted (unless stainless steel) to avoid corrosion. Never use wood shelving because it may absorb spilled CP product materials.



Construct floors of seamless metal or concrete sealed with a chemical-resistant paint. For concrete, use a water-cement ratio no higher than 0.45:1 by weight, and leave a rough finish to provide adhesion for the sealant. Equip the floor with a continuous curb to retain spilled materials. While a properly sealed sump may be included to help recover spilled materials, do not include a drain. Provide sloped ramps at the entrance to allow handcarts to safely move material in and out

of the storage area.

When designing the facility, keep in mind that temperature extremes during storage may reduce safety and affect CP product efficacy. Provide automatic exhaust fans and an emergency wash area. The emergency wash area should be located outside the storage building. Explosion proof lighting and fans may be required by local fire and electrical codes. It is recommended that the light/fan switch be located outside of the building so that both are on before entering and until people have left the building.

CP product storage structures should be labeled such that the nature of the contents is made known to those approaching the building.

The BMPs discussed often address the ideal situation of newly constructed permanent facilities. However, the user is encouraged to apply the principles and ideas put forth to existing facilities, and to portable or temporary facilities that may be used on leased land where permanent structures are not practical.

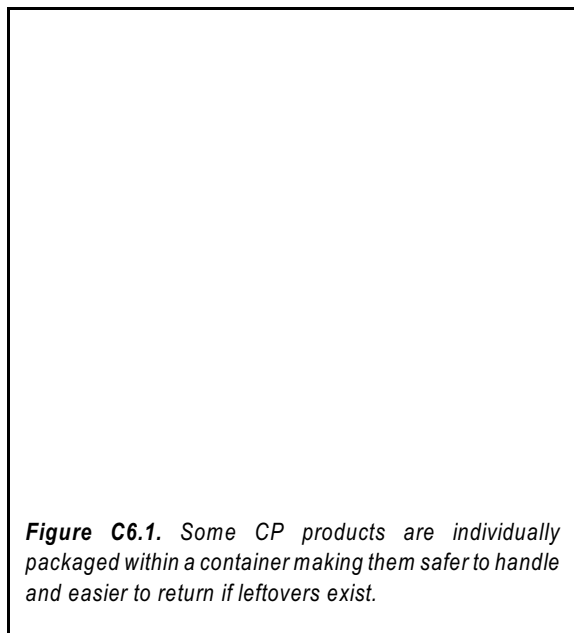
Plans and specifications for CP product storage buildings are available from several sources, including the Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture, the Midwest Plan Service, and the UF-IFAS Publications Office.

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- HS-139. Pesticide Mix-load and Sprayer Wash-down Systems for Florida Citrus.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-59. Basic Pesticide Training.

C6. Excess Formulation

When possible, return excess formulated materials to the dealer where it was purchased. In most cases, the excess material must be in an unopened, original container. Contact local dealers for their requirements.



The single best practice to handle excess CP product material is to use it as a CP product in accordance with the label instructions. However, it is not always possible to avoid generating waste. The appropriate practice to be followed depends on the type of CP product waste.

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- PL-18. Proper Disposal of Pesticide Wastes.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-59. Basic Pesticide Training Department of Community Affairs Booklet on Complying.
- SM-57. Building Plans and Management Practices for a Permanently-Sited Pesticide Storage Building in Florida.

C7. Permanent Mix-Load Sites

When available, utilize permanent mix-load stations to reduce CP product spillage. Spills can result in expensive hazardous waste cleanup and/or environmental contamination.

Locate CP product loading stations away from ground water wells and areas where runoff may carry spilled CP products into surface water bodies. If such areas cannot be avoided, protect wells by properly casing and capping them and use berms to keep spills out of surface waters.

To minimize the risk of CP products accumulating in the environment from repetitive spills, you may wish to construct a permanent mix/load facility with an impermeable surface (such as sealed concrete) so that spills can be collected and managed.

A permanently located mixing and loading facility, or chemical mixing center (CMC), is designed to provide a place where spill-prone activities can be performed over an impermeable surface that can be easily cleaned and permits the recovery of spilled materials (Fig. C7.1). Where feasible, the mixing and loading facility should be located in close proximity to the CP product storage building to reduce the potential for accidents and spillage when transferring CP products to the mixing site. Do not build new facilities on potentially contaminated sites, since subsequent cleanup efforts may require the operation to be relocated.

In its most basic form, a CMC consists of a concrete pad treated with a CP product-resistant sealant and sloped to a liquid-tight sump where all of the spilled liquids can be recovered. When considering a permanent CMC, it is important to assess the level of training and supervision required by the staff that will be using the center, so that it is operated in a safe and responsible manner. Even the best-designed facility will not prevent environmental contamination if it is not properly managed.

It is crucial that a CMC facility be properly designed and constructed. Mistakes can be costly and can

result in unintended environmental contamination. Several publications are available to explain design, construction and operational guidelines for permanent mix/load facilities. It is strongly recommended that these publications be consulted before designing any facility. These publications are listed in the reference section.

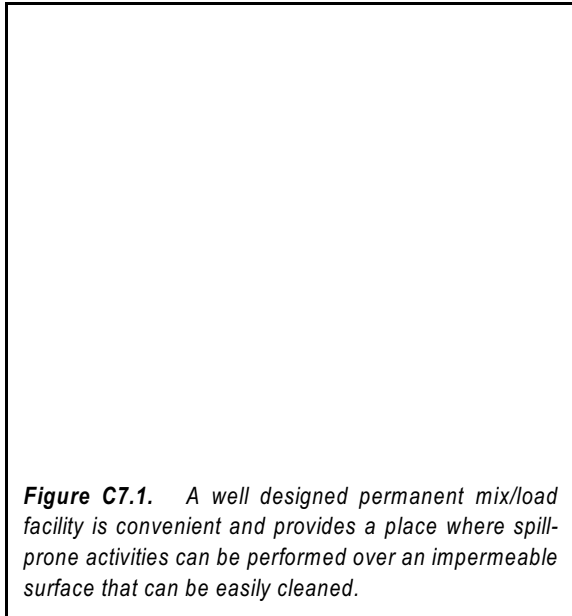


Figure C7.1. *A well designed permanent mix/load facility is convenient and provides a place where spill-prone activities can be performed over an impermeable surface that can be easily cleaned.*

It is very important that wherever feasible, a CMC be located a safe distance away from wells or surface water bodies. It should also be elevated above known flood plains. The first principle of CMC management is that any material that collects on the pad must be applied as a CP product or disposed as a (potentially hazardous) waste. Any water, including rain, that collects on the pad must be used as a CP product or disposed of as a (potentially hazardous) waste. An open building must have a roof with a substantial overhang (minimum 30 degrees from vertical, 45 degrees recommended) on all sides to protect against windblown rainfall.

In constructing a concrete mix/load pad, it is critical that the concrete have a water-cement ratio no higher than 0.45:1 by weight. This is needed to minimize cracking and to ensure that the concrete does not fail in tension near the sealant-concrete

interface. Superplasticizers and/or fly ash may be added to increase workability of the mix, but additional water must not be added. The concrete should receive a light broom finish to provide adhesion for the sealant. See *Designing Facilities for CP product and Fertilizer Containment* (MWPS-37) for full details of concrete specifications.

Materials other than concrete, such as steel or durable synthetics, also may be used in some cases. These materials also are used for portable CMCs where a permanent facility is not practical.

The CMC sump should be small and easily accessible for cleaning (Fig. C7.2). There must be a way to pump liquid trapped in the sump into the sprayer or storage tanks. Immediate application in accordance with the label instructions is usually the preferred method of handling both spills and rinsate. If rinsate storage tanks are used, there should be at least one tank for each group of compatible CP product types. This allows rinsate to be saved and used as make-up water for the next time that type of material is applied.

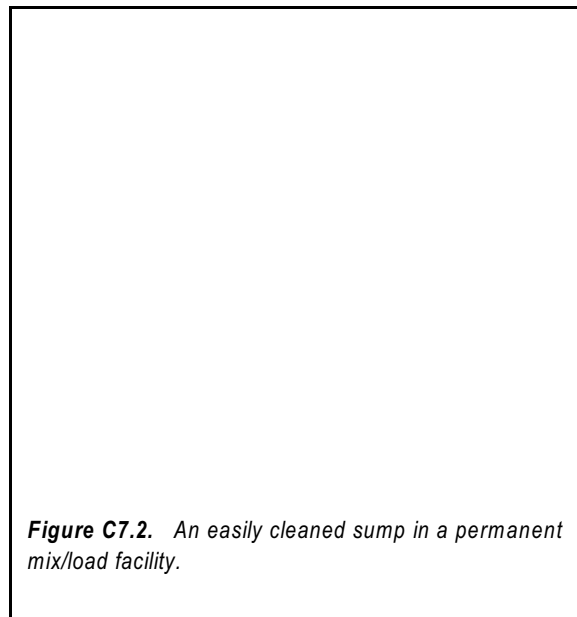


Figure C7.2. *An easily cleaned sump in a permanent mix/load facility.*

All spills should be cleaned up immediately. For small liquid spills (e.g. when backpack sprayers are being loaded), absorbents such as montmorillonite

clays (cat litter) or sand may be used. These can be applied as a top dressing in accordance with the label instructions, or disposed as a (possibly hazardous) waste. Solid materials can be swept up and reused

Pump the sump dry and clean it by the end of each day. Liquids and sediments should be removed from the sump and the pad any time CP product materials are changed to an incompatible product (incompatible products are those which cannot be legally applied to the same crop). Liquids and sediments then can be applied to the site as a CP product at less than labeled rates, instead of requiring disposal as a (possibly hazardous) waste.

Adapted from Howard et al., 1998. *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*, FDACS/FDEP

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- Circ. Z-361. Coating Concrete Secondary Containment Structures Exposed to Agrichemicals.
- Code 703. NRCS Conservation Practice Standard, Agrichemical Handling Facility.
- HS-139. Pesticide Mix-load and Sprayer Wash-down Systems for Florida Citrus.
- MWPS-37. Designing Facilities for Pesticide and Fertilizer Containment.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1, Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-57. Building Plans and Management Practices for a Permanently-sited Pesticide Storage Facility in Florida.
- SM-58. Building Plans and Management Practices for a Permanently-sited Agricultural Mixing/loading Facility in Florida.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.

C8. Non-Permanent Mix-Load Sites

When permanent facilities are not available or feasible, utilize portable mix-load stations to reduce CP product spillage (Fig. C8.1). CP product loading areas should be conducted at random locations in the field with the aid of nurse tanks.

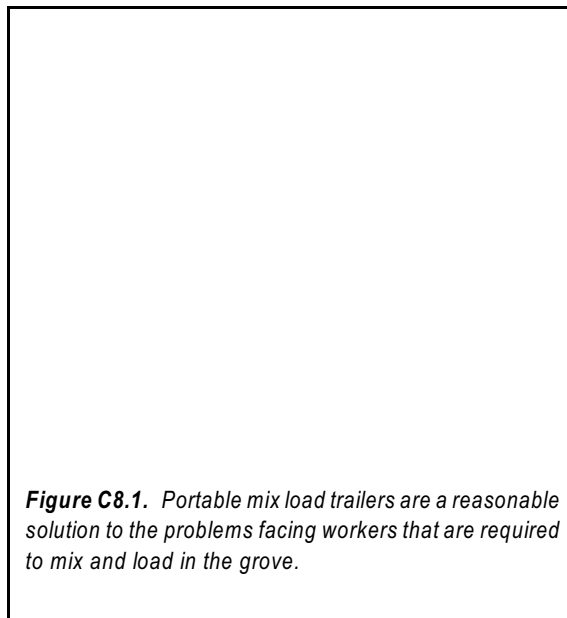


Figure C8.1. Portable mix load trailers are a reasonable solution to the problems facing workers that are required to mix and load in the grove.

Spills can result in expensive hazardous waste cleanup and/or environmental contamination. Locate CP product loading stations away from ground water wells and areas where runoff may carry spilled CP products into surface water bodies. If such areas cannot be avoided, protect wells by properly casing and capping them and use berms to keep spills out of surface waters.

Field Mixing and Nurse Tanks

Conducting all mixing and loading operations at random locations in the field away from wells or surface water bodies is an inexpensive way to reduce potential environmental contamination. Mixing chemicals at random sites in the field lessens the chance of a buildup of spilled materials in one place. If concentrated CP product is spilled at the field mixing site, the soil should be dug up and collected immediately. It can then be applied within the labeled rate (unless prohibited by the label).

If it is not practical to conduct field mixing operations away from wells, every effort should be made to properly case and cap wells, or retrofit open uncased wells to protect the ground water from spills and runoff. Check with your local Soil and Water Conservation District (SWCD) or Water Management District (WMD) to see if cost-share grants are available for these activities.

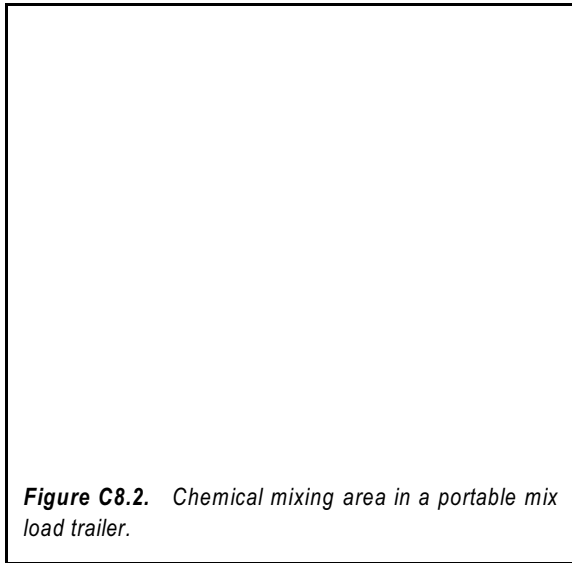


Figure C8.2. Chemical mixing area in a portable mix load trailer.

Nurse tanks are tanks of clean water transported to the field to fill the sprayer. Nurse tanks make it possible to move the mixing and loading operation away from permanent sites (which are often near wells or surface water) to random locations in the field.

Inject CP products into the transfer line or add them to the spray rig during filling. The CP products may be introduced by conventional pouring, or by pumping in a closed system, depending on label requirements and the type of container. Always use a check valve at the nurse tank to prevent backflow into the nurse tank.

Regardless of the water source, an air gap should be maintained between the water source and the chemical to provide positive backflow protection. Where allowed by the label, anti-foaming agents should be used. Always leave adequate

headspace (usually 10%) when filling the tank. Never leave a tank unattended while filling.

In some areas of Florida, water is drawn directly from canals or ditches in the field. In such situations, use a barrier such as a berm or some type of portable containment system to prevent spills from contaminating surface water. Use at least two forms of backflow protection to stop CP products from siphoning back into the canal. These could be an air gap at the fill point and a foot valve on the pump, or for a closed system, a double check valve and vacuum breaker.

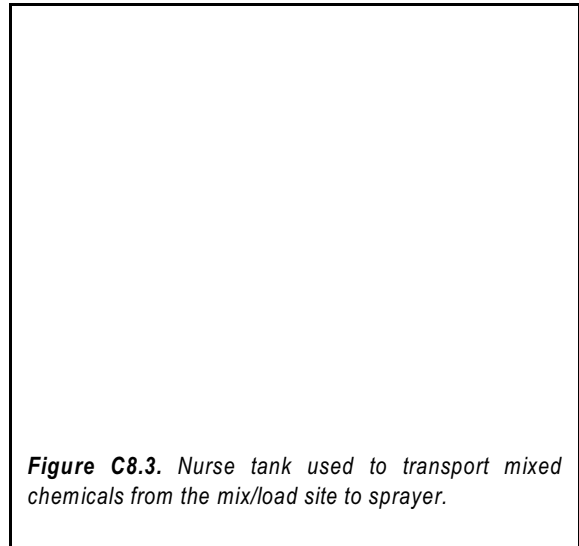


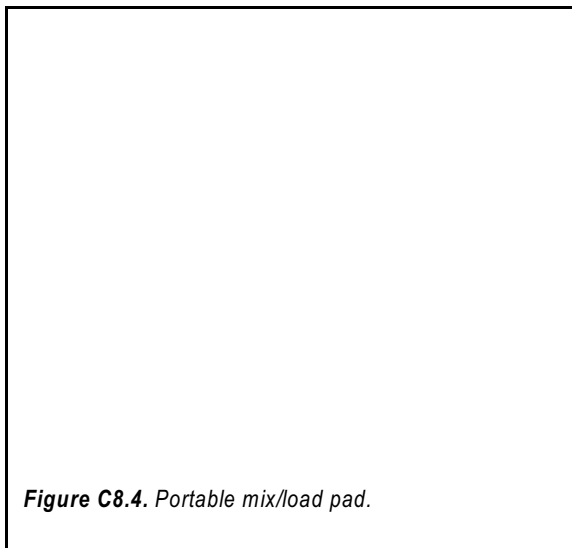
Figure C8.3. Nurse tank used to transport mixed chemicals from the mix/load site to sprayer.

Portable Mixing Centers

Another option for preventing contamination of mixing and loading sites is to use a portable mixing center. Some are little more than a pad of very durable material, while others are made of interlocking steel sections with a custom fitted liner and built-in sump. One variation is a self-contained mix/load trailer with a nurse tank at one end and a mix/load area at the other, where the mixture is pumped directly into the sprayer. Another use is portable containment facilities with nurse tanks to set up a temporary mixing/loading site in a remote field, or on leased land where no permanent structure is practical.

Portable mixing centers usually have no roof, but should be protected from rain. Since the pad may contain CP product residues, the accumulated rainwater may need to be applied as a CP product or disposed of as hazardous waste. A heavy rain can cause the pad to overflow, washing CP products into the environment. A sudden thunderstorm can result in a considerable amount of contaminated runoff, or even a spill. Clean portable mixing centers thoroughly immediately after a spill, because the liner material could be damaged by the CP product formulation. Where practical, portable pads for mixing and loading should be used away from wells or surface water. Never leave a tank unattended while filling.

Role of standard operating procedures (SOPs) in mixing materials: SOPs should be developed, documented and used to insure proper use of mix and load facilities by all users.

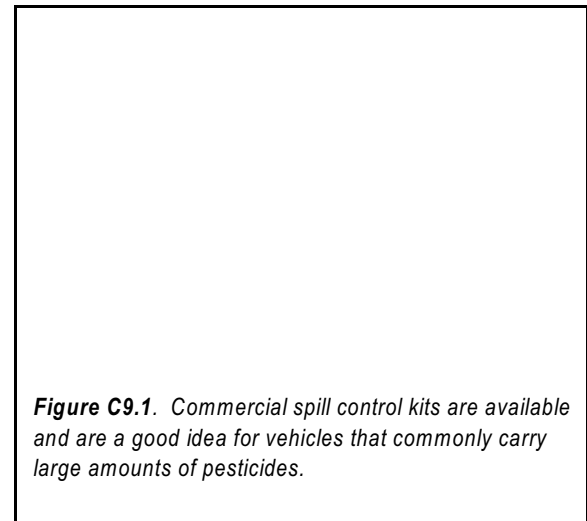


References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- Code 703. NRCS Conservation Practice Standard Portable Agrichemical Mixing Station.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.

C9. Spill Management

Establish a plan-for-action in the event that chemical spills occur. Potential for off-site movement of spilled CP products in water is reduced if the spill is controlled, contained, and cleaned-up quickly.



Clean up spills as soon as possible. The sooner you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Always use the appropriate PPE as indicated on the MSDS and the label. In addition, consider the following four steps:

- **CONTROL** actively spilling or leaking materials by setting the container upright, plugging leak(s), or shutting the valve.
- **CONTAIN** the spilled material using barriers and absorbent material.
- **COLLECT** spilled material, absorbents, and leaking containers and place them in a secure and properly labeled container.
- Store the **CONTAINERS** of spilled material until they can be applied as a CP product or appropriately disposed of.

Small liquid spills may be cleaned up by using an absorbent such as cat litter, diluting with soil, and then applying the absorbent to the crop as a CP product in accordance with the label instructions.

Farmers, farm managers, and landowners must comply with all applicable federal, state, and local regulations regarding spill response training for employees, spill reporting requirements, spill containment, and cleanup. Keep spill cleanup equipment readily available when handling CP products or their containers.

If a spill involves a CP product covered by certain state and federal laws, you may need to report any accidental release if the spill quantity exceeds the "reportable quantity" of active ingredient specified in the law. See the sections on "Spill Reporting Requirements" (Appendix 3) and "Important Telephone Numbers" (Appendix 2).

Emergencies

For emergency (only) information on hazards or actions to take in the event of a spill call CHEMTREC, at 1-800-424-9300. CHEMTREC is a service of the Chemical Manufacturers Association. For information on whether a spilled chemical requires reporting, call the SARA Title III help line at 1-800-535-0202 or the RCRA Superfund & EPCRA call center at 1-800-424-9346.

References

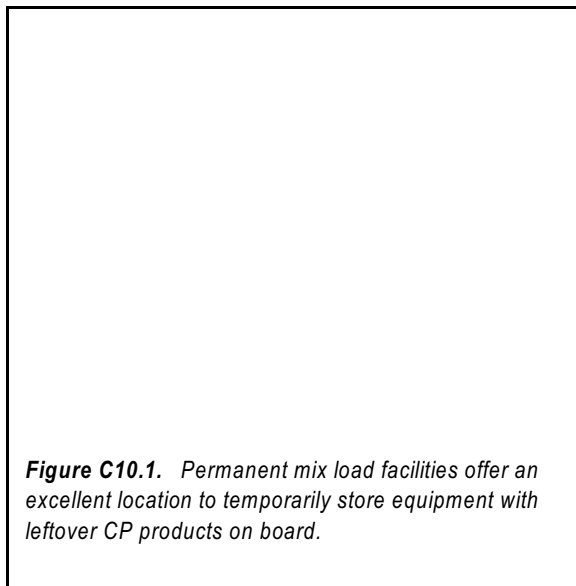
- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- SM-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.

Adapted from *Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*, FDACS/FDEP

C10. Excess Mixture

Mix only the amount of CP products needed during an application period.

It is not always possible to avoid generating excess spray material. The appropriate practices to be followed depend on the type of CP product waste. If there is excess CP product material, use it in accordance with the label instructions.



References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- PI-18. Proper Disposal of Pesticide Wastes.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- Sm-1. Applying Pesticides Correctly: a Guide for Pesticide Applicators.
- Sm-59. Basic Pesticide Training.

C11 Protect Water Sources During Mixing

Protect your water source by keeping the water pipe or hose well above the level of the CP product mixture. This prevents contamination of the hose and keeps CP products from back-siphoning into the water source. If you are pumping water directly from the source into a tank, use a check valve, anti-siphoning device or backflow preventer to prevent back-siphoning if the pump fails.

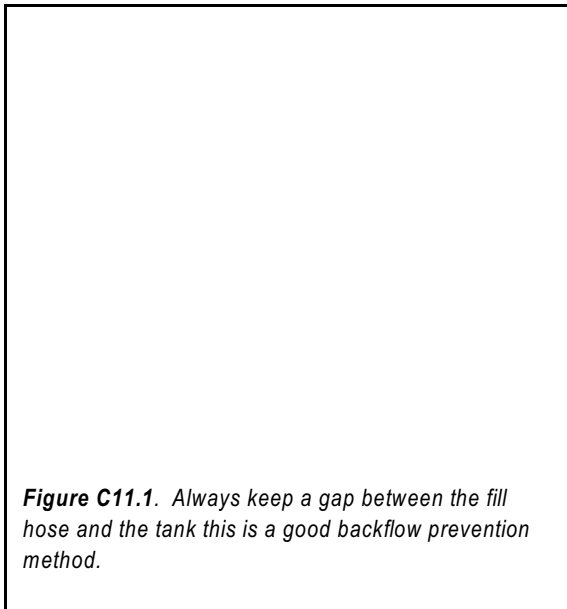


Figure C11.1. Always keep a gap between the fill hose and the tank this is a good backflow prevention method.

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- HS-139. Pesticide Mix-load and Sprayer Wash-down Systems for Florida Citrus.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-59. Basic Pesticide Training.

C12 Handling and Measurement

Read and understand the CP product label. The label is the law. Pay special attention to the “Environmental Hazards” section of the label.

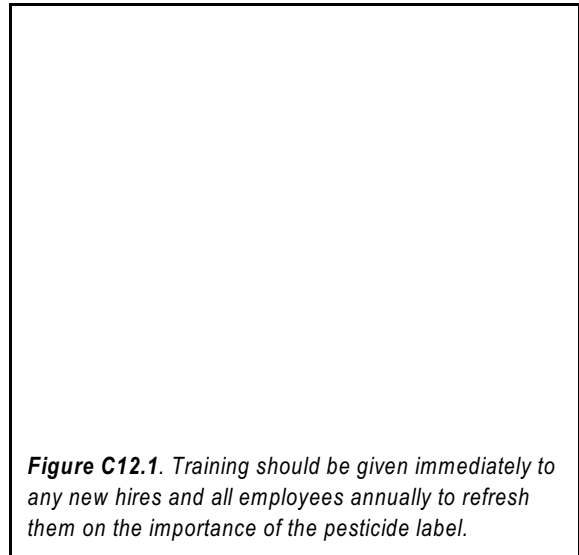


Figure C12.1. Training should be given immediately to any new hires and all employees annually to refresh them on the importance of the pesticide label.

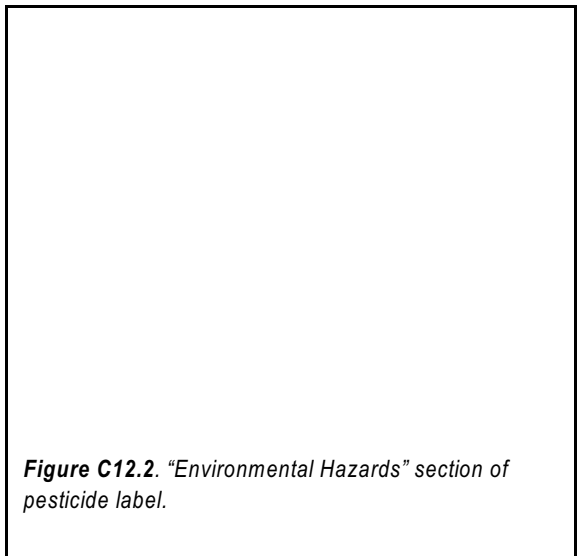


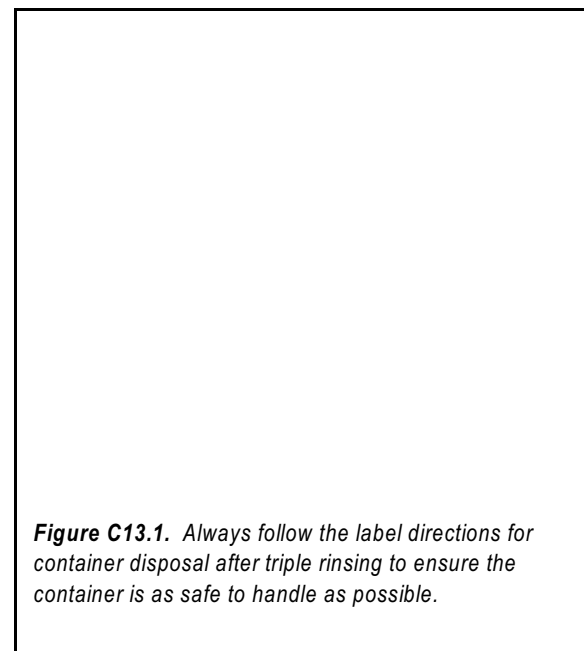
Figure C12.2. “Environmental Hazards” section of pesticide label.

References

- SM-1. Applying Pesticides Correctly.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.

C13 Container Management

Develop and implement procedures to appropriately rinse and dispose of, or recycle agricultural chemical containers.



Try to avoid the need to dispose of CP product containers as wastes by:

- Using containers that are designed to be refilled by the CP product dealer or the chemical company
- Arranging to have the empty containers recycled or reconditioned
- Using soluble packaging when available

When disposal is needed, rinse CP product containers as soon as they are empty. Pressure rinse or triple rinse containers and add the rinse water to the sprayer. Shake or tap non-rinseable containers such as bags or boxes so that all dust and material falls into the application equipment. Always wear the proper personal protective equipment (PPE) when conducting these rinse operations.

After cleaning, puncture the CP product containers

to prevent re-use (except glass and refillable mini-bulk containers). Keep the rinsed containers in a clean area, out of the weather, for disposal or recycling. Storing the containers in large plastic bags is one option to protect the containers from collecting rainwater.

Recycle rinsed containers in counties where an applicable program is available, or take them to a landfill for disposal. Check with your local landfill before taking containers for disposal, as not all landfills will accept them.

For information about CP product container recycling programs in your area, contact:

University of Florida
Pesticide Information Office
352-392-4721

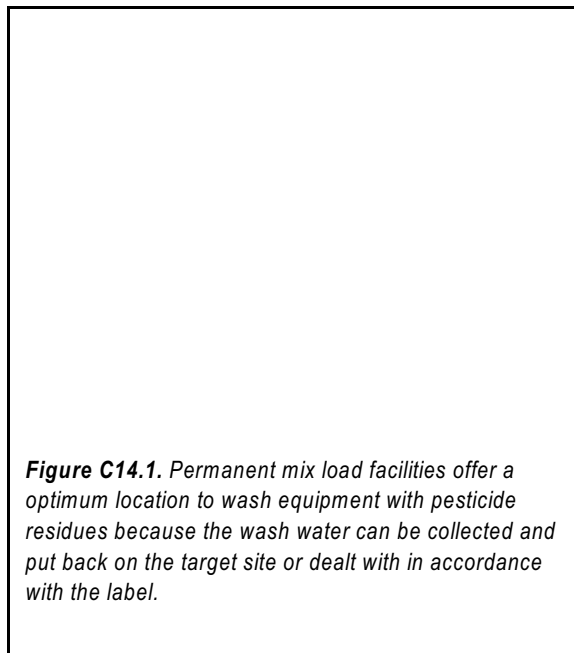
If permitted by the label and local ordinances, bags, boxes and group I pesticide containers may be burned in an open field by the owner of the crops. Burn each day's accumulation and do not store them overnight for later burning. Group I containers are containers of organic or metallo-organic CP products, except for organic mercury, lead, cadmium, or arsenic compounds.

References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- SM-1. Applying Pesticides Correctly.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.

C14 Equipment Sanitation and Wash Water Handling

Wash-water from CP product application equipment must be managed properly since it may contain CP product residues.



Wash-water from CP product application equipment must be managed properly since it may contain CP product residues. Wash the outside of the equipment at random places in the field using water from a nurse tank. Clean the tires and dirty areas of the equipment exterior prior to bringing it into the pad area. These practices prevent unwanted dirt from getting on the mix/load pad and sump or from being recycled into the sprayer. Avoid washing contaminated equipment in the vicinity of wells or surface water bodies. For intensive centralized or urban operations, it may be necessary to discharge the wash-water to a DEP permitted treatment facility.

The inside of the application equipment should be washed on the mix/load pad. This rinsate may be applied as a CP product (preferred) or stored for use as make-up water for the next compatible application. Otherwise it must be treated as a potentially hazardous waste. After washing the equipment and before an incompatible product is

handled, the sump should be cleaned of any liquid and sediment.

You may use equipment rinsate as a diluent for future mixtures of CP products if:

- The CP product in the rinsate is labeled for use on the target site where the new mixture is to be applied;
- The amount of CP product in the rinsate plus the amount of CP product in the mixture does not exceed the labeling rate for the target site;
- The rinsate is used to dilute a mixture containing the same CP product or a compatible CP product; or
- You comply with other application instructions specified on the labeling, including any specific labeling instructions for application as an excess CP product.

The rinsate cannot be added to a CP product mixture if:

- The CP product labeling does not list the rinsate as an acceptable diluent; for example, if the rinsate contains a strongly acidic or alkaline neutralizing agent;
- The rinsate contains strong cleaning agents such as bleach or ammonia, which might harm the plant, animal, or surface to which the CP product will be applied; or
- The rinsate will alter the CP product mixture and make it unusable; for example, if the CP products are physically or chemically incompatible.

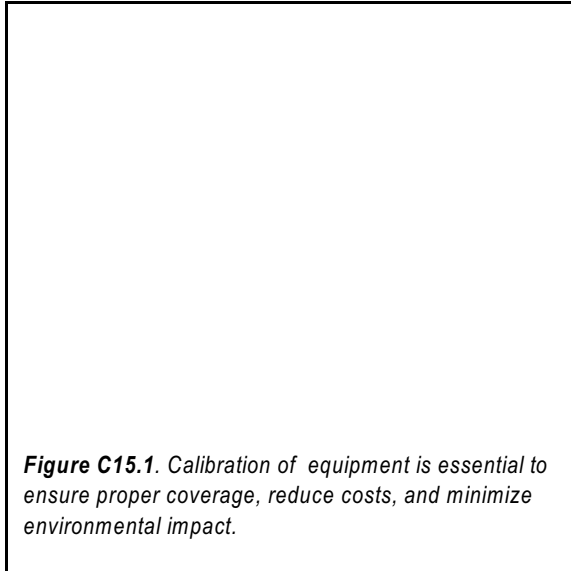
References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- SM-57. Building Plans and Management Practices for a Permanently-sited Pesticide Storage Facility in Florida.
- SM-59. Basic Pesticide Training.

Adapted from Howard et al., 1998. *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*; and *Basic Pesticide Training*, UF/IFAS publication SM-59.

C15 Application Equipment Calibration and Maintenance

Proper calibration and maintenance of CP product application equipment is essential for minimizing the potential for misapplication of agricultural chemicals.



Calibration is the process of measuring and adjusting equipment performance. Application equipment that must be calibrated includes granule-applying devices; hand, backpack, boom, air-blast and other sprayers; soil fumigation devices; and injection equipment used for chemigation work. Calibration is not difficult. Calibration requires some arithmetic. Consult IFAS publication SM-53 or other publications for details and examples of calibration calculations.

CP product application equipment can deliver the correct amount of CP product to the target site only if it is working correctly. Before you start to calibrate any equipment, first make sure that all components are clean and in good working order.

To accurately calibrate any device, you must be familiar with the machinery. Follow the manufacturer's directions carefully – they usually explain how to adjust the equipment. Pay particular attention to the parts (such as nozzles

and hopper openings) that regulate how much CP product is released. If these parts are clogged, not enough product will be released. If they are worn, too much product will be released. Keep application equipment properly calibrated and in good repair. Correct measurement will keep you in compliance with the label, reduce risks to applicators, farm workers, and the environment, and save you money. Calibrate using clean water and do not calibrate equipment near wells, sinkholes, or surface water bodies. Measure CP products and diluents accurately to avoid improper dosing, preparation of excess or insufficient mixture, or preparing a tank-load of mixture at the wrong strength.

Proper application of CP products will help reduce farm costs and increase profits. Improper application can result in wasted chemicals, marginal pest control, excessive carry-over, or crop damage. As a result, inaccurate application is usually very expensive.

Points to Consider:

- How precise must calibration be?
When you measure nozzle output, calculate application rate, or do other calibration related calculations, the acceptable variation is plus or minus ten percent.
- Speed
For most types of application equipment, the speed at which the equipment moves (or is carried) through the target site is one of the main factors that determines the actual application rate. This means that for most types of application equipment, you must measure actual travel speed in order to correctly calibrate the device. For certain types of granule-applying devices, you do not need to consider actual travel speed when calibrating.
- Uniform Release
If the application equipment has more than one nozzle or hopper, measure the output from each one. This insures that each one is releasing the desired amount of CP product. Always

determine that each nozzle (or hopper) is delivering within $\pm 10\%$ of the amount desired.

- **Calibration Methods**

No matter what calibration method you use, your main goal is always the same: to measure how much CP product the equipment is actually applying to a specific area.

Whenever possible, apply something other than the actual CP product (i.e. plain water) when you make test applications during calibration runs. As a general rule, if the CP product is normally diluted with water, you can use plain water for the test runs. If the CP product is a dust, granule, fumigant, or a liquid diluted with liquid other than water; it is generally better to use the actual CP product in your test runs. In such cases, always be sure to follow the product's label directions for proper handling during mixing and loading. Begin calibration runs at lower equipment settings and adjust upwards until the correct rate is achieved.

- **Calculate the Actual Application Rate**

The total amount of CP product spray applied, divided by the amount of target area actually covered, is your equipment's actual application rate. If your equipment's actual application rate is not within $\pm 10\%$ of the label rate, then your equipment needs to be calibrated.

- **Check Calibration Often**

Sprayers should be calibrated when new or when nozzles are replaced. Once you have calibrated your equipment, do not assume that it will continue to deliver the same rate forever. Clogging, corrosion, and normal wear will eventually cause the delivery rate to change; the best settings on the best equipment still gradually get out of adjustment. Recalibrate equipment periodically to compensate for wear in pumps, nozzles, and metering systems.

- **Calibrating Sprayers**

To calibrate spray equipment, you must know:

1. The appropriate pump pressure

2. The spray volume needed per unit of area
3. The type of diluents to use (usually water)
4. The type of nozzle tips and strainers
5. Nozzle spacing and height

Most CP products are applied with hydraulic sprayers. Tractor-mounted, pull type, pickup-mounted and self-propelled sprayers are available from numerous manufactures to do all types of spraying.

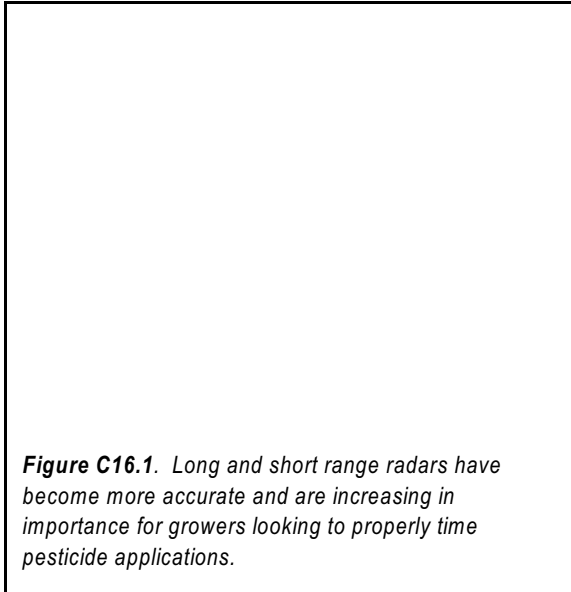
The amount of chemical solution applied per acre depends upon the forward speed, system pressure, size of nozzle, and spacing of nozzles on the boom. A change in any one of these will change the rate of application. Consult the manufacture's operator manual for information on a particular sprayer.

References

- AE-5. The 1/128th of an Acre Calibration Method.
- AE-259. Florida Citrus Pest Management Guide: Pesticide Application Technology - Foliar.
- HS-184. Herbicide Calibration and Application.
- MP-348. Agricultural Aircraft Calibration and Setup for Spraying.
- MP-351. Agricultural Aircraft Spreader Setup.
- PI-23. Broadcast Boom Sprayer Nozzle Uniformity Check.
- PI-24. Broadcast Boom Sprayer Calibration.
- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.
- SM-1. Applying Pesticides Correctly: Guide for Pesticide Applicators.
- SM-2. Aerial Applicator Training Manual.
- SM-3. Aquatic Pest Control Training Manual
- SM-38. Spray Equipment and Calibration.
- SM-41. Aerial Application.
- SM-53. Private Applicator Agricultural Pest Control.
- SM-59. Basic Pesticide Training.
- SM-60. Introduction to Safe Pesticide Handling for Pest Control Technicians: Five Days to Pesticide Safety.
- SM-62. Airblast Sprayer Calibration.
- SM-63. Agricultural Tree Crop Pest Control.

C16 Environmental Conditions & Timing for Application of Crop Protection Products

Time CP product applications in relation to current soil moisture, anticipated weather conditions, and irrigation schedule to achieve greatest efficiency and reduce potential for offsite transport. Do not apply CP products when rain and high-velocity winds are expected.



For weather information

- Florida Automated Weather Network <http://fawn.ifas.ufl.edu/>
- National Oceanic and Atmospheric Administration www.NOAA.gov
- National Oceanic and Atmospheric Administration <http://weather.noaa.gov/>
- The Weather Channel: www.weather.com

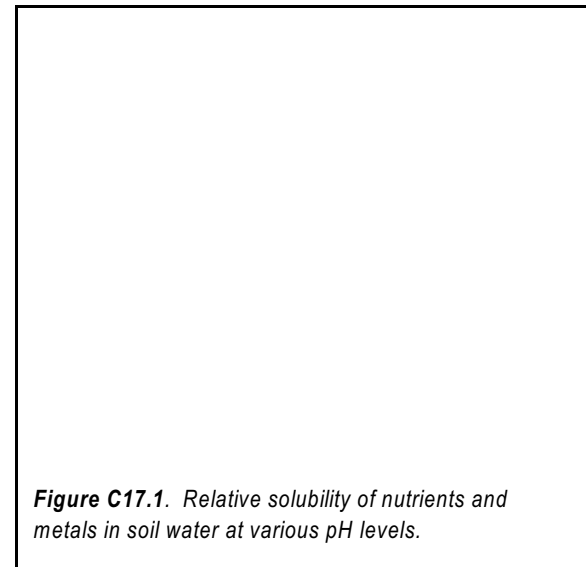
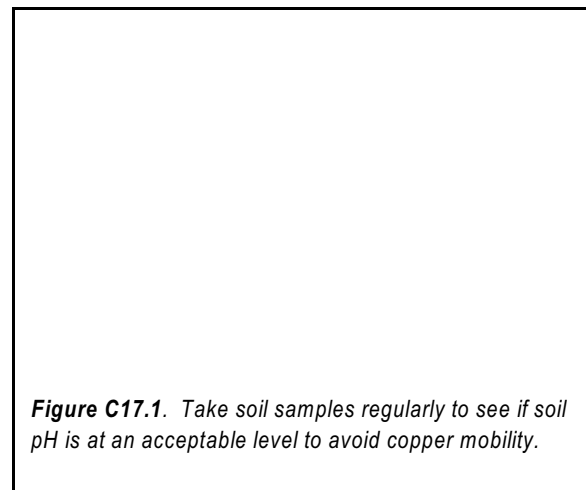
References

- RF-WQ-108. Best Management Practices to Protect Groundwater from Agricultural Pesticides.

C17 Maintain Soil pH to Avoid Mobility of Copper

Where tests indicate excessive copper in the soil, the soil pH should be maintained at a level to reduce surplus copper mobility in the soil.

A soil pH in the moderate to highly-acidic range can solubilize soil Cu, which is toxic to plants. As little as 1 ppm Cu in the soil solution can kill roots. Maintaining soil pH close to neutrality (pH 7.0) is recommended to reduce Cu toxicity and solubility in water. Many metals, including Cu, are more soluble in water at more acidic pH levels.

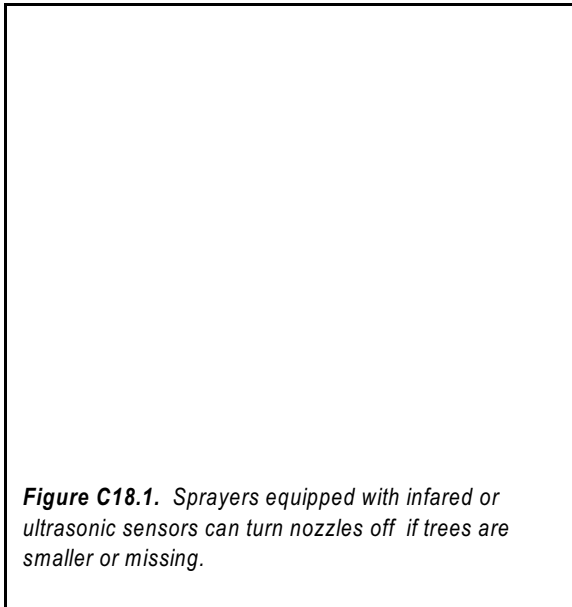


References

- SP-169. Nutrition of Florida Citrus Trees

C18 Precision Application of CP Products

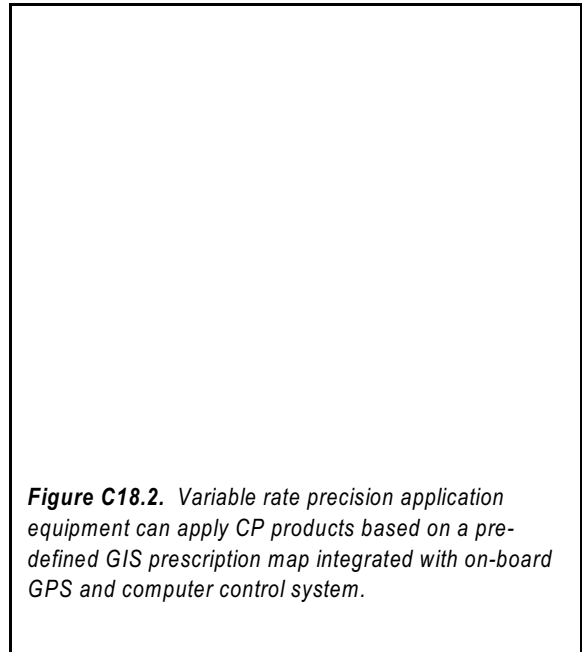
Use precision applications of reduced amounts of material to smaller trees in order to minimize application of CP products to non-target areas and result in more efficient utilization of applied materials. The method of CP product application, such as ground or aerial spraying, wicking, granules, etc., is important since the degree of drift and volatilization can vary considerably.



Some “intelligent “ spraying systems are equipped with three-dimensional range sensors that can map the image of a tree up to 100 ft away on either side of the sprayer. These sensors feed the size, height, and location of the tree into an on-board computer that then turns on spray nozzles inches before the sprayer reaches the tree and turns them off inches past the tree. The nozzles are controlled by electric solenoid valves which are set up in zones so that only the foliage detected by the scanner is sprayed.

Other systems have been developed that utilize sonar for detecting foliage. These systems utilize ultrasonic impulses to detect the presence or absence of trees and plants. Sensors are installed on each side of the sprayer that may be aimed in any desired direction to cover optimal zones. The

number of sensors can vary depending on the diversity of tree sizes within the grove.



References

- AE-259. Florida Citrus Pest Management Guide: Pesticide Application Technology - Foliar.
- HS-140. Sensor-controlled Spray Systems for Florida Citrus.
- Stover et al., 2003a. Pesticide Spray Reduction from Use of a Sensor-actuated Spray System in Indian River Grapefruit.
- Stover et al. 2002b. Influence of Spray Volume, Ground Speed, and Sensor-actuated Spray Manifolds on Pest Control in Fresh Grapefruit.

C19. Crop Protection Product Use Record Keeping

The Florida pesticide law requires certified applicators to keep records of all restricted use pesticide (RUP). The federal Worker Protection Standard (WPS) requires employers to inform employees of all pesticides applied. Maintain accurate CP product records to meet legal responsibilities and to document production methods.

CP product record keeping requires you to have current knowledge concerning the application of CP product materials within your area of influence. In addition, Florida law requires that you record the following items to comply with the restricted use pesticide record-keeping requirement:

- Brand or product name
- EPA registration number
- Total amount applied
- Location of application site
- Size of area treated
- Crop / variety / target site
- Month / day / year of application
- Name and license number of applicator (If applicator is not licensed, record his/her name and the supervisor's name and license number.)
- Method of application
- Name of person authorizing the application, if the licensed applicator does not own or lease the property

Florida regulations require that information on RUPs be recorded within two working days of the application and be maintained for two years from the application date. The Worker Protection Standard (WPS) requires information on all CP products to be recorded and posted when a CP product is about to be applied or has recently been applied. WPS requires that records be made available for 30 days after an expired Restricted Entry Interval (REI).

Required records must be made available upon request to FDACS representatives, USDA authorized representatives, and licensed health care professionals.

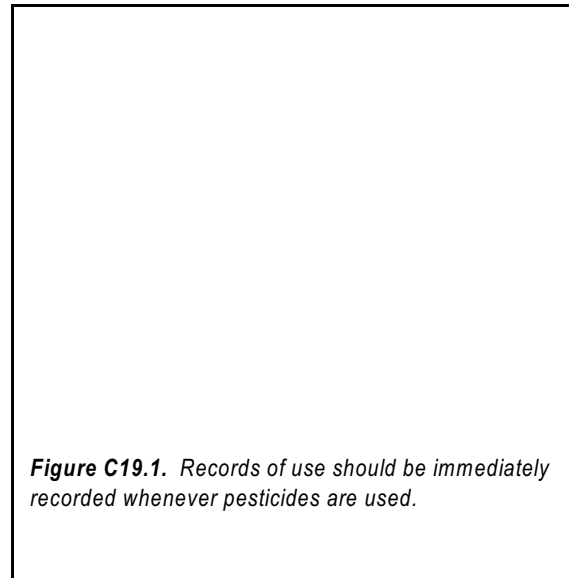


Figure C19.1. Records of use should be immediately recorded whenever pesticides are used.

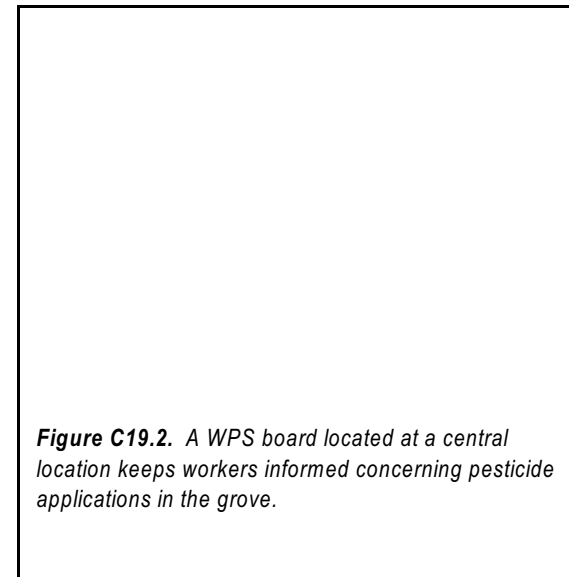


Figure C19.2. A WPS board located at a central location keeps workers informed concerning pesticide applications in the grove.

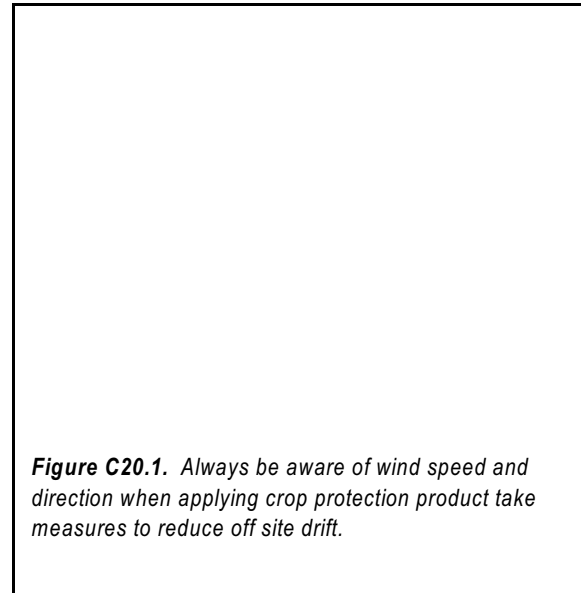
References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- Sm-63. Ag Tree Crop Pest Control.

Adapted from Howard et al., 1998. *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*

C20 Reduce Spray Drift and Off-Target Deposition

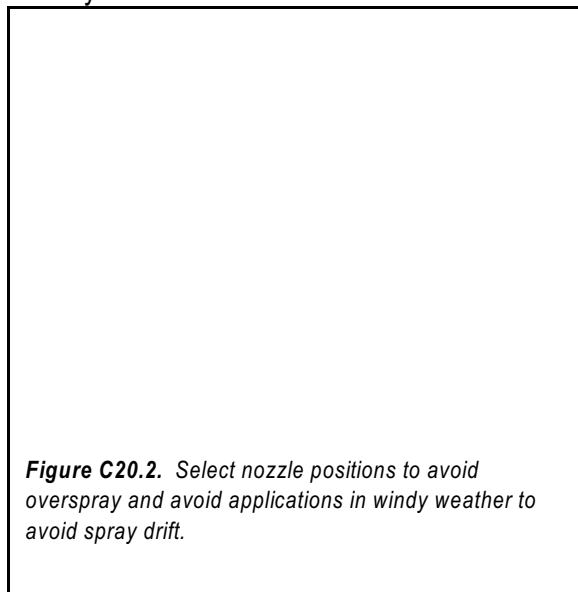
Reduce the potential for drift through appropriate selection of nozzles, spray pressure, and application methods/techniques for the formulation applied. Make applications when the wind is blowing away from any highly sensitive non-target areas.



- Use nozzles that produce as large of a droplet size as possible while yielding adequate plant coverage and pest control. Large nozzle orifices and low spray pressure create a large droplet size. It may be necessary to apply higher than normal amounts of diluted spray per acre when using large droplets to avoid drift and to achieve adequate coverage.
- Do not make applications during temperature inversions. An inversion is a stable atmospheric condition characterized by an increase in air temperature with an increase in height above the ground until at some height a barrier of cold air is met. Use a column of smoke near the application site to check for an inversion. The smoke will rise to the level of the cold air barrier and will then move laterally below it.
- Make applications when the wind is blowing away from highly sensitive nontarget areas and the wind velocity should range between 3 to 10 mph.

Extremely low winds are avoided because they indicate inversion conditions and winds above 10 mph are avoided because relatively large droplets can be transported into neighboring fields and sensitive areas.

- Leave a buffer zone according to the crop protection label between the treated field and any particularly sensitive areas. Buffer zones will avoid contamination of neighboring areas by the displacement of relatively large spray droplets. However, buffer zones will not effectively eliminate low-level contamination of distant areas by the small droplets formed by all commercially available nozzles.
- The nozzles must provide adequate coverage and pest control while minimizing small, drift-prone droplets. Request a droplet spectrum data sheet from the manufacturer that contains information about the percentage of the droplets that are smaller than 150 μm (micrometers). Use nozzles with the smallest portion below this size.
- Use the lowest pressure possible that will give adequate coverage and control to limit the number of drift-prone droplets.
- Make the application at the minimum height that provides a uniform spray pattern.
- Spray early in the morning, late in the evening, or at night, whenever possible, to avoid killing honey bees.



Recommendations for Aerial Applications

- Orient the nozzles straight back to minimize small droplet formation due to wind shear.
- Limit the boom length to 75% of the wingspan of the aircraft in order to prevent small droplets from becoming entrained in the wing tip vortices and contributing to drift problems.
- Limit aircraft speed when applying chemicals to which crops in neighboring nontarget fields are particularly sensitive. Modern turbine powered aircraft capable of flying in the 150 to 160 mph range will create more small drift-prone droplets at these speeds.
- Dress the ends of a field with a couple of passes, so that the sprayer does not have to be turned on before the aircraft is level at the beginning of a pass or left on after pulling up at the end of a pass.
- If a customer wants a field treated “now” when conditions indicate a high potential for a drift problem, explain to the customer why it would be unwise to make the application under the existing conditions.
- Clear-water rinse over the field being sprayed, not over the air strip.

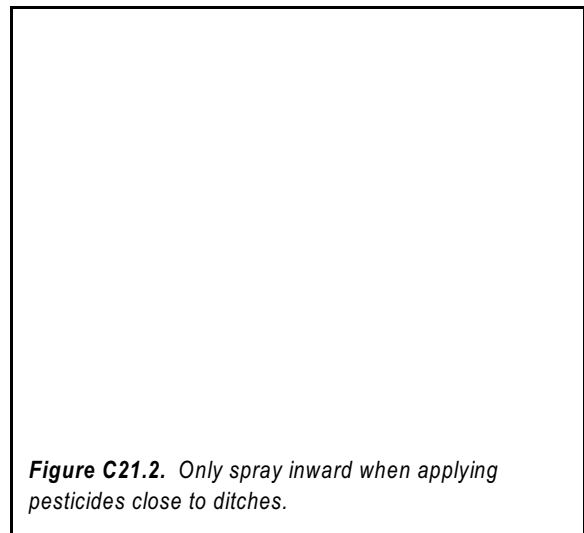
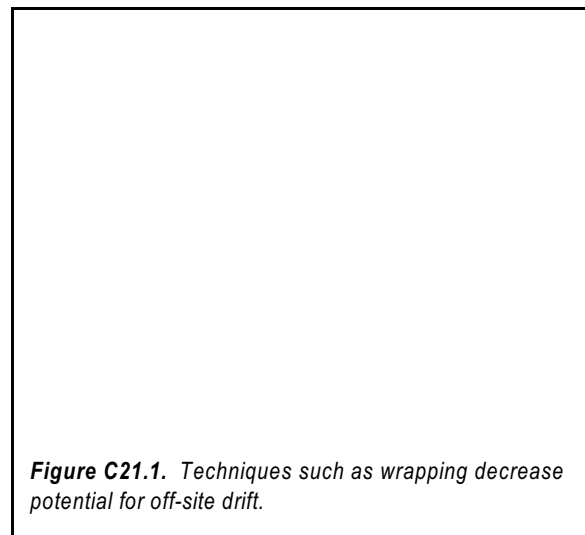
References

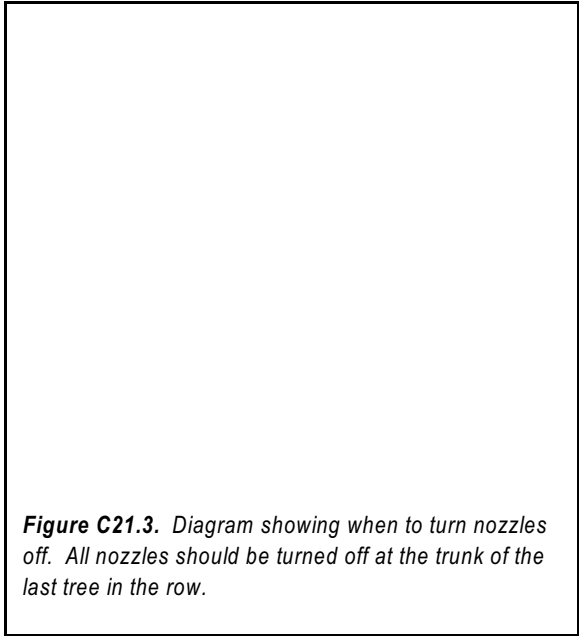
- Circ. 1105. Agricultural Chemical Drift and its Control
- E948. Aerial Pesticides Drift Management: Ok Cooperative Extension Service.
- HS-127. Spray Applications to Citrus: Survey of Current Practices in the Indian River Area.
- HS-128. Spray Applications to Citrus: Overview of Factors Influencing Spraying Efficacy and Off-target Deposition.
- SM-41. Aerial Application.
- SP-43. Florida Citrus Pest Management Guide.
- Stover, E., Scotto, D., Wilson, C., Salyani, M. 2003b. Pesticide Spraying in Indian River Grapefruit: li. Overview of Factors Influencing Spray Efficacy and Off-target Deposition.
- Stover et al., 2002a. Pesticide Spraying in Indian River Grapefruit: I. Survey of Current Practices.

C21 Turn Sprayer Nozzles Off at Row Ends

Turn sprayer nozzles off at the trunk of the last tree within rows. The end trees can be sprayed by making a final pass around the outside perimeter with only the inside nozzles turned on (wrapping).

This practice prevents over-spray of non-target areas such as surface water within drainage ditches and canals. Some CP product labels may be more restrictive. Always consult the label before applying a CP product.





C22 Consider Integrated Pest Management Decisions in the Context of Broader Production BMPs.

Interaction of IPM strategies and tactics with other cultural operations and management actions is essential to achieve the desired goals of IPM while not interfering with other operations. Due to risks of human exposure to CP products, IPM should be planned in accordance with other grove activities involving presence of workers, contact with plant tissues, etc. Efficiency and profitability in citrus production can only be obtained if IPM goals are consistent with broader production and marketing goals and budget realities.

NUTRIENT MANAGEMENT

| | Page |
|--|------|
| D0. Purpose | D-1 |
| D1. Education | D-2 |
| D2. Nutrient Management | D-3 |
| D3. Utilization of Waste Resources | D-4 |
| D4. Employ Tissue and Soil Analyses | D-5 |
| D5. Use Appropriate Application Equipment | D-11 |
| D6. Equipment Calibration/Maintenance ... | D-13 |
| D7. Apply Materials to Target Sites | D-14 |
| D8. Avoid High Risk Applications | D 14 |
| D9. Fertilizer Storage | D-15 |
| D10. Spilled Fertilizer | D-15 |
| D11. Use Caution When Loading Near Ditches, Canals, and Wells | D-16 |
| D12. Alternate Loading Operation Sites | D-16 |
| D13. Use Backflow Prevention Devices | D-17 |
| D14. Split Applications Throughout Season | D-18 |
| D15. Erosion Control | D-18 |
| D16. Irrigation Management | D-19 |
| D17. Incorporate Organic Materials | D-19 |
| D18. Well Protection | D-20 |
| D19. Use Appropriate Sources and Formulations | D-21 |
| D20. Salinity | D-23 |
| D21. Conservation Buffers and Setbacks . | D-25 |

D0. Purpose

Good nutrient management is an integral part of a system of agricultural practices that help conserve and protect natural resources. In fact, water and nutrients are oftentimes linked, and the Florida citrus industry has made great strides in converting many existing groves to low volume irrigation systems. These conversions allow more precise nutrient management via the use of fertigation. As such, implementing appropriate nutrient management practices helps maintain or improve agricultural productivity while minimizing environmental risk.

Management of nitrogen and phosphorus levels, in particular, is essential in maintaining healthy surface water bodies and natural systems in the Peace River Basin and Charlotte Harbor. These nutrients originate from a variety of land uses, including: agricultural, urban, suburban, and natural areas. Excess nutrients stimulate algal blooms and growth of noxious plants in receiving water bodies and wetlands. This stimulation of growth may eventually result in reduced dissolved oxygen concentrations due to excessive decomposition of plant material. Moreover, lower dissolved oxygen concentrations may stress desirable game fish, and promote less desirable fish species.

Nitrogen and phosphorus are two of the essential elements for plant and animal growth and are necessary to maintain profitable crop and livestock production. They can also increase the biological productivity of surface waters by accelerating eutrophication, the natural aging of lakes or streams brought on by nutrient enrichment. Although eutrophication is a natural process, it can be accelerated by changes in the land use of a watershed that increase the amount of nutrients added to an aquatic system (Fig. D0.1). Nitrogen and phosphorus both affect eutrophication, but phosphorus is the critical element in most fresh water systems.

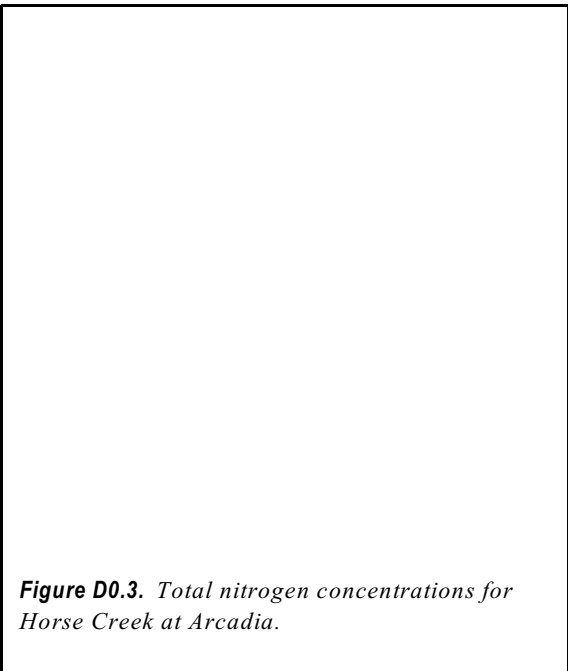
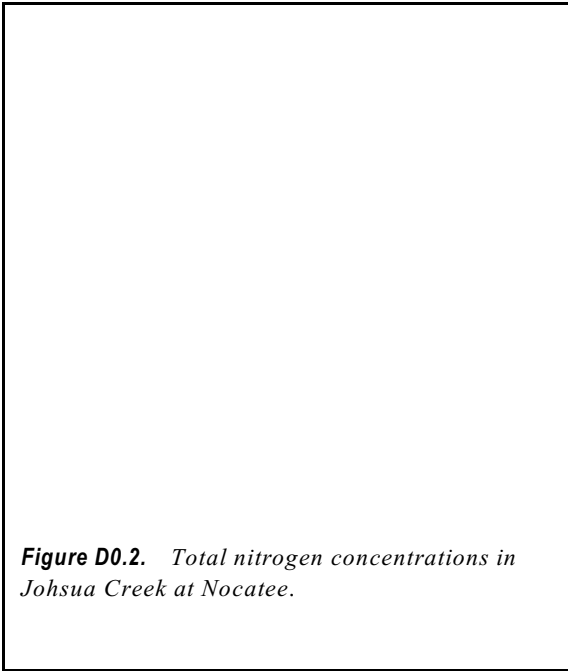
Where water salinity increases, as in estuaries, nitrogen generally controls aquatic plant growth. Complicating the problem is the fact that eutrophication sometimes occurs many miles from where high-nutrient runoff originally enters the surface water system. By the time the water quality effects are noticeable (sometimes years to decades after the runoff occurs), remedial strategies can be difficult and expensive to implement. This is why source control of nutrients used in fertilization programs is so important.



Historical analytical records indicate that concentrations of phosphorus are considerably higher than the median value, while nitrogen concentrations can be higher than median values in the Peace River and Charlotte Harbor for Florida's streams and estuaries. Various ecological parameters, such as the Trophic State Index, are typically used to characterize biological productivity in water bodies. By definition, these values are scale of numbers ranging from 1 to 100 that can be used to indicate the relative trophic state of a water body.

In general, values are within the "good" range in all parts of the Harbor itself, with the best water quality found in the lower portions of the Harbor. Values from stations located in the estuarine portions of the Peace River and Myakka River are mostly in the "fair" range, although values from the Peace River at US Highway 41 oftentimes border on the "poor" category. Values in the middle and upper Peace River range between "fair" and "poor", with Lake Hancock, in the headwaters of the Peace River, being one of the most polluted lakes in Florida.

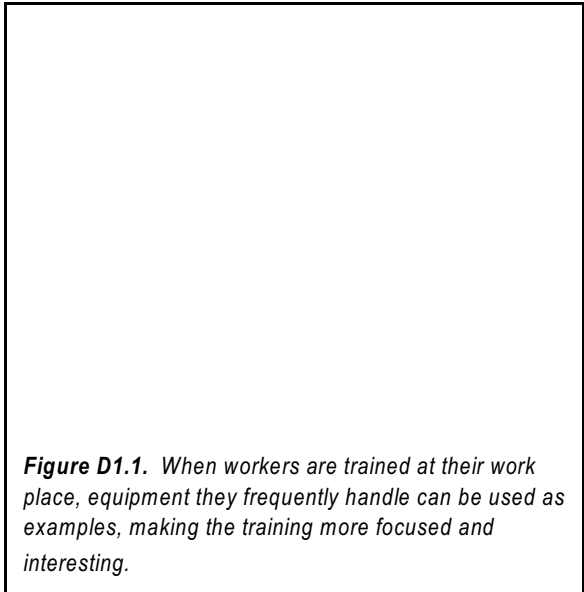
In addition to Lake Hancock, other tributaries to the Peace River can also be significant sources of nitrogen loads to Charlotte Harbor. For example, Joshua Creek, which comprises nearly 6% of the gauged watershed of the Peace River, was responsible for 12.9% and 12.8% of the total nitrogen load from the Peace River watershed in Water Years 2000 and 2001, respectively. In addition, Shell Creek was a disproportionately high source of nitrogen loads during Water Years 2000 and 2001. In contrast to most of the Peace River, nitrogen concentrations in Joshua Creek appear to be elevated in recent years and mostly higher than the median value for Florida streams of 1.2 mg/l (or ppm) Total Nitrogen (Fig. D0.2 compared to Fig. D0.3).



D1. Education

Proper training of the field operators responsible for handling, loading, and operating fertilizer spreading equipment, and for correct maintenance of field equipment can help achieve desired placement of fertilizers, avoid waste, and prevent contamination of open waters.

Re-enforce training with checklists of critical operating points before application of materials. Confirm that each assigned employee is adequately informed about machine operation, rates of discharge, and intended zone of nutrient placement that focuses on “feeding the tree.”



References

- Code 590. NRCS Conservation Practice Standard, Nutrient Management.
- Code 633. Conservation Practice Standard, Waste Utilization.
- SP-28. Fertilizer Management – Key to a Sound Water Quality Program.
- SP-169. Nutrition of Florida Citrus Trees.

D2. Nutrient Management

Develop a nutrient management plan based upon soil, water, plant and organic material sample analyses and expected crop yields.

USDA-NRCS routinely develops nutrient management plans, and requires them for practices that receive cost-share benefits. Nutrient management is: management of the amount, source, placement, form, and timing of the application of nutrients and soil amendments to ensure adequate soil fertility for plant production and to minimize the potential for environmental degradation, particularly water quality impairment.

General Criteria

1. Nutrient Management Plans should include the following components, as applicable:
 - Aerial site photographs or maps and a soil map.
 - Current and/or planned production sequence.
 - Soil test results and recommended nutrient application rates.
 - Plant tissue test results, when used for nutrient management.
 - A complete nutrient budget for nitrogen, phosphorus, and potassium for the production system.
 - Realistic yield goals and a description of how they were determined.
 - Quantification of all important nutrient sources (this could include but not be limited to commercial fertilizer, animal manure and other organic byproducts, irrigation water, etc.).
 - Planned rates, methods, and timing (month & year) of nutrient application.
 - Location of designated sensitive areas or resources (if present on the conservation management unit).
 - Guidance for implementation, operation, maintenance, and record keeping.
2. Maximum single application rates of nutrients will be determined based on optimum level of production, producer's goals, soil limitations, site factors, and off-site transport potential.

3. Additional conservation practices that keep nutrients in the soil and root zone area should be planned in environmentally sensitive areas.

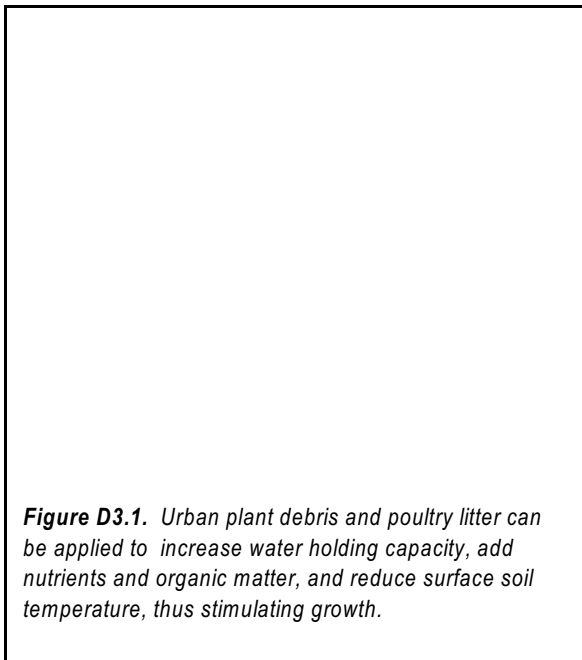
Environmentally sensitive areas include, but are not limited to: wetlands, sink holes, wells, mixing sites, karst areas, soils with excessive permeability, and areas that drain into state or federal nutrient restricted areas.

Considerations

1. A nutrient budget worksheet (FL 590-JS) including an estimate of residual amounts present in the soil and in residues of previous crops, along with any organic waste additions, can determine crop nutrient requirements.
2. Realistic yield goals should be set based on soil type, crop variety, tree age and condition, tree density, historical yield data, climatic conditions, and fertilizer costs versus returns.
3. The form of fertilizer and its timing, placement, and method of application can be planned to conform to seasonal variations in nutrient uptake throughout crop development.
4. Consider effects of the seasonal water budget on nutrient balance and on the potential loss by surface runoff or leaching into ground water.
5. Evaluate water quality standards and designated use limitations that exist locally or statewide.
6. Avoid excessive or luxury levels of N, P, and K in the soil to reduce the potential for induced deficiencies of micronutrients.
7. Maintain proper soil pH to provide optimum availability of applied nutrients.
8. Use appropriate application methods and fertilizer formulations that minimize nutrient losses.
9. In high water table soils, water table management will affect the availability and movement of nutrients.
10. Proper calibration and use of equipment will improve nutrient material application efficiency and will reduce undesirable over-applications.
11. Avoid same-place loading/transfer sites to preclude excess contamination of soils in working areas.

D3. Nutrient Management and Utilization of Waste Resources

Use of animal waste and other waste products on land in an environmentally acceptable manner can be helpful in maintaining or improving soil, air, plant, and water resources.



Wastes include those from farm, feedlot, and dairy operations, municipal waste treatment plants, and agricultural processing plants.

General Criteria

1. Compliance with Federal, state and local laws is required for all utilization of wastes including liquid, slurry, and solid waste.
2. Waste application should be accomplished in a manner (timing and rate) such that runoff from the application area will not occur due to the application method used.
3. Application of wastes should comply with Florida NRCS Conservation Practice Standard, Nutrient Management (Code 590).
4. Waste should be applied based on the most limiting nutrient or metal.
5. Specific conditions for land application of domestic wastewater residuals are contained in the Florida Department of Environmental Protection (FDEP) Rule, Chapter 62-640 Florida Administrative Code

(F.A.C.).

6. The soil-limiting nutrient (either N or P) for waste application should be based on the Phosphorus Index calculation (see references for publications showing how the Phosphorus Index is calculated). The following ranks:

< 75: LOW potential for P movement from the site. Waste materials can be applied at rates based on the crop N requirement.

75–150: MEDIUM potential for P movement from this site. Nitrogen-based waste application rates are satisfactory for this site when conservation measures are taken to lessen the probability of P loss.

151–225: HIGH potential for P movement from the site and for an adverse impact on surface waters to occur. Soil and water conservation and P management practices are necessary (if practical) to reduce the risk of P movement and water quality degradation. If risk cannot be reduced, then waste application rates will be P-based.

>225: VERY HIGH potential for P movement from the site and for an adverse impact on surface waters. Waste materials will be applied at rates based on the crop P requirement.

7. Crop nutrient removal rates should be based on realistic yields. Crop removal rates can be obtained from Agricultural Waste Management Field Handbook (AWMFH) or from the Institute of Food and Agricultural Sciences (IFAS).
8. Waste application setbacks shall be increased from surface water bodies, wells, sink holes, or fractures. Setbacks should be based on criteria for effective filter strips as contained in Florida NRCS Conservation Practice Standard, Filter Strip (Code 393).
9. Content of waste should be analyzed for nutrient and metal content.

Considerations

- Supplemental fertilizer may be needed to meet the needs of the crop at various stages of plant growth.
- Apply wastewater with no more than 1,000 ppm total dissolved solids (TDS) to prevent leaf burn. This corresponds to an approximate specific conductance of 1,500 micromhos (umhos/cm) per centimeter. Please note that use of wastewater with this high of conductance could accumulate salts and nutrients into drainage systems, and possibly affect downstream receiving water bodies. These same water bodies may have specific water quality standards or Total Maximum Daily Loads (TMDL) that could be violated through the introduction of high TDS concentrations.

Adapted from *Natural Resources Conservation Service Conservation Practice Standard for Waste Utilization*, Code 633.

References:

- SP-169. Nutrition of Florida Citrus Trees.
- Circ. 1322. UF/IFAS Nutrient Management Series: Computational Tools for Field Implementation of the Florida Phosphorus Index - Charlotte County Florida.
- Code 590. NRCS Conservation Practice Standard, Nutrient Management.
- Code 633. NRCS Conservation Practice Standard, Waste Utilization.
- NRCS Phosphorus Index Assessment Tool web site: <http://www.nrcs.usda.gov/technical/ecs/nutrient/pindex.html>
- SP-28, Fertilizer Management – Key to a Sound Water Quality Program.
- SL-129. UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops.
- SS-385. UF/IFAS Nutrient Management Series: Computational Tools for Field Implementation of the Florida Phosphorus Index - Desoto County Florida.
- SS-380. UF/IFAS Nutrient Management Series: Computational Tools for Field Implementation of the Florida Phosphorus Index - Manatee County Florida.
- SS-384. UF/IFAS Nutrient Management Series: Computational Tools for Field Implementation of the Florida Phosphorus Index - Hardee County Florida.
- SS-381. UF/IFAS Nutrient Management Series: Computational Tools for Field Implementation of the Florida Phosphorus Index - Sarasota County Florida.

D4. Employ Tissue and Soil Analyses

Fertilizer applications based on leaf tissue and soil tests will help avoid over-fertilization and subsequent losses of nutrients in runoff water.

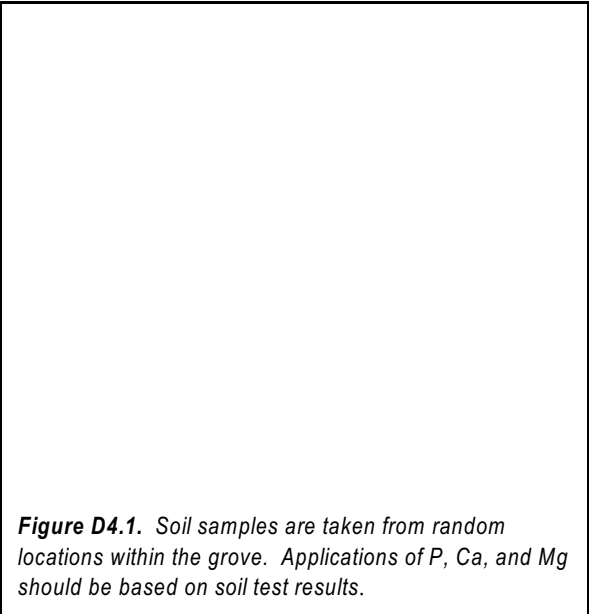


Figure D4.1. Soil samples are taken from random locations within the grove. Applications of P, Ca, and Mg should be based on soil test results.

Application of mobile elements such as N (nitrogen) and K (potassium) should be made on the basis of leaf tissue analysis and production levels instead of routine applications. Applications of less mobile elements such as Ca (calcium), Mg (magnesium), and P (phosphorus) should be based on soil testing and leaf analysis, instead of regular applications of specific amounts. The comparison of both types of testing will give production standards for applications which are based on plant need and response, rather than routine applications of standard amounts. Proper fertilization results in high yields and minimal environmental effects.

Tissue Analysis

Because citrus is a perennial crop, it is its own best indicator of appropriate fertilization. The composition of plant tissue reflects tree health and productive potential supported by prior fertilization and production practices. For this reason, tissue sampling is a useful management tool for fertilizer decisions. Considerable research involving tissue testing of citrus has established the reliability of this method.

Leaf analysis, in all its stages from sampling to interpretation of results and developing the nutritional program is a relatively complicated and costly procedure. Sampling guidelines should be followed precisely to insure that analytical results are meaningful. Interpretation of analytical results and development of nutrient recommendations should be made by those trained in horticulture, or in consultation with them.

The best indicators of appropriate fertilizer management practices for citrus are leaf nutritional

levels. Leaf concentrations should be within the optimum ranges listed in Table D4.1. These leaf analysis standards (first published in 1954) are based on long-term, well-designed field fertilizer experiments and are accepted throughout the world. The ranges have been modified very little over the years in spite of many fertilizer studies conducted in different countries with different citrus varieties, rootstocks, and management practices. Leaf analysis provides the best available guideline for managing citrus nutritional programs when leaves have been properly sampled, handled, processed, and analyzed.

Table D4.1. Guidelines for interpretation of leaf analysis based on 4-to-6-month-old spring flush leaves from non-fruiting terminals.

| Element | Deficient | Low | Optimum | High | Excess |
|--------------------------|-----------|-----------|------------------|-----------|--------------------|
| N (%)¹ | <2.2 | 2.2-2.4 | 2.5-2.7 | 2.8-3.0 | >3.0 |
| P (%) | <0.09 | 0.09-0.11 | 0.12-0.16 | 0.17-0.30 | >0.30 |
| K (%) | <0.7 | 0.7-1.1 | 1.2-1.7 | 1.8-2.4 | >2.4 |
| Ca (%) | <1.5 | 1.5-2.9 | 3.0-4.9 | 5.0-7.0 | >7.0 |
| Mg (%) | <0.20 | 0.20-0.29 | 0.30-0.49 | 0.50-0.70 | >0.70 |
| Cl (%) | - | - | <0.2 | 0.20-0.70 | >0.70 ² |
| Na (%) | - | - | - | 0.15-0.25 | >0.25 |
| Mn (ppm) | <17 | 18-24 | 25-100 | 101-300 | >300 |
| Zn (ppm) | <17 | 18-24 | 25-100 | 10-300 | >300 |
| Cu (ppm) | <3 | 3-4 | 5-16 | 17-20 | >20 |
| Fe (ppm) | <35 | 35-59 | 60-120 | 121-200 | >200 |
| B (ppm) | <20 | 20-35 | 36-100 | 101-200 | >200 |
| Mo (ppm) | <0.05 | 0.06-0.09 | 0.10-1.0 | 2.0-5.0 | >5.0 |

¹Percent concentration x 10,000 = ppm.

²Leaf burn and defoliation can occur at Cl concentration of > 0.5%.

Adapted from SP-169, *Nutrition of Florida Citrus Trees*, 1995

Tissue Sampling Methodology

In addition to assisting with diagnostic problems within the grove, tissue sampling can serve as an excellent growth and yield monitoring tool. Tissue collected on an annual basis will provide information about nutritional trends with time.

- Selection of management units.

The sample must represent the portion of the grove from which it was collected. This source of error can be controlled by grouping like areas of variety, tree age, and soil into units of the grove that receive the same management practices.

- Leaf sample collection.

Leaf samples should be collected from within the management unit (or indicator block) by randomly picking 15 to 20 trees. Four-to-six-month old spring flush leaves should be taken from non-fruiting twigs. The age of the leaf influences the concentration of mineral elements as shown in Fig. D4.2.

The concentration of most macronutrients remains stable between 4 to 6 months following leaf emergence. Therefore, this stage of growth should be chosen for sampling the leaves for evaluation of mineral contents. The critical limits of various mineral elements shown in Table D4.1 are based on the analysis of leaves at this maturity stage. A representative sample should consist of at least 100 leaves, or about 6 leaves per tree.

- Sampling time.

Sampling spring-flush leaves on an annual schedule between July and September will ensure obtaining leaves of the correct age. Soil samples should also be collected around the same trees from which leaves are gathered.

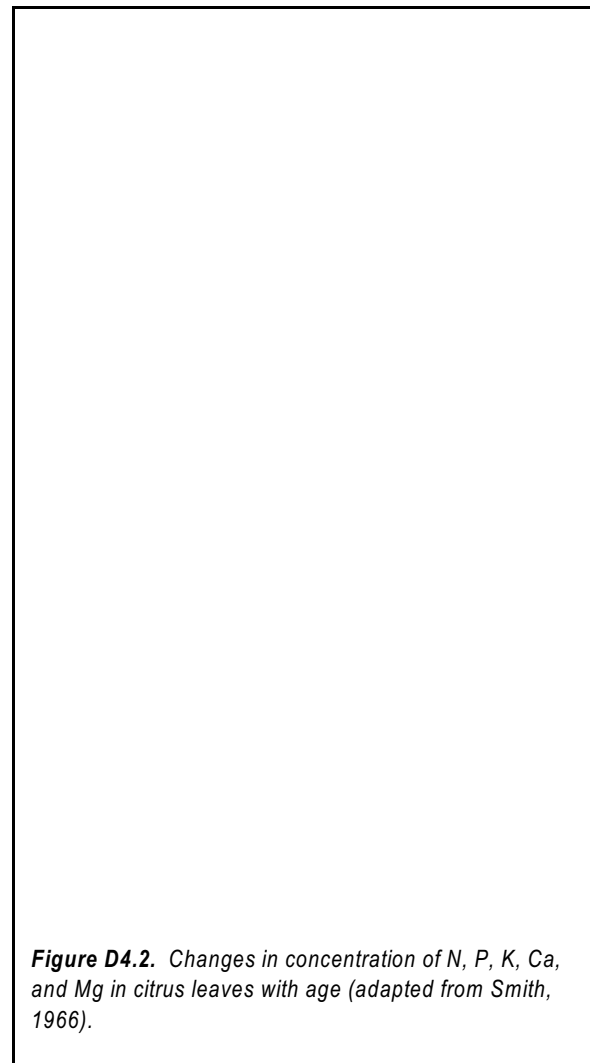
- Leaf contamination.

Leaves that have been recently sprayed with micronutrients for fungicidal or nutritional purposes should not be used for micronutrient analysis. Washing recently unsprayed, fresh leaves to remove soil and dust particles is

recommended prior to analysis.

Interpretation of Results

Data in Table D4.1 show the most current interpretation of citrus leaf tissue analyses. If annual test results are found to be in the deficient or low categories, an increase in annual fertilization for that nutrient is recommended. Alternately, if test results fall within the high or excessive ranges, the annual fertilization for that nutrient should be adjusted downward. If a change in fertilization is indicated, the adjustment should be reasonable. The intent is to find the correct nutrient management level that maintains leaf tissue in an optimum range, but does not lead to over fertilization and possible adverse environmental and economic results.



Soil Analysis

Another management tool which links crop nutrient requirements to nutrient recommendations is a calibrated soil test. A soil test is said to be calibrated when a relationship has been demonstrated between extractable soil-test values and a positive crop response.

Unfortunately, soil test calibration research costly and most effective on short term crops such as vegetables or agronomic crops. Calibration of soil-test extractant for citrus has not been completed. Work on citrus fertilization has demonstrated a relationship between soil-extractable P and citrus fruit production. Citrus is a perennial crop with a root system extending below typical soil sampling depths. Soil testing methodology was developed for short-term, shallow-rooted crops. Thus, immobile nutrients like P can be expected to be calibrated better to citrus response than K, which is relatively mobile in Florida soils.

Soil Sampling Methodology

Soil sampling should be based upon the same management unit concept described for tissue sampling. This process helps to minimize errors by grouping similar tree and soil types. Additionally, annual sampling may be completed at the same time as tissue collection (July through September). Sampling at this time will reduce the sampling effort and provide information for fall fertilization decisions.

As with tissue sampling, 15 to 20 trees should be randomly selected from within the management unit or indicator block. One 6-inch deep core, about 1 inch in diameter, should be taken within the irrigated zone close to the dripline of each sampled tree. Each core should be placed into a plastic bucket and thoroughly mixed with other cores from that unit or block. A small sample taken from this composite sample should be air-dried prior to shipping to a soil testing laboratory.

- Sampling the effect of irrigation.
Irrigation water originating from aquifers in

Florida is often quite high in carbonates, effectively liming the wetted zone. For this reason, an additional (separate) soil sample from the 0- to 6-inch depth may be taken every 2 years from outside the wetted zone for determining soil pH and available Ca content. Soil pH values between the wetted and unwetted zones can differ by as much as 1-2 units.

- Sampling newly formed flatwoods beds.
When beds are formed in flatwoods soils, soil layers are mixed and inverted, resulting in a new surface layer of soil over the original surface. This situation may require sampling at 2 or more depths to aid in making informed decisions concerning fertilization and liming. Such sampling is probably only needed during the establishment phase, and once again early in the production phase.

Interpretation of Results

The interpretation scale for a variety of crops for the double acid (Mehlich- 1) extractant used by the University of Florida, IFAS, Extension Soil Testing Laboratory is presented in Table D4.2. Ammonium acetate (pH 4.8 and 7.0; example, Table D4.3) and Bray P1 are other extractants used by commercial soil-testing laboratories. The Bray P1 extracts considerably more P than does the Mehlich-1. Because the different extractants yield data that are not identical, growers are advised to utilize the same analytical procedure for comparison of results.

The main value of soil testing is the identification of changes with time rather than basing management decisions on individual test results. If the pH is 6.0 or above and Ca is about 500 lb per acre, liming is not required unless high Cu levels are found. Since the pH of most irrigation water is above 7, soil pH within the wetted pattern tends to increase over time. Therefore, liming programs should be based on pH levels both inside and outside the irrigation zones.

As with tissue analysis, annual soil-test measurements are helpful for making adjustments

in fertilization, especially for P. Changes in extractable K, Ca, and Mg, should be interpreted with caution. If extractable values are in the high and very high ranges, then it is wise to adjust

fertilization downward. However, large changes in fertilization rates should be avoided to preclude making costly errors.

Table D4.2. Interpretation of soil analysis data for citrus using double acid (Mehlich-1) extractant.

| Item | Very Low | Low | Medium | High | Very High |
|------|----------------------------------|-------|------------------|--------|-----------|
| | ----- lb/acre ¹ ----- | | | | |
| P | <20 | 20-30 | 30-60 | 60-120 | >120 |
| K | <40 | 40-70 | 70-120 | 70-250 | >250 |
| Mg | - | <30 | 30-60 | >60 | - |
| Ca | - | - | 500 ² | - | - |

¹Pounds per acre/2 = ppm.

²The University of Florida Extension Soil Testing Laboratory does not interpret extractable Ca. Recent work on young citrus suggests an adequate level of 500 lb per acre.

Table D4.3. Interpretation of soil analysis data for citrus using ammonium acetate (pH = 4.8) extractant (adapted from SP-169, *Nutrition of Florida Citrus Trees*).

| Soil Texture | Element | Rating | | |
|---------------|---------|----------------------------------|---------|------|
| | | Low | Medium | High |
| | | ----- lb/acre ¹ ----- | | |
| Organic | P | <9 | 9-17 | >17 |
| Sandy | P | <7 | 7-15 | >15 |
| Loamy Sands | P | <4 | 4-9 | >9 |
| Sandy Loams | P | <2 | 2-4 | >4 |
| Organic | K | <125 | 125-250 | >250 |
| Mineral Soils | K | <75 | 75- 125 | >125 |

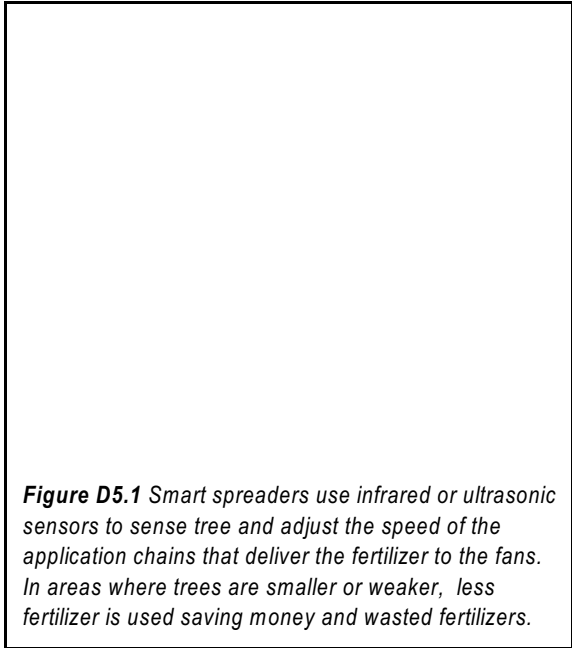
¹Pounds per acre/2 = ppm.

References

- Circ. 1127. Citrus Fertilizer Management on Calcareous Soils.
- SP-169. Nutrition of Florida Citrus Trees.
- SL-185. Effects of P and K Fertilization on Young Citrus Tree Growth.
- SL-186. Managing Phosphorus Fertilization of Citrus Using Soil Testing.

- SL-199. Prioritizing Citrus Nutrient Management Decisions.
- SL-115. Citrus Grove Leaf Tissue and Soil Testing: Sampling, Analysis, and Interpretation.
- SL-193. Common Soils Used for Citrus Production in Florida.

D5. Use Appropriate Application Equipment
Operate machinery as designed so as to achieve precise and desired placement of nutrient materials at specified rates consistent with the form and source of nutrient materials.



Efficient application practices are critical for insuring fertilizer delivery only to target areas, and for reducing losses to leaching and runoff. The following is a list of application techniques for different formulations of fertilizers. Growers may adopt a combination of placement methods exploiting their respective advantages in efficiency and cost. The ultimate goal is to focus on “feeding the tree” by placing nutrients within the root zone of individual trees or drip-line bands along hedgerows of trees. Avoid placement in areas prone to off-site transport of nutrients.

Precision Agriculture

The use of site-specific placement of crop protection materials and fertilizers is increasing within the Florida citrus industry. These new technologies are embraced under the broad heading of precision agriculture.

Precision agriculture applications will apply variable rates of material(s) applied based upon specific site

conditions within a given location. To enable this precise application, systems may be controlled remotely, either via global position units (GPS) utilizing geographical information systems (GIS) or by electronic sensors which sense grove conditions based upon tree size or other conditions which can be measured electronically from the application equipment as it passes through the grove.

When materials are applied using traditional methods (without this new technology), the whole block receives the same amount of products. Small trees, declining trees, and blank areas where trees have been removed all receive the same amount of fertilizer. If application rates are calculated on that required for healthy mature trees, weaker trees and reset trees receive more products than are necessary to achieve maximum economical production.

In contrast, precision application technology can result in significant environmental benefits since specific amounts of crop protection products or fertilizers can be applied based upon soil type, tree age, variety, rootstock, etc. As the non-uniformity of trees in a block increases, the benefits of precision application methods increase compared to traditional methods. These benefits include lower material costs and decreased leaching and runoff of applied materials.

Web-based Resources

Precision AG

<http://www.precisionag.com/>

NESPAL

<http://nepsal.cpes.peachnet.edu/PrecAg/>

<http://www.nal.usda.gov/wqic/preci.html>

Rate Controllers

Mid-Tech: <http://www.mid-tech.com/>

Raven: <http://www.ravenind.com/RavenPrecision/>

Micro-Trak: <http://www.micro-trak.com/>

GPS

Trimble: <http://www.trimble.com/>

Mobile Mapper GPS

<http://products.thalesnavigation.com/en/products/product.asp?PRODID=928>

Accessories

Ram mounts: <http://www.ram-mount.com/>

M & D Spreaders: <http://www.desotomachine.com/>

Chemical Containers: <http://www.chemicalcontainers.com/>

Software

FarmWorks; <http://www.farmworks.com/>

ESRI: <http://www.esri.com/>

Dry Material Spreaders

- Dry material spreaders should be adjusted to place fertilizers over or within the root zone.
- Tree skirts can be pruned to facilitate placement of fertilizers and other agrichemicals such as herbicides.
- Young tree spreaders with manual or electronic discharge devices can deliver rates of fertilizer quite accurately within the root zones of smaller trees so that nutrients are not lost to runoff or to leaching beyond the root zone.
- Equipment to apply and incorporate granular controlled-release products should be evaluated to reduce surface movement of nutrients by rainfall and wind.
- When animal manure is applied, spreading equipment should be designed to place the manure over the root zone.

Fertigation

- Application of liquid fertilizer through irrigation systems (fertigation, Fig. D5.2) enables multiple applications with little added cost, since fertilizing is scheduled with irrigations.
- An additional advantage of fertigation is that it applies nutrients to the wetted areas of the root zone where the most active roots are located. Boom application of liquid or suspension fertilizers also offers this advantage.

● Effective nutrient management using fertigation requires:

1. Systems with high irrigation efficiency,
2. Routine monitoring of all system components including pumps, injection devices, lines, filters, tanks, and emitters;
3. A routine monitoring program of the fertigation process with particular emphasis on start-up and shut-down periods;
4. Calibration and re-checking of injection rates and times frequently to ensure proper operation of the systems;
5. Prevention of leaks, runoff, excess applications, and application to areas near surface water;
6. Flushing of all system components with clean water following each use.

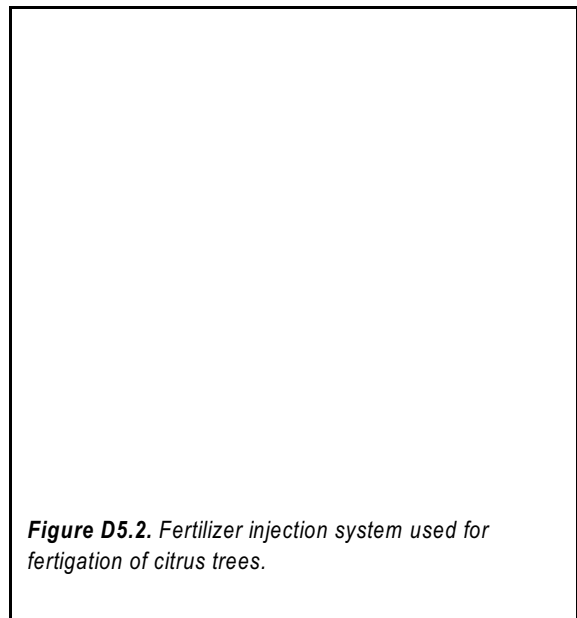


Figure D5.2. Fertilizer injection system used for fertigation of citrus trees.

● During fertigation, it is recommended that the fertilizer solution not increase the specific conductance of the irrigation water by more than 1,500 umhos/cm. This corresponds to an approximate increase in TDS concentration of 1,000 ppm. Fertilizers can cause leaf burn, even if relatively low salinity irrigation water is used. Therefore it is critical to know the specific conductance of the irrigation water prior to the introduction of fertilizers so the combined

concentrations do not cause leaf burn. In addition, the use of fertilizer solutions could accumulate salts and nutrients into drainage systems, and possibly affect downstream receiving water bodies. These same water bodies may have specific water quality standards or Total Maximum Daily Loads (TMDL) that could be violated through the introduction of high TDS concentrations.

- It is preferable to inject small dosages frequently, than to make fewer applications at higher rates.

- Proper and legal backflow prevention devices must be used in the irrigation system to prevent fertilizers from being back-siphoned into the water supply.

Boom Applications

- Boom-applied fertilizers can be placed directly over the root zone and offer the opportunity to apply other agrichemicals such as herbicides, insecticides, and soil fungicides at the same time.

- Liquid fertilizer itself can provide some burn down of weed foliage, thus complementing residual herbicides. However, care should be taken to avoid incompatibility of materials.

- Boom application equipment should be modified to withstand corrosive fertilizer materials.

Aerial Application

- Aerial application of micronutrients and other sprays is an accepted practice, but is not recommended for dry fertilizers.

- Precautions should be taken to prevent drift into surface water bodies and non-target areas.

Adapted from SP-169, *Nutrition of Florida Citrus Trees*

References:

- SP-169. Nutrition of Florida Citrus Trees.
- SM-53. Private Applicator Agricultural Pest Control.
- Miller, W.M 2003. Variable-rate Technologies for Nutrient Replacement.

D6. Equipment Calibration and Maintenance

Proper calibration and maintenance of fertilizer application equipment is essential to avoid misapplication of nutrients.

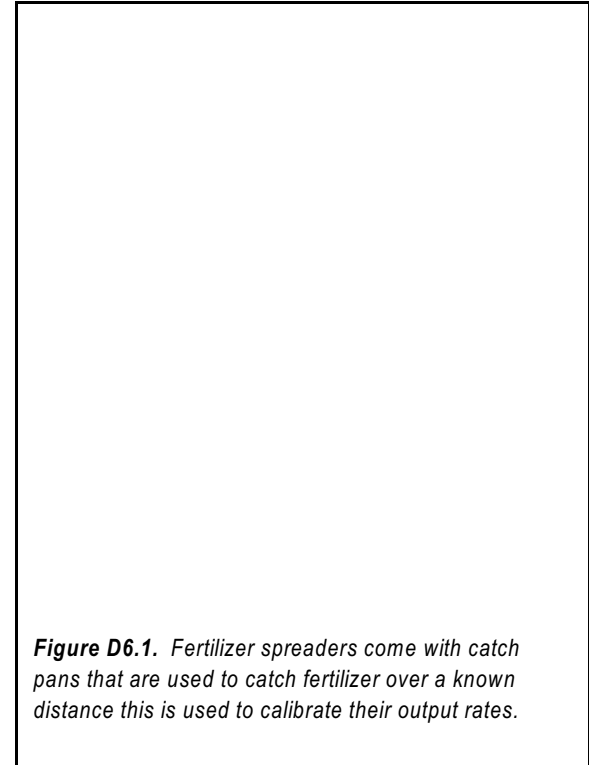


Figure D6.1. Fertilizer spreaders come with catch pans that are used to catch fertilizer over a known distance this is used to calibrate their output rates.

References

- SM-53. Private Applicator Agricultural Pest Control.
- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.

D7. Apply Materials to Target Sites

Place nutrients within the root zone of individual trees or drip-line bands along hedgerows of trees. Avoid placement in areas prone to off-site transport of nutrients, especially water furrows.

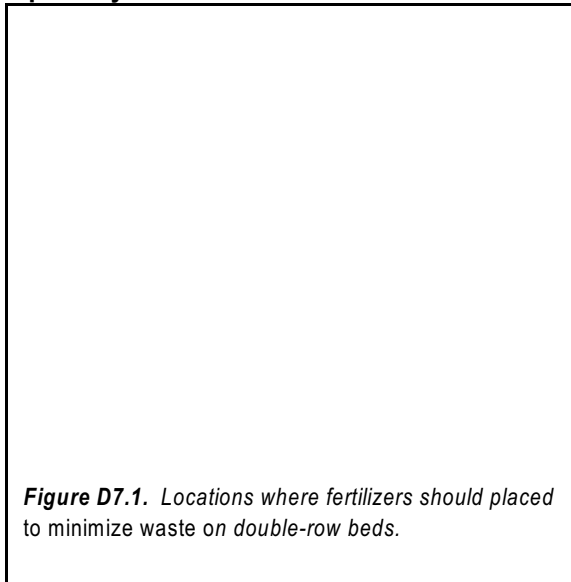


Figure D7.1. Locations where fertilizers should be placed to minimize waste on double-row beds.

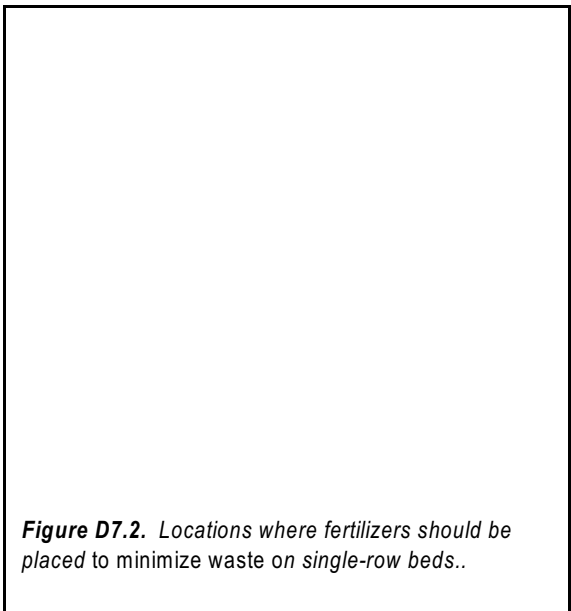


Figure D7.2. Locations where fertilizers should be placed to minimize waste on single-row beds..

D8. Avoid High Risk Applications

Do not apply materials under “high risk” situations, such as before forecasted rainfall. Avoid applications of nutrients during intense rainfall, on bare soils with extreme erosion potential, or when water tables are near the soil surface.

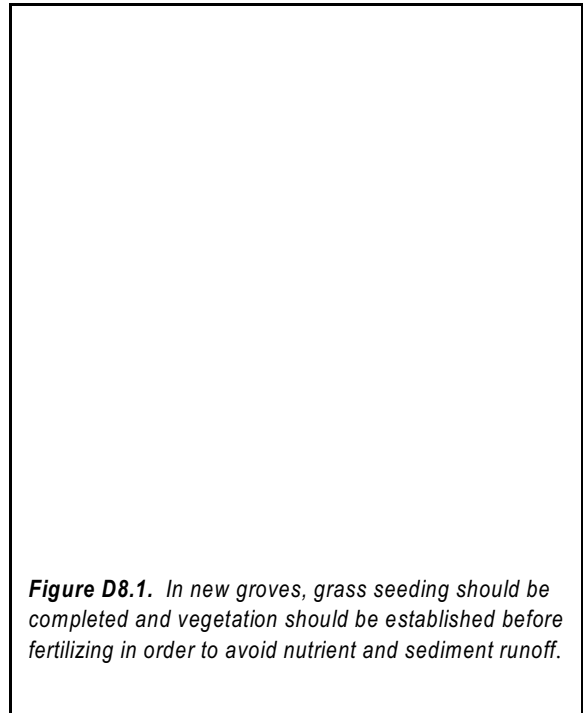


Figure D8.1. In new groves, grass seeding should be completed and vegetation should be established before fertilizing in order to avoid nutrient and sediment runoff.

For weather information on the Internet, go to:

FAWN: <http://fawn.ifas.ufl.edu/>

NOAA: <http://www.nws.noaa.gov>

<http://weather.noaa.gov/>

The Weather Channel: www.weather.com

CNN Weather: <http://www.cnn.com/WEATHER/>

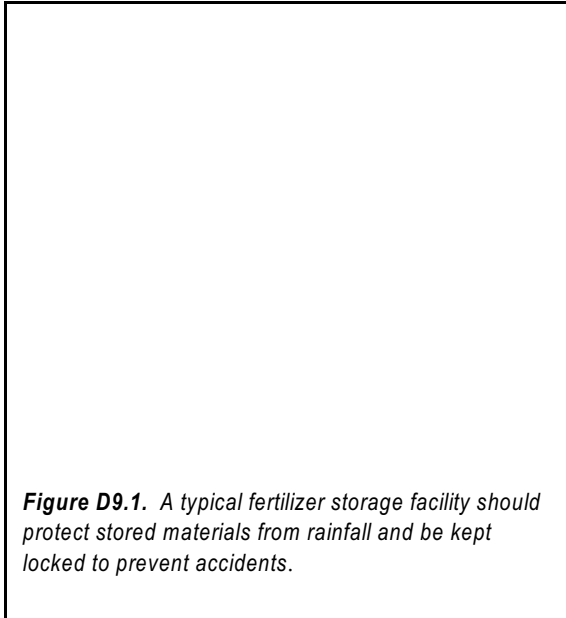
AccuWeather: <http://www.accuweather.com>

References

- SP-169. Nutrition of Florida Citrus Trees.
- SP-28. Fertilizer Management – Key to a Sound Water Quality Program.

D9. Fertilizer Storage

Use caution when storing fertilizer to prevent contamination of nearby ground and surface water.



Fertilizer should be stored in an area that is protected from rainfall. Always store fertilizers separately from pesticides, solvents, gasoline, diesel, motor oil, or other petroleum products. Many fertilizers are oxidants and can accelerate a fire.

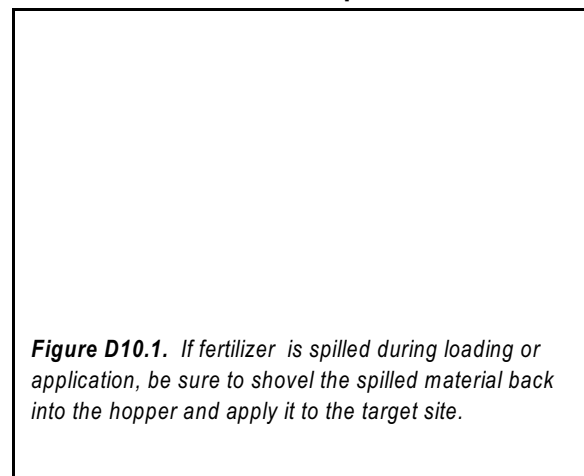
Storage of dry bulk materials on a concrete or asphalt pad may be acceptable if the pad is adequately protected from rainfall and from water flowing across the pad. Secondary containment of stationary liquid fertilizer tanks larger than 550 gallons is addressed in DEP rule 62-762, Florida Administrative Code (F.A.C.). Even where not required, the use of secondary containment is a sound practice.

Reference

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.
- MWPS-37. Designing Facilities for Pesticide and Fertilizer Containment.

D10. Spilled Fertilizers

Immediately remove any fertilizer materials spilled on ground surfaces and apply at recommended rates to crops.



When possible, place a tarp over ground surfaces where fertilizer transfer operations are conducted. Spilled materials should be transferred to the spreader for application to target sites. Spillage can contaminate open waters and thereby cause proliferation of aquatic weeds. Operators of fertilizer spreaders should be trained how to recover spilled materials for spreader application. Removal of some soil with the spilled materials is usually necessary and adequate for proper maintenance of this BMP. By its design, the spreader equipment will apply the fertilizer and soil to the target site.

At fixed loading sites, the area can be cleaned by sweeping or vacuuming (or with a shovel or loader, if a large spill), or by washing down the loading area to a containment basin that is specifically designed to permit recovery and reuse of the washwater. Washwater generated should be collected and applied to the target site.

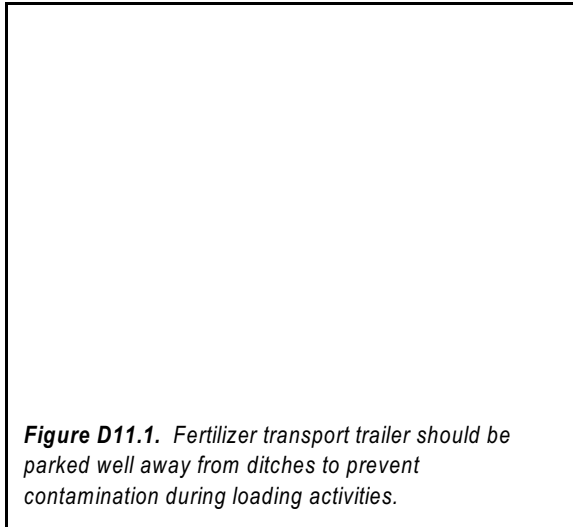
Discharge of this washwater to water bodies, wetlands, storm drains or septic systems is illegal.

Reference

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance.

D11. Use Caution When Loading Near Ditches, Canals, and Wells

Minimize the potential for spilled materials to pollute surface waters. When possible, locate mixing and loading activities away from ground water wells, ditches, canals, and other areas where runoff may carry spilled fertilizer into surface water bodies.



If such areas cannot be avoided, protect wells by properly casing and capping them and use berms to keep spills out of surface waters. Recover and apply spilled materials to intended zone of application.

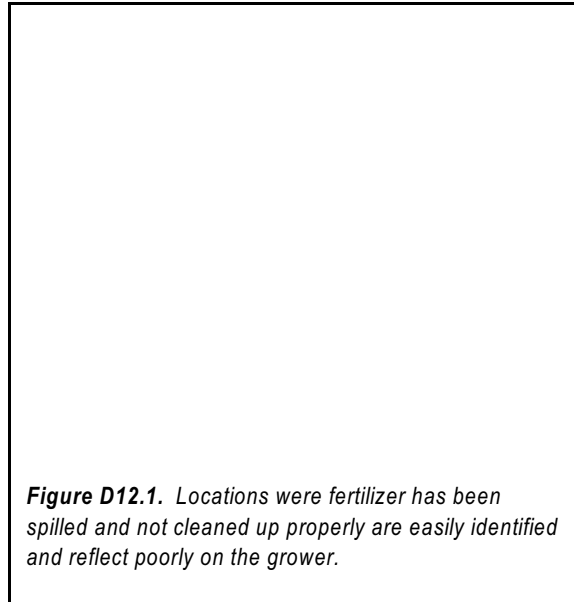
A concrete or asphalt pad with rainfall protection permits easy recovery of spilled material. If this is not feasible, loading at random locations in the field can prevent a buildup of nutrients in one location. In this case, place a tarp on the ground underneath the fertilizer hopper while loading. **Do not load fertilizers on a pesticide Chemical Mixing Center (CMC) because of the potential for cross-contamination.** Fertilizers contaminated with pesticides may cause crop damage or generate hazardous wastes.

Reference

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance. May, 1998.

D12. Alternate Loading Operation Sites

Use multiple fertilizer loading and transfer sites to prevent concentration of nutrients in a single area.



References

- Howard et al., 1998. Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance. May, 1998.
- Code 590. NRCS Conservation Practice Standard, Nutrient Management.

D13. Use Backflow Prevention Devices

Use backflow prevention devices on irrigation and spray tank filling systems to preclude entry of nutrients into surface waters. Never leave a filling-tank unattended.

Filling Tanks in the Field

Special precautions should be taken when filling tanks using a hose. Maintain an air-gap between the filling-hose and the liquid tank-mixture. Never leave a tank unattended when it is being filled.

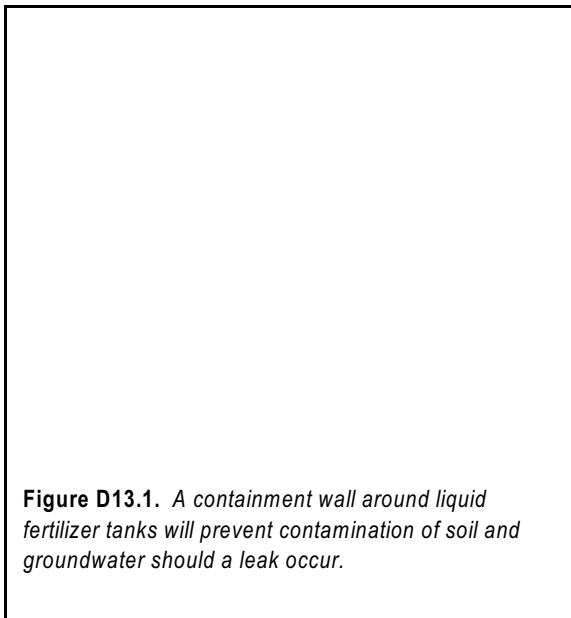


Figure D13.1. A containment wall around liquid fertilizer tanks will prevent contamination of soil and groundwater should a leak occur.

Fertigation and Backflow Prevention Equipment

An anti-siphon device is a safety device used to prevent backflow of a mixture of water and chemicals into the water source, or vice versa. In the case of fertigation, the chemicals are fertilizers. Currently, Florida state law (Florida Statutes Section 487.055) requires that backflow prevention equipment be installed and maintained on irrigation systems in which chemicals are injected for agricultural purposes (Fig. D13.2). The possible dangers in fertigation include backflow of fertilizers to the water source causing contamination, and water backflow into the fertilizer storage tank. Backflow prevention is an extremely important practice in the prevention of both ground and

surface water contamination. Backflow to the storage tank can rupture the tank or cause overflow, contaminating the area around the tank and perhaps indirectly contaminating the water source. Safety equipment is available which, when properly used, will protect both the water supply and the purity of the fertilizer in the storage tank.

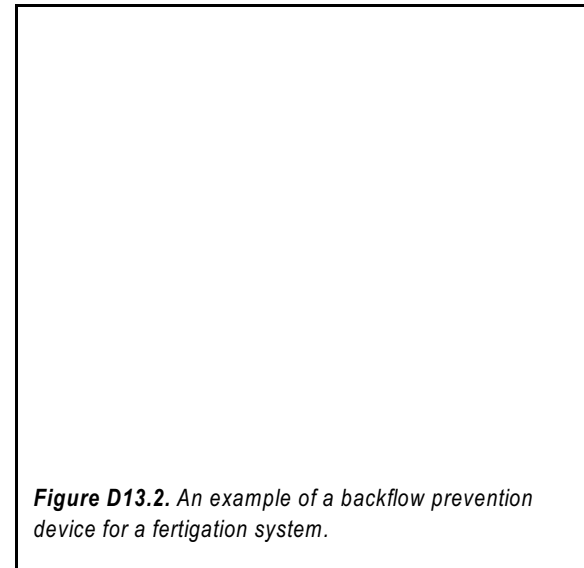
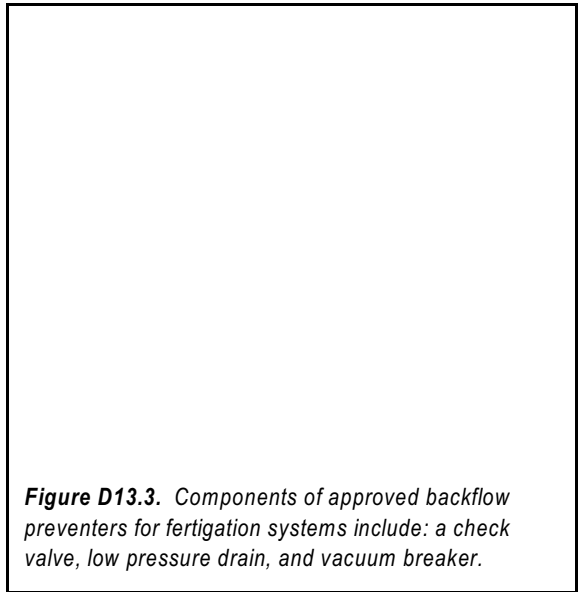


Figure D13.2. An example of a backflow prevention device for a fertigation system.

Any irrigation system designed or used for the application of chemicals should be equipped with the following components:

1. A functional check valve located in the irrigation supply line between the irrigation pump and the point of injection of chemicals is required. The check valve should be installed so that it is no more than 10 degrees from the horizontal. The check valve will prevent water from flowing from a higher elevation or pressure in the irrigation system back into the well or surface water supply. Thus, water contaminated with chemicals cannot flow back into the water supply.
2. A low pressure drain (Fig. D13.3) with an orifice size of at least 3/4 inch diameter is required. State law requires that it be located on the bottom of the horizontal pipe between the check valve and the water source. It must be located so that the water flow does not drain



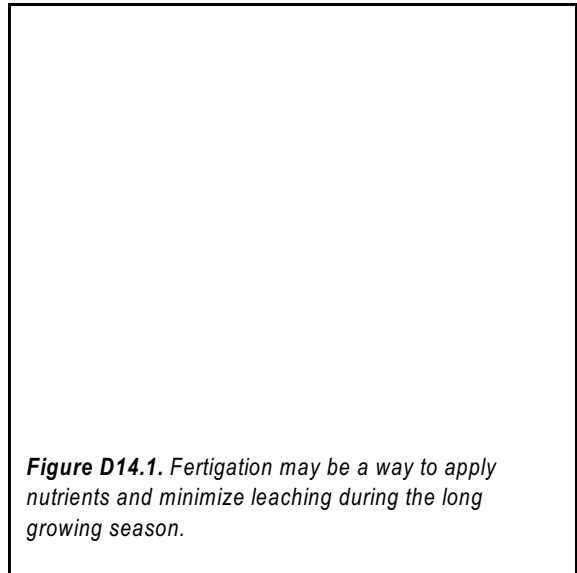
back to the water source. It must be level, must not extend beyond the inside surface of the pipe, and the outside opening of the drain must be above grade. A clearance of two inches between the drain and ground surface is required to assure that the drain will operate freely.

3. A vacuum breaker should be installed on the top of the horizontal pipe between the check valve and the irrigation pump, and opposite to the low pressure drain. The vacuum breaker needs to have an orifice size of at least 3/4 inch diameter and must be located upright and above the irrigation pipe so that it functions effectively. The vacuum breaker will allow air to enter the pipe when pumping stops so that water flowing back to the pump will not create a suction, pulling additional water and chemicals from the irrigation system with it.

References:

- SP-169. Nutrition of Florida Citrus Trees.
- Code 590. NRCS Conservation Practice Standard, Nutrient Management.
- Code 441 NRCS Conservation Practice Standard, Micro Irrigation.
- SP-281. Water and Florida Citrus, Chapt. 33. *Chemigation equipment and Techniques.*
- SP-281. Water and Florida Citrus, Chapt. 35. *Fertigation and Nutrient Management.*

D14. Split Applications Throughout Season
Dividing the annual fertilizer requirement into two or more applications can minimize leaching during the summer rainy season and help maintain the supply of nutrients over the long growing season of Florida.



Frequent fertigations can be an efficient method of application for N and K while minimizing the potential for leaching of nutrients during excessive rainfall events. The trade-off between costs vs. fertilizer use efficiency and resource protection must be considered.

Reference

- SP-169. Nutrition of Florida Citrus Trees.
- SP-281. Water and Florida Citrus, Chapt. 35. *Fertigation and Nutrient Management.*

D15. Erosion Control

Erosion-control practices should be considered to minimize soil loss and runoff that can carry dissolved and attached nutrients on soil particles to surface waters.

Vegetative filter strips are effective in reducing the levels of suspended solids and nutrients.

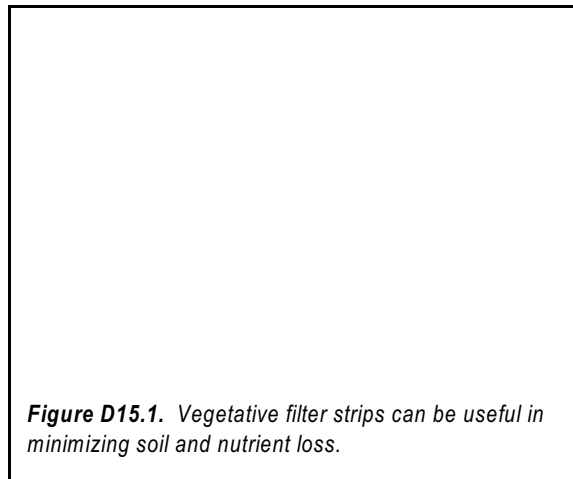


Figure D15.1. *Vegetative filter strips can be useful in minimizing soil and nutrient loss.*

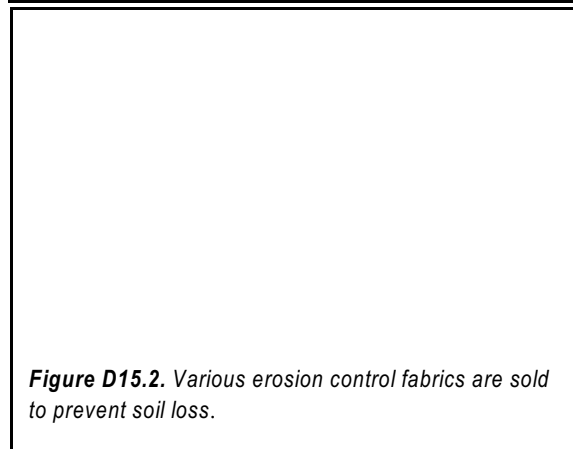


Figure D15.2. *Various erosion control fabrics are sold to prevent soil loss.*

References

- Code 590. NRCS Conservation Practice Standard, Nutrient Management.
- Code 342. NRCS Conservation Practice Standard, Critical Area Planting.
- Code 391a. NRCS Conservation Practice Standard, Riparian Forest Buffer.
- Code 410. NRCS Conservation Practice Standard, Grade Stabilization Structure.
- SP-28. Fertilizer Management – Key to a Sound Water Quality Program.

D16. Irrigation Management

Irrigation should be limited to wetting only the root zone where possible.

Excessive irrigation can transport nutrients below the root zone through leaching. Proper scheduling and uniform water distribution are necessary to assure control.

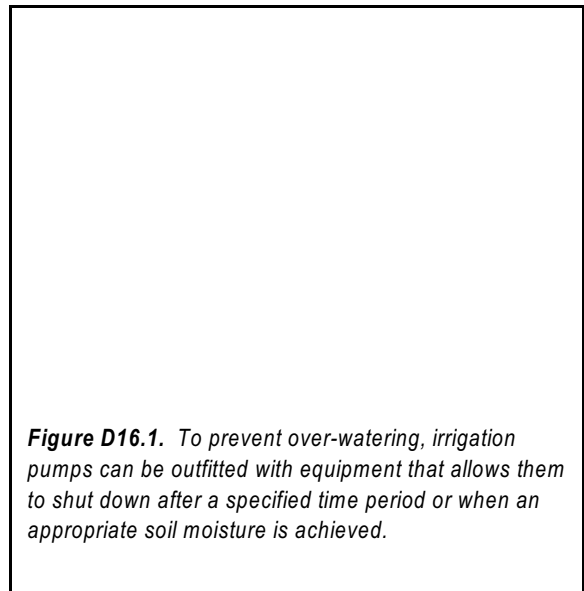


Figure D16.1. *To prevent over-watering, irrigation pumps can be outfitted with equipment that allows them to shut down after a specified time period or when an appropriate soil moisture is achieved.*

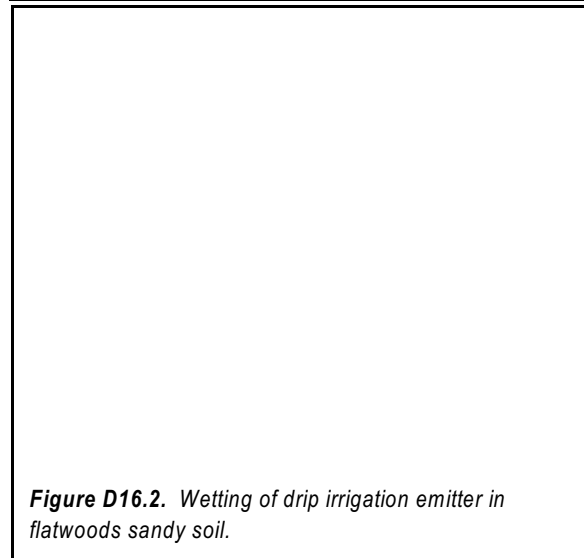


Figure D16.2. *Wetting of drip irrigation emitter in flatwoods sandy soil.*

References

- SP-28. Fertilizer management – Key to a Sound Water Quality Program.
- Code 449. NRCS Conservation Practice Standard, Irrigation Water Management.

D17. Incorporate Organic Materials

Increase the surface application (mulching) of organic materials like horticultural waste and urban plant debris (yard trimmings) when possible to help increase soil organic matter, retain nutrients and moisture, improve biological ecosystems, and supply slowly-released nutrition.

The surface application of slowly-degraded organic waste materials like horticultural waste and urban plant debris can increase soil moisture retention and nutrient-holding capacity. The nutrient additive properties of organic matter support:

- Economical ways to safely use non-hazardous wastes.
- Maintenance or increases in soil organic matter content.
- Protection of water quality.
- Protection of air quality.
- Reduction of energy used in manufacturing chemical fertilizer.

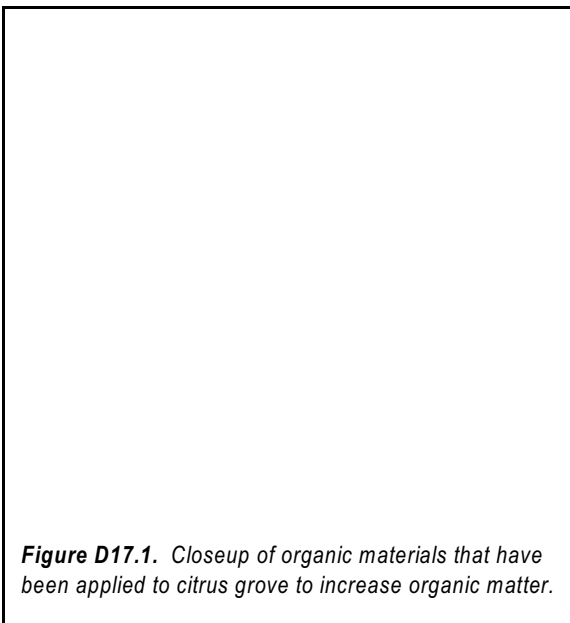


Figure D17.1. Closeup of organic materials that have been applied to citrus grove to increase organic matter.

Both microbial mineralization and immobilization can occur during decomposition of high carbon-low nitrogen organic materials like horticultural waste. Mineralization occurs when organic forms of a nutrient are converted to inorganic forms. Immobilization is the reverse of

this process where microorganisms convert inorganic forms of nutrients to organic forms. The organic forms of the nutrients are not available to plants as they are bound in some part of the soil organic matter. Plants take up nutrients in inorganic forms. Thus, immobilization reduces nutrient (particularly nitrogen) availability, while mineralization increases nutrient availability.

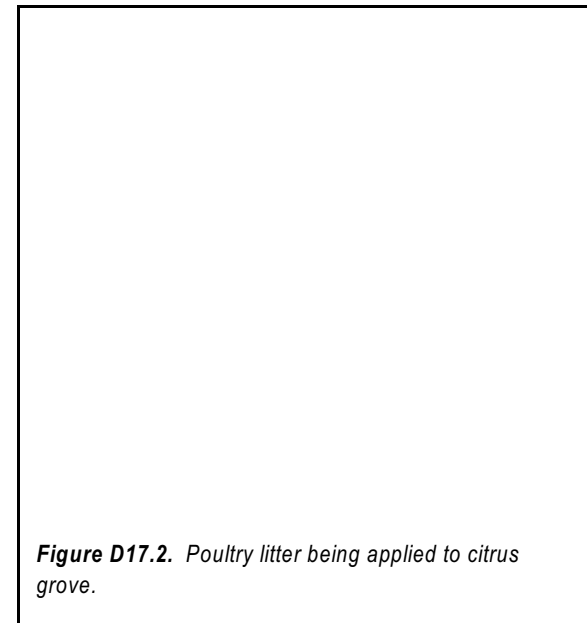


Figure D17.2. Poultry litter being applied to citrus grove.

Nitrogen-poor organic materials like straw, fresh sawdust and most fresh horticultural waste cause microorganisms to remove large amounts of inorganic nitrogen from the soil during decomposition, since that nitrogen is required to build new microbial cells. This process decreases nitrogen availability to citrus trees. However, the nitrogen consumed by the microorganisms will be slowly released when microbial cells decompose.

References

- ENH-125. Compost Utilization by State Departments of Transportation in the United States.
- SS-AGR-166. Utilization of Organic Wastes in Florida Agriculture.

D18. Well Protection

Prevent ground water contamination by backplugging improperly constructed and/or deteriorated irrigation wells.

This practice involves the protection of existing wells and prevention of problems in wells that are being planned. For existing wells, management activities are aimed at reducing the potential for contamination. This includes evaluating and, if necessary, moving or modifying potential sources of pollution. Such sources of pollution may include fueling areas and/or areas where pesticides and fertilizer are handled or mixed.

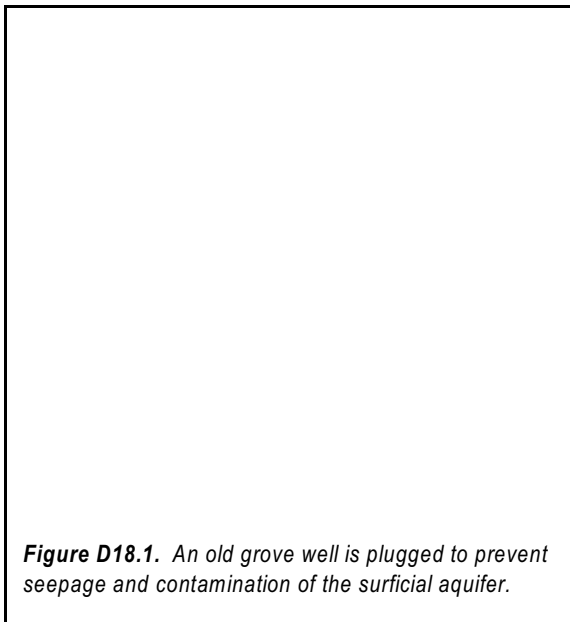


Figure D18.1. An old grove well is plugged to prevent seepage and contamination of the surficial aquifer.

The permanent plugging and elimination of such wells may be eligible for cost-share assistance under the Southwest Florida Water Management District's Quality of Water Improvement Program (QWIP). Please contact your local Southwest Florida Water Management District Service Office for information.

Points to Consider

- Anti-siphon devices should be attached to all system discharge points so that backflow siphoning does not contaminate the aquifer.

- Check with local health departments or state water management districts for setback guidelines regarding wells.
- When no longer in use, proper decommissioning or plugging of a well prevents the re-entry of surface water and transport of contaminants to the ground water. Check with your local water management district or USDA-NRCS office for well decommissioning and plugging guidelines.
- Wells should be capped or fitted with valves that close tightly when not in use to reduce the potential for contamination. Artesian wells should be fitted with control valves so that water flow can be regulated or stopped when water is not needed.

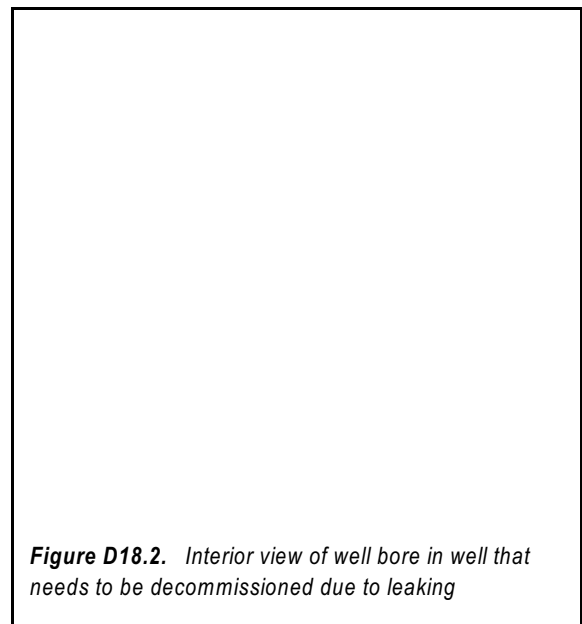


Figure D18.2. Interior view of well bore in well that needs to be decommissioned due to leaking

Reference

- Code 351. NRCS Conservation Practice Standard, Well Decommissioning.

D19. Use Appropriate Sources and Formulations

Reduce the potential for nutrient leaching and off-site movement by choosing appropriate sources and formulations of fertilizer based on nutritional needs, season (rainy vs. dry), and anticipated weather conditions to achieve greatest efficiency and reduce potential for offsite transport. Utilize controlled-release and slow-release formulations when feasible.

Nitrogen source materials are grouped into three categories: inorganic, synthetic organic, or natural organic. The inorganics and synthetic organics are usually high-analysis materials that are most economical to use in citrus groves. These nutrient source materials are readily available to plants unless they have been formulated in a controlled-release form. Natural organic materials are less readily available and are usually lower in nutrient analysis.

Following is a general description of the types of fertilizer source materials. You should keep in mind that opportunities for nutrient losses by runoff or leaching are greater for the more available (soluble) materials. Thus, dividing total applications limits the amount of readily available materials in the field at any one time. This reduction in the amount per application will limit the losses in runoff or by leaching. Proper selection of fertilizer source materials and formulations should take into account the season (wet or dry) of the application. Choose materials that will be less available for leaching and runoff.

●Dry

These are usually bulk-blended into multi-analysis (N, P, K plus micronutrients) blends for applications in citrus groves. Uniform particle size is required to prevent segregation of mixtures. Most dry nutrient forms are water soluble and readily available for tree uptake. Dry fertilizers are applied with conventional application equipment.

●Solutions

Solution fertilizers are usually free of solids and are

made by dissolving readily-soluble sources of plant nutrients in water. Nutrient sources used to manufacture solutions include ammonium nitrate, urea, potassium nitrate, potassium chloride, ammonium polyphosphate, and phosphoric acid. Solution fertilizers are suited for application through microsprinkler, or drip irrigation systems. Caution should be taken when applying solutions containing phosphorus (P) through such systems. If the pH of the fertilizer-water mixture is not kept acidic, solution P can combine with dissolved calcium (Ca) in the irrigation water to form an insoluble precipitate, which can clog irrigation lines.

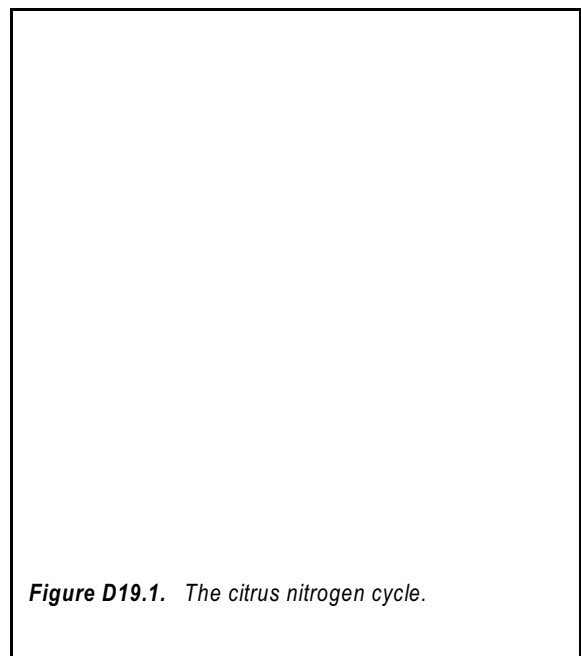


Figure D19.1. The citrus nitrogen cycle.

●Suspensions

Suspension fertilizers are fluids in which the solids are held in suspension (prevented from settling) by use of a suspension agent, usually a swelling-type clay such as attapulgite or bentonite. Suspensions provide an excellent way to apply fertilizer-herbicide mixtures and small amounts of micronutrients uniformly. Mechanical agitation may be necessary to maintain a uniform suspension. Suspensions are usually applied with a specially designed herbicide-type boom in a band underneath the tree canopy.

●Foliar N sources

In Florida citrus production areas where groundwater nitrate contamination exists or is seen as a potential problem, urea sprays can be used to provide a portion of the tree N requirements, especially during the summer months when leaching potential is greatest. However, tank mixing N sources with pesticides, oil, and other products should be approached with caution, as urea is known to be phytotoxic at higher rates, particularly in combination with oil.

●Slow release

These materials have limited water solubility which, during decomposition, release plant-available N (e.g., IBDU and ureaform). These fertilizers are grouped according to their mode of nutrient release in soil. For example, release of N from the ureaforms requires both dissolution of the fertilizer and microbial decomposition (nitrification), while release of N from IBDU involves slow dissolution only (in acidic soils).

Processed waste products release N through microbial degradation. Examples include municipal composts, dried sewage sludge (e.g., Milorganite, Hou-Actinite, Florida Organix), and tankages (e.g., Organiform).

●Controlled-release

Controlled-release fertilizers contain one or more plant nutrients in a coated form that delays their availability for plant uptake after application, or that extends their availability to the plant significantly longer than a readily-available fertilizer, such as ammonium nitrate, urea, or potassium chloride.

Controlled-release fertilizers are characterized by the rate at which nutrients are released into the soil solution, which may be related to soil temperature or water content. The rate at which nutrients are released by the coating is controlled by varying its thickness or physical characteristics during manufacture.

Controlled-release fertilizers are substantially more expensive than standard materials, thus their use may be limited to selected situations such as

fertilization of newly-planted trees or in environmentally-sensitive areas. Many controlled-release fertilizer products have been recently developed and many contain a complete N-P-K combination with small amounts of micronutrients. Growers are advised to consult the label of each product to determine its characteristics.

●Biosolids Sources

Biosolids are nutrient-rich, predominately organic materials. They are generated when solids accumulated during domestic sewage processing are treated further to meet regulatory requirements for land application. Biosolids can be a beneficial agricultural resource because they contain nutrients and organic matter that can improve soils and stimulate plant growth with negligible human health or environmental impacts.

Although biosolids contain many essential plant nutrients, nitrogen and phosphorus are in greatest concentration. Crops use nutrients from biosolids efficiently because they are released slowly throughout the growing season as biological decomposition occurs. Biosolids release N slowly, therefore is unlikely the N will leach. Biosolids application rates to citrus must not exceed the N rates outlined in Chapter 5E-1, F.A.C., otherwise known as Nitrogen Best Management Practices for Florida Ridge Citrus, after taking into account the N availability factor for biosolids (as explained in Chapter 7, USEPA, *Process Design Manual for Land Application of Sewage Sludge and Domestic Septage*). For purposes of this document, N availability from biosolids is assumed to be 50% of the total rate applied during the first 12 months after application. Consult your County's ordinances for additional requirements beyond state law.

The amount of Phosphorus (P) can be relatively high compared to the amount of Nitrogen (N) when biosolids or non-poultry animal waste is used as a fertilizer source. Physical characteristics of the site and soil, such as, filterstrips, soil organic matter, and clay or coated sand particles all contribute to reducing the risk of P moving to nearby ground

and/or surface water.

The Phosphorus Index is a qualitative risk assessment for P moving into ground or surface water. The Phosphorus Index can be used to assess the risk of off-site P movement when biosolids or animal waste is being used. It would be an appropriate screening tool in watersheds known to be impaired or sensitive to excess nutrients.

Abbreviations:

N nitrogen
P phosphorus
K potassium
Ca calcium

References

- SP-28. Fertilizer Management – Key to a Sound Water Quality Program.
- SP-169. Nutrition of Florida Citrus Trees.
- Chapter 5E-1, F.A.C.
<http://election.dos.state.fl.us/fac/index.shtml>
- NRCS Phosphorus Index Assessment Tool web site:
<http://www.nrcs.usda.gov/technical/ecs/nutrient/pindex.html>
- SL-205. The Basics of Biosolids Application to Land in Florida.
- SS-AGR-166. Utilization of Organic Wastes in Florida Agriculture.
- SS-AGR-167. Biosolids: Are These Residuals All the Same?
- Florida Administrative Code 62-640.
- USEPA. Process Design Manual for Land Application of Sewage Sludge and Domestic Seepage.

D20. Salinity

Fertilizer sources should be monitored closely in groves with high salinity levels. Fertilizers with high salt index levels can compound existing salinity problems.

A table of salt Indexes for inorganic and natural organic fertilizer sources can be found in Appendix 4. Additional discussion on salinity management is found in the Water Resource Management chapter.

The frequency of injecting nutrients or of applying granular fertilizer has a direct effect on the concentration of total dissolved solids (TDS) in the soil solution. A fertilization program that uses frequent applications with relatively low concentrations of salts will normally result in less salinity stress than programs using only two or three applications per year. Controlled-release fertilizers and frequent fertigations are ways to economically minimize salt stress when using high salinity irrigation water.

Selecting nutrient sources that have a relatively low osmotic effect in the soil solution can help reduce salt stress. The osmotic effect that a material adds to a soil solution is defined as its salt index relative to sodium nitrate, taken to be equal to 100 (see Salt Index table in Appendix 4). Since sources of phosphorus (P) generally have a low salt index, they usually present little problem. However, the salt index per unit (lb) of N and potassium (K) should be considered.

The salt index of natural organic fertilizers and slow-release products are low compared to the commonly used soluble fertilizers. High-analysis fertilizers may have a lower salt index per unit of plant nutrient than lower-analysis fertilizers since they may be made with a lower salt index material. Therefore, at a given fertilization rate the high-analysis formulation may have less of a tendency to produce salt injury. For instance, the salt index of a fertilizer blend made from ammonium nitrate and potassium nitrate will be about 30% less than that with the same N-P-K analysis blend made from ammonium nitrate and muriate of potash (KCl). In

addition, the Cl in KCl or Na in NaNO₃ materials add more toxic salts to the soil solution.

Choose fertilizer formulations that have the lowest salt index per unit of plant nutrients. Increase the frequency of fertilizations, thereby making it possible to reduce the salt content of each application and aid in preventing excess salt accumulation in the root zone. Maintain optimum but not excessive nutrient levels in soil and leaves with rates based on the long-term production from the grove. Fertilizer rates can usually be lower for trees with high salinity since production levels will probably be lower. Leaf tissue analysis should be used to detect excessive Na or Cl levels or deficient levels of other elements caused by nutrient imbalances from the salt stress. Leaf Na levels greater than 0.2% and Cl levels over 0.5% indicate imminent problems.

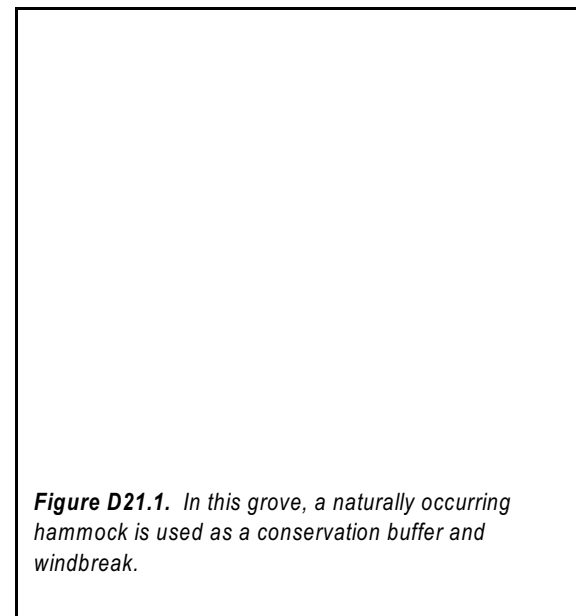
High rates of salt application can alter soil pH and thus cause soil nutrient imbalances. Some ions can also add to potential nutrient imbalances in trees. For example, Na displaces K, and to a lesser extent Ca, in soil solutions. This can lead to K deficiencies and, in some cases, even to Ca deficiencies. Such nutrient imbalances can compound the effects of salinity stress. Problems can be minimized if adequate nutritional levels are maintained, especially those of K and Ca.

References

- Boman, B. J. 1993. First-year Response of 'Ruby Red' Grapefruit on Four Rootstocks to Fertilization and Salinity.
- Boman, B. J. , and E. W. Stover. 2002. Managing Salinity in Florida Citrus, <http://edis.ifas.ufl.edu/AE171>
- Boman, B. J. , and E. W. Stover, 2002. Outline for Managing Irrigation of Florida Citrus with High Salinity Irrigation, <http://edis.ifas.ufl.edu/AE217>
- Syvertsen, J. P., M. L. Smith, and B. J. Boman, 1993. Tree Growth, Mineral Nutrition, and Leaching Losses from Soil of Salinized Citrus
- Syvertsen, J. P., B. J. Boman, and D. P. H. Tucker, 1989. Salinity Problems in Florida Citrus.
- SP281. Water and Florida Citrus, Chapt. 13. *Salinity Problems*.

D21.Conservation Buffers and Setbacks

Strategically incorporating vegetative buffers – either naturally occurring ones or planted forbs and grasses – into the citrus grove design can help to protect water quality by providing biological filtration, increasing residence time and/or residual nutrient uptake.



Managed properly, these vegetative areas or conservation buffers may provide pretreatment, formal treatment and other treatment train opportunities. A treatment train effect is simply a combination of nonstructural and structural BMPs which, are generally effective for reducing or preventing non-point source pollution. Generally speaking, there are certain non-cropped areas that could qualify as conservation buffers within a typical agro-ecosystem. Vegetated field borders, tree row middles, water furrows, ditch and ditch banks, wetlands/setback areas and associated reservoir systems are examples.

Depending on the grove's surface water management system design, buffer areas can contribute significantly and help to manage offsite nutrient impacts. This whole farm management approach ultimately reduces a grower's risk of incurring negative environmental consequences. The BMPs discussed below are intended to give

the reader information for the practical application of conservation buffers.

Pretreatment Options

Manage tree row middles by keeping them well grassed and by maintaining a minimum blade height of two inches. Growers should not rotary mow when standing water is present. Growers may also want to investigate the feasibility of incorporating leguminous plant(s) within the middles, as these plants may be used as an additional source of nitrogen.

Water furrows and lateral ditches should also be managed to encourage grass cover in order to help reduce flow velocities, thus providing an opportunity for particulate matter to settle out. See BMP Nos. B6, B8, B10, and B16 in the *Erosion Control and Sediment Management* chapter for more information on water furrow and ditch bank maintenance.

Formal Treatment Options

●Riparian Buffers – A riparian buffer is an area of trees and/or shrubs located adjacent to and up-gradient from associated watercourses. Existing groves that border perennial watercourses and were constructed before SWFWMD surface water regulations should, when economically feasible, explore the use of a riparian buffer. Water sheet flowing across this type of buffer will be afforded treatment before discharging to the watercourse. Air drainage is an important aspect of crop and tree damage during cold periods. Prior to implementing a riparian buffer, consideration should be given to its effects on air drainage.

●Dedicated Conservation Buffers – Grassed waterways and/or filter strips are both excellent conservation buffer choices, and can be used to convey and treat smaller volumes of discharge water with a moderate degree of success. In general, these passive treatment areas are more effective in removing phosphorus that is attached to soil particles rather than dissolved nitrogen. Groves that have some topographic relief should consider using grassed waterways or filter strips to

treat and discharge surface water runoff.

●Treatment Train Effects - Consider using a combination of structural and non-structural controls to mitigate the potential for offsite nutrient impacts, especially when discharging to sensitive downstream water bodies. See B17 in the Erosion Control and Sediment Management Section for more information.

Other Required Setbacks

Wetland setback areas, also referred to as wetland buffer zones, provide water quality treatment opportunities. If you have an Agricultural Ground and Surface Water Management (AGSWM) exemption issued by the SWFWMD, you are required to abide by a 50 foot setback from on-site jurisdictional wetlands. If you have an active Environmental Resource Permit for your grove, you are generally required to abide by an average 25 foot setback. Likewise, NRCS generally requires 50 feet along the path of water flow for a filter strip that is being used to address soluble nutrient problems. NRCS buffer practices are listed below and each practice has slightly different uses that should be matched with the specific site. Each NRCS buffer practice may have different minimum widths and other specifications based on the specific resource problem(s) to be addressed.

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Appendix 1. REFERENCES

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APPENDIX 2. IMPORTANT TELEPHONE NUMBERS

Emergency Reporting

| | |
|--|-----------------|
| <u>For Ambulance, Fire, or Police:</u> | Dial 911 |
| <u>State Warning Point</u> (24hrs.) | 800-320-0519 |
| or | |
| Department of Community Affairs, Division of Emergency Management | 850-413-9911 |
| <u>National Response Center</u> (24hrs.) | 800-424-8802 |
| (Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous substance [including oil when water is or may be affected] or a material identified as a marine pollutant, must immediately notify the NRC). | |

DEP

| | |
|-----------------------|--------------|
| NPS Section | 850-246-7508 |
| Hazardous Waste | 850-245-8705 |

Help line numbers for chemical hazard information and regulatory questions

| | |
|---|--------------|
| CHEMTREC Hot Line (Emergency only, 24 hrs | 800-424-9300 |
| SARA Title III help line | 800-535-0202 |
| CERCLA / RCRA help line | 800-424-9346 |

Non-Emergency Numbers

| | |
|--|--------------|
| <u>Charlotte Harbor National Estuary Program</u> | 941-995-1777 |
| Southwest Florida Regional Planning Council 4980 Bayline Dr. 4th Fl. (P.O. Box 3455) North Fort Myers, FL 33917-3455 | |
| <u>EPA National Office</u> | |
| Office of Water | 202-382-5700 |
| 4604, 40 M Street, SW Washington, DC 20460 (Provides Information on Clean Water Act and related water pollution regulations) | |

| | |
|--|---------------------|
| U.S. EPA Region IV | 404-562-9900 |
| 61 Forsyth Street | |
| Atlanta, GA 30303-3104 | |
| <u>Florida Administrator of EPA Pesticide Registration</u> | 850-487-2130 |
| Bureau of Pesticides, Division of Inspection | |
| FDACS | |
| 3125 Conner Blvd., MD-2 | |
| Tallahassee, FL 32399-1650 | |
| <u>FDACS</u> | |
| Bureau of Pesticides | 850-487-0532 |
| Bureau of Compliance Monitoring | 850-488-3314 |
| Division of Agriculture and Environmental Services | 850-488-3731 |
| Office of Ag Water Policy | 850-488-6249 |
| www.floridaagwaterpolicy.com | |
| <u>FDEP</u> | |
| FDEP Stormwater/Nonpoint Source Management Section (Tallahassee) . | 850-921-9472 |
| FDEP Hazardous Waste Management Section (Tallahassee) | 850-488-0300 |
| FDEP District offices: | |
| <u>DeSota, Hardee, Manatee, and Sarasota Counties</u> | |
| Southwest District | 813-744-6100 |
| 3804 Coconut Palm Drive | |
| Tampa, Florida 33619-8318 | |
| <u>Charlotte County</u> | |
| South District | 239-332-6975 |
| P.O. Box 2549 | |
| 2295 Victoria Avenue, Suite 364 | |
| Fort Myers, Florida 33902-2549 | |
| <u>Florida Fish and Wildlife Conservation Commission</u> | 850-488-4066 |
| 620 South Meridian Street | |
| Tallahassee, FL 32301 | |
| <u>National Pesticide Telecommunications Network</u> | 800-858-7378 |
| Provides information on pesticides and pesticide poisonings. | |
| (24 hours a day, 365 days a year.) | |
| <u>NRCS</u> | |
| <u>Charlotte County</u> | 239-995-5678 ext. 3 |
| NRCS Ft. Myers Service Center | |
| 3434 Hancock Bridge Parkway, Suite 209B | |
| N. Ft. Myers, Florida 33903 | |

| | |
|--|---------------------|
| <u>Hardee and DeSoto Counties</u> | 863-773-4764 ext. 3 |
| NRCS Wauchula Service Center | |
| 316 North 7 th Ave. Suite 101 | |
| Wauchula, FL 33873 | |
| <u>Sarasota and Manatee Counties</u> | 941-907-0011 |
| NRCS Sarasota Service Center | |
| 6942 Professional Pkwy E., Unit 200 | |
| Sarasota, FL 34240-8426 | |
| <u>State Emergency Response Commission (NOT a 24 hr No.)</u> | 800-635-7179 |
| (For state spill reporting requirements. This is for followup reporting. | |
| In an emergency, call the State Warning Point. If Federal reporting | |
| is required, also call the National Response Center.) | |
| <u>Southwest Florida Water Management District</u> | 352-796-7211 |
| 2379 Broad Street | |
| Brooksville, FL 34604-6899 | |
| Bartow Service Office | 863-534-1448 |
| 70 Century Boulevard | |
| Bartow, FL 33830-7700 | |
| Counties: Hardee, Highlands, Polk | |
| Sarasota Service Office | 941-377-3722 |
| 6750 Fruitville Road | |
| Sarasota, FL 34240-9711 | |
| Counties: Charlotte, DeSoto, Manatee, Sarasota | |
| <u>University of Florida</u> | |
| Pesticide Information Office (Gainesville) | 352-392-4721 |
| Agricultural Law Policy Office (Gainesville) | 352-392-1881 |
| Indian River REC (Ft. Pierce) | 772-468-3922 |
| Citrus REC (Lake Alfred) | 863-956-1151 |
| Southwest Florida REC (Immokalee) | 239-658-3400 |
| <u>County Cooperative Extension Service Offices</u> | |
| Charlotte County | 941-764-4340 |
| De Soto County | 863-993-4846 |
| Hardee County | 863-773-2164 |
| Manatee County | 941-722-4524 |
| Sarasota County | 941-861-9800 |

Assistance available

FDACS, USDA-NRCS, local Soil and Water Conservation Districts, the Southwest Florida Water Management District, University of Florida/IFAS, and the private sector provide assistance to growers to implement BMPs.

FDACS: will provide technical assistance and cost-share programs.

FSA (Farm Service Agency): the commodity payment arm of USDA will provide information and cost-share programs to help implement BMPs.

NRCS: administers programs which offer cost-sharing and technical assistance for planning and implementation of BMPs including the following:

- Disposal of hazardous wastes
- Nutrient management plans
- Technical assistance for sustaining BMP practices
- Integrated pest management
- Technical design and engineering
- Soils data
- Grove evaluations
- Irrigation water management
- Contracting
- BMP demonstrations

Local Soil & Water Conservation Districts

- Information on cost-share programs and technical support for implementation of BMPs.
- Water quality education and information on cost-share programs.
- Mobile irrigation lab and rental on conservation equipment.

Southwest Florida Water Management District

- BMP cost-share assistance
- Technical support
- When applicable, coordination on permitting issues relative to BMP implementation

UF/IFAS

- Technical assistance
- Grove evaluations
- Education programs
- BMP research and demonstrations

Web Resources

- ★CHEMTREC <http://www.chemtrec.org/>
- ★Citrus REC (Lake Alfred) <http://www.crec.ufl.edu/>
- ★Charlotte Harbor National Estuaries Program: <http://www.charlotteharbornep.org/>
- ★EDIS (UF/IFAS Extension Publications): <http://edis.ifas.ufl.edu/>
- ★Environmental Protection Agency <http://www.epa.gov/>
- ★Florida Department of Agriculture: <http://doacs.state.fl.us/>
- ★FDACS, Office of Ag Water Policy: www.floridaagwaterpolicy.com
- ★Florida Department of Community Affairs: <http://www.dca.state.fl.us/>
- ★FDEP, Nonpoint Pollution Section: <http://www.dep.state.fl.us/water/nonpoint/>
- ★FDEP Bureau of Emergency Response <http://www.dep.state.fl.us/law/BER/default.htm>
- ★Florida Farm Bureau/County Farm Bureau: www.fb.com/flfb/
- ★Florida Fish and Wildlife Conservation Commission: <http://www.floridaconservation.org/>
- ★Florida NRCS website: www.fl.usda.nrcs.gov/
- ★IFAS/County Extension: www.ifas.ufl.edu/
- ★Indian River REC: <http://irrec.ifas.ufl.edu/>
- ★Indian River Citrus BMP Site: <http://ircitrusbmp.ifas.ufl.edu>
- ★National response Center <http://www.nrc.uscg.mil/nrchp.html>
- ★NRCS: <http://www.nrcs.usda.gov>
- ★NRCS Phosphorus Index: <http://www.nrcs.usda.gov/technical/ecs/nutrient/pindex.html>
- ★Peace River Valley Citrus Growers Association: <http://home.earthlink.net/~prvcga/>
- ★Southwest Florida REC <http://www.imok.ufl.edu/>
- ★Southwest Florida Water Management District: <http://www.swfwmd.state.fl.us/>
- ★State Warning Point <http://www.floridadisaster.org>

Grove Worker BMP Materials (English and Spanish)

- ❖ First Aid, Heat Stress, and Safety for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE242>
Primeros Auxilios, Insolación y Seguridad para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE270>

- ❖ Understanding the Pesticide Label for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE243>
Entendiendo la Etiqueta del Pesticida para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE271>

- ❖ Personal Protection Equipment for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE244>
Equipo de Protección Personal para los trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE272>

- ❖ Equipment Safety for Citrus Grove Workers
<http://edis.ifas.ufl.edu/AE245>
Seguridad con el Equipo para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE273>

- ❖ Herbicide Application Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE246>
Mejores Prácticas de Manejo en Aplicaciones de Herbicida para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE274>

- ❖ Pesticide Application Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE247>
Mejores Prácticas de Manejo en Aplicaciones de Pesticida para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE281>

- ❖ Fertilizer Application Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE248>
Mejores Prácticas de Manejo en Aplicaciones de Fertilizante para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE275>

- ❖ Aquatic Vegetation Management Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE249>
Mejores Prácticas de Manejo en Aplicaciones de Malezas Acuáticas para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE276>

- ❖ Drainage Management Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE250>
Mejores Prácticas de Manejo con Drenaje para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE277>

- ❖ Irrigation Management Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE251>
Mejores Prácticas de Manejo con Irrigación para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE278>

- ❖ Riser Board Water Control Structures Best Management Practices for the Citrus Grove Worker
<http://edis.ifas.ufl.edu/AE252>
Mejores Prácticas de Manejo con compuertas de retención de agua para los Trabajadores de Cítrico
<http://edis.ifas.ufl.edu/AE279>

- ❖ Best Management Practices for Agricultural Maintenance Facilities
<http://edis.ifas.ufl.edu/AE253>
Mejores Prácticas de Manejo para el Mantenimiento en Facilidades Agrícolas
<http://edis.ifas.ufl.edu/AE280>

APPENDIX 3. Spill Reporting Requirements

Public Law 965 10 and Public Law 925000 (CERCLA) require immediate notification of the appropriate agency of the United States Government of a discharge of oil or hazardous substances. "*Any such person who fails to notify immediately such agency of such discharge shall, upon conviction, be fined not more than \$ 10,000 or imprisoned for not more than one year, or both.*"

Pursuant to Chapters 376 and 403, Florida Statutes:

Any owner or operator of a facility who has knowledge of any release of a hazardous substance from a facility in a quantity equal to or exceeding the reportable quantity (see MSDS sheet) in a 24 hour period shall immediately notify the State Warning Point. The owner or operator having a discharge of petroleum products exceeding 25 gallons on a pervious surface (or any amount in a water body) must report such discharge to the Department of Environmental Protection or the State Warning Point.

The penalty is not in reporting a spill, it is in failing to report a spill.

REPORT THE FOLLOWING INFORMATION

1. Name, address, and telephone number of person reporting
2. Name, address, and telephone number of person responsible for the discharge or release, if known
3. Date and time of the discharge or release
4. Type or name of substance discharged or released
5. Estimated amount of the discharge or release
6. Location or address of discharge or release
7. Source and cause of the discharge or release
8. Size and characteristics of area affected by the discharge or release
9. Containment and cleanup actions taken to date
10. Other persons or agencies contacted

Appendix 4. Salt index of inorganic and natural organic fertilizer sources.

| Material and Analysis | Salt Index (Sodium Nitrate=100) | |
|---|--------------------------------------|--------------------------------------|
| | Per equal weights of materials basis | Per unit (100 lb) of plant nutrients |
| Nitrogen | | |
| Ammonium nitrate, 35% N | 105 | 3.0 |
| Ammonium nitrate, 20.5% N | 61 | 3.0 |
| Ammonium sulfate, 21.2% N | 69 | 3.3 |
| Calcium nitrate, 12% N | 53 | 4.4 |
| Calcium nitrate, comm. grade, 15.5% N | 65 | 4.2 |
| Sodium nitrate, 16.5% N | 100 | 6.1 |
| Urea, 46.6% N | 75 | 1.6 |
| Nitrate of Soda Potash, 15% N, 14% K ₂ O | 92 | 3.2 |
| Natural organic, 5% N | 4 | 0.7 |
| Phosphate | | |
| Normal Superphosphate, 20% P ₂ O ₅ | 8 | 0.4 |
| Concentrated Superphosphate, 45% P ₂ O ₅ | 10 | 0.2 |
| Concentrated Superphosphate, 48% P ₂ O ₅ | 10 | 0.2 |
| Monoammonium phosphate, 12.2% N, 61.7% P ₂ O ₅ | 30 | 0.4 |
| Diammonium phosphate, 18% N, 46% P ₂ O ₅ | 34 | 0.5 |
| Potash | | |
| Potassium chloride, 60% K ₂ O | 116 | 1.9 |
| Potassium chloride, 63.2% K ₂ O | 114 | 1.8 |
| Potassium nitrate 13.8% N, 46.6% K ₂ O | 74 | 1.2 |
| Potassium sulfate, 46% K ₂ O | 46 | 0.9 |
| Monopotassium Phosphate, 52% P ₂ O ₅ , 35% K ₂ O | 8 | 0.1 |
| Sulfate of potash-magnesia, 21.9% K ₂ O | 43 | 2.0 |
| Miscellaneous | | |
| Dolomite, 20% MgO | 0.8 | 0.042 |
| Magnesium oxide, 100% MgO | 1.7 | 0.002 |
| Gypsum, 32.6% CaO | 8.1 | 0.247 |
| Calcium carbonate, 56% CaO | 4.7 | 0.083 |

CITRUS BEST MANAGEMENT PRACTICES CHECKLIST

I. INTRODUCTION

The following checklist is designed to assist Peace River and Mannasota Basin citrus growers in identifying the appropriate Best Management Practices (BMPs) or group of strategies for their specific site and growing conditions. The results should be kept on file and reviewed annually to document implementation of BMPs, and to determine whether further practices may be appropriate. Providing the information requested below for the Introduction Section is not mandatory, but listing this voluntary information will help the grove manager select BMPs that are appropriate for their specific grove configuration

Grower Information: Please fill in below.

A.) Property Owner : _____

B.) Grove Name : _____

C.) County: _____

D.) Tax ID Number: _____

Section: _____

Township: _____

Range: _____

E.) Grove Acres: _____

F.) Bed Configuration: _____

G.) Tree Spacing: _____

H.) Rows Per Bed: _____

I.) Number of Trees Per Acre: _____

J.) Irrigation Method: Drip Micro Flood

Note:

A YES answer for any question indicates that the grove being surveyed is in compliance with the referenced BMPs. A NO answer indicates that the referenced BMPs might improve the environmental performance of the grove, but implementation of all BMPs so referenced is not required. Review BMPs listed for questions that were answered NO. Select specific BMPs from those indicated by a NO answer that are appropriate for application to the grove unit surveyed. These BMPs to be implemented should be listed in Section VIII (BMP's to be implemented). (Note: Implementation of all BMPs indicated blank with a NO answer is not required.)

Use the comment section at the end of this document (Section VI) to explain why certain BMPs from questions that were answered NO will not be implemented. The comment section can also be used to elaborate on any items or questions that may be unclear or ambiguous, or to explain particular grove conditions. Comments should be referenced to the specific section and question number of the survey. N/A may be used if the question or section does not apply to that particular grove.

Numbers listed next to the answer box refer to specific BMPs referenced in "Best Management Practices for Citrus Groves in the Peace River and Mannasota Basins".

Property Owner Name: _____ Evaluator's Name: _____

Grove Name: _____ Evaluation Date: _____

A. WATER RESOURCE MANAGEMENT

YES NO N/A BMP

Irrigation Practices

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------|
| 1. Are irrigation events scheduled based on evapotranspiration, rainfall events, water table wells, or other scientific data? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2, D15 |
| 2. Have all irrigation sources been analyzed for water quality? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |
| 3. Have high salinity irrigation sources been offset by lower salinity irrigation sources to the greatest extent practicable? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |

Infrastructure

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|-------------------|
| 4. Can on-site detention or storage be provided using the present system of canals, ponds and/or ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A6, A7, A9 |
| 5. Are the grove off-site drainage outlets (pumps or discharge structures) adequately maintained to allow safe and efficient operation? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A8 |

Drainage Management

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|------------------------|
| 6. Are pumps and/or discharge structures set up to achieve uniform drainage throughout the grove? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2, A3, A8, B15 |
| 7. Following intense rainfall events are drainage rates and volumes considered when releasing water minimizing off site impact? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A3, A6 |
| 8. Is the irrigation system periodically evaluated to determine efficiency and uniformity? If deficiencies are noted, are the problems corrected? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |
| 9. Are bottom slope on furrows maintained between beds to achieve uniform drainage? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B15, B16 |

Water Table Management

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|-------------------|
| 10. Are water table wells and/or soil moisture sensors (i.e. tensiometers) used to avoid excess water depletion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2, A5 |
|--|--------------------------|--------------------------|--------------------------|-------------------|

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|--------------|
| 11. Do you follow a well written drainage management plan that provides specific directions based on levels of rainfall? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2, A6 |
| 12. Are groundwater levels monitored to meet tree water demands and prevent root pruning? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2 |
| <i>Drainage Structures</i> | | | | |
| 13. Are culverts with functional riser/sinker boards installed on appropriate lateral and side ditch connections? If so are they being maintained properly? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B1 |
| 14. Are settling basins maintained in front of drainage pipe inlets in water furrows? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B14 |
| <i>Ditch Infrastructure</i> | | | | |
| 15. Are there settling basins or sumps to trap sediment at field ditch connections to laterals and other main canals prior to discharge? If so are they being maintained? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B2 |
| 16. Are ditches and canals constructed with proper side bank stabilization methods; i.e. sloping or shoring? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B3 |
| <i>Ditch Management</i> | | | | |
| 17. Are ditches maintained to prevent aquatic plants from clogging discharge structures or moving off-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B3, B9 |
| 18. When selecting aquatic herbicides for target species is mode of action, residual toxicity, and potential for offsite movement considered? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B9, C22 |
| 19. Is vegetative cover maintained near canal or ditch banks to stabilize bare soils and prevent erosion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B4, B6 |
| 20. Are techniques such as herbicides or maintenance mowing used to decrease the growth of shade producing shrubs; i.e. Brazilian Pepper? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B6 |
| 21. When mechanically removing vegetation from ditch bottoms are operators trained to do these practices without disrupting grass slopes? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B6, B7, B8 |
| 22. Are water furrows and drain pipes maintained to reduce the velocity of water flowing into drainage ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B15, B16 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|--|--------------------------|--------------------------|--------------------------|-------------------|
| 23. Is there a management plan for removing sediments from canals and farm ditches on a regular basis? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B10 |
| 24. Are ditch bank top edges contoured or bermed to divert water and avoid side bank erosion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B5, B7 |
| 25. Are riprap, concrete headwalls, sandbags, or wingwalls used to protect canal banks from erosion, and are they contoured properly to prevent over flow of storm water directly down the ditch bank? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B7 |
| <i>Bed/Furrow Management</i> | | | | |
| 26. Are water furrows properly shaped and grassed to prevent erosion, rutting, and other problems that may result in excess sediment transport off-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B16 |
| 27. Is PVC or flexible pipe used to connect all water furrows or field ditches to lateral ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B15 |
| 28. Is precaution used during construction and all other land-altering events to reduce sediment transport? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B4, B10, B13, B17 |
| 29. Are herbicide bands maintained at the minimum width appropriate for the size of the trees? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B11, B12 |
| <u>C. PEST MANAGEMENT</u> | | | | |
| <i>Equipment Maintenance</i> | | | | |
| 30. Is all pesticide application equipment properly calibrated and maintained? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C15 |
| <i>Educational Training</i> | | | | |
| 31. Are regularly scheduled training sessions held for spray applicators and others responsible for applying, handling, mixing/loading, calibrating and recommending pesticides? If so, does it accommodate speakers of other languages? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3 |
| 32. Are applicators trained to control and contain spilled pesticides? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3, C9 |
| <i>Pollution Prevention and Preparedness</i> | | | | |
| 33. Is the purchase of crop protection products scheduled to avoid the risk of having to store the products for extended periods? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C4 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|-------------|
| 34. Are routine inspections of the pesticide storage area conducted to check for leaks and spills, and are there well-charged fire extinguishers kept on-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3, C5 |
| 35. Do you consider weather, equipment and operator capabilities, and grove conditions to avoid disposing of excess material? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C5, C10 |
| 36. When possible, do you return unopened, unused pesticides in their original container to your local agrichemical dealer? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C13 |
| <i>Application Methods</i> | | | | |
| 37. Are appropriate measures taken to reduce spray drift (i.e nozzle selection, spray pressure, drift reducing adjuvants, and/or other drift control materials)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C20, C21 |
| 38. Are practices taken that prevent over-spray of non-target areas (i.e. wrapping)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C21 |
| 39. Is the efficiency of pesticides maximized by selecting target-specific active ingredients that complement epidemiological cycles? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C1, C2, C22 |
| 40. Are all of the required records for pesticide applications, including date, time, location of treatment, target site, crop, total area, brand name, EPA Registration number, total amount, and method of application recorded by a certified applicator? Are they posted? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C19 |
| 41. Are pesticide labels reviewed with employees with special attention given to the "Environmental Hazards" section? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C12 |
| <i>Mixing and Loading Activities</i> | | | | |
| 42. Is application equipment washed on a concrete pad with a sump, and is the wash-water collected and reused in other applications? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C14 |
| 43. Are anti-siphoning devices, artesian pressure, or other measures utilized to prevent back siphoning of pesticides into ditches, canals, or wells? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C11 |
| 44. If pesticides are mixed at or near the same site year after year, is there a concrete pad with a sump to minimize contamination from small spills and leaks? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C7 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|------------|
| 45. When permanent mix-load station(s) are not available or feasible, do you utilize portable mix-load stations to minimize contamination from small spills and leaks? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C8 |
| 45. Are wellheads properly elevated or grouted to prevent contamination of wells during pesticide mixing/loading operations? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C11 |
| 47. Are appropriate measures taken to rinse and dispose of pesticide containers? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C13 |
| <i>Integrated Pest Management</i> | | | | |
| 48. Are a combination of control measures used targeting specific pests and diseases, including mechanical, cultural, biological, and chemical systems (i.e. Integrated Pest Management)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C1, C22 |
| 49. Are precision application techniques, such as global positioning systems, infrared imaging, or other advanced sensing devices used when applying crop protection products? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C18 |
| 50. Is soil pH maintained at a level that reduces the solubility of free copper ions to reduce off-site movement? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C17 |
| 51. Are specific factors of both the target area, such as the soil type, and the leaching and runoff potential of the pesticide to be applied considered when selecting a chemical for a specific pest? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C2 |
| 52. Is the efficiency of pesticides maximized by timing applications based on anticipated weather conditions and irrigation events | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C16 |
| <u>D. NUTRIENT MANAGEMENT</u> | | | | |
| <i>Pollution Prevention</i> | | | | |
| 53. Is proper education and training given to employees concerning handling, loading, and application of nutrients? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D1 |
| 54. Is the machinery used to make applications consistent with the form and source of the nutrients? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D4 |
| 55. Is machinery calibrated and operated so as to achieve precise and desired placement at the specified rate? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D5, D6, D7 |
| 56. Are nutrients applied to the target area within the root zone or dripline as to avoid placement in areas prone to runoff (i.e. furrows)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D7 |

57. Are anti-siphoning devices, artesian pressure, or other measures utilized to prevent back siphoning of nutrients into surface water and/or groundwater? D13, D18
58. Are fertilizer trailers parked away from canals, ditches, or wells (as much as is practical) to avoid contaminating adjacent water bodies during loading operations? D11
59. Is spilled fertilizer transferred to application equipment and applied to the target area? D10
60. Is the site used to load and unload fertilizer moved frequently? D12
61. Is fertilizer always stored in an area protected from rainfall? D9
62. Are fertilizer applications managed to protect environmentally sensitive areas by using: controlled release fertilizers, frequent low concentration fertigation events, multiple applications, and variable rate technology? D2, D19
63. Are organic matter amendments (i.e. Class A sludge or other approved organic matter sources) an integral part of the nutrient management program? D3, D17
64. Have you developed a nutrient management plan based on analyses of soil, water, and plant tissues? D2
65. Are there conservation buffers and setbacks that are generally effective for reducing or preventing nonpoint source pollution? D15

Sampling and Analysis

66. Is there a nutrient management plan that allows for optimum crop production based on soil, water, and plant sample analyses? D2, D4
67. Is there a program of annual soil, leaf tissue and irrigation water sampling, analysis and interpretation to formulate a nutrient recommendation based on crop response? D4

Application Methods

68. Are "high risk" fertilizer applications avoided? (such as prior to a storm, on bare soils with a high potential for erosion, or when the water table is at or near the surface) D8, D14
69. Are a combination of liquid, dry, or foliar feeding used to maximize plant uptake and minimize losses of nutrients? D2, D19

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|--|--------------------------|--------------------------|--------------------------|------------|
| 70. Are erosion control practices considered to minimize soil loss? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D15 |
| 71. When irrigation practices take place, is water applied so as to limit the wetting to only the root zone? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D16 |
| 72. Are low salt index fertilizers used to the greatest extent practicable? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D19, D20 |

VII. CONCLUSION AND RESOLUTION:

Assessment conducted by (print name): _____

Signature: _____

Grove representative (if different from above): _____

Signature: _____

Date: _____

Comments: _____

VIII. BMPs TO BE IMPLEMENTED

BMPs selected from those indicated by NO answers that grove management agrees to implement with year of anticipated implementation (i.e A6-2006, B9-2005, and D16-2007, etc.):

CITRUS BEST MANAGEMENT PRACTICES CHECKLIST

I. INTRODUCTION

The following checklist is designed to assist Peace River and Mannasota Basin citrus growers in identifying the appropriate Best Management Practices (BMPs) or group of strategies for their specific site and growing conditions. The results should be kept on file and reviewed annually to document implementation of BMPs, and to determine whether further practices may be appropriate. Providing the information requested below for the Introduction Section is not mandatory, but listing this voluntary information will help the grove manager select BMPs that are appropriate for their specific grove configuration

Grower Information: Please fill in below.

A.) Property Owner : _____

B.) Grove Name : _____

C.) County: _____

D.) Tax ID Number: _____

Section: _____

Township: _____

Range: _____

E.) Grove Acres: _____

F.) Bed Configuration: _____

G.) Tree Spacing: _____

H.) Rows Per Bed: _____

I.) Number of Trees Per Acre: _____

J.) Irrigation Method: Drip Micro Flood

Note:

A YES answer for any question indicates that the grove being surveyed is in compliance with the referenced BMPs. A NO answer indicates that the referenced BMPs might improve the environmental performance of the grove, but implementation of all BMPs so referenced is not required. Review BMPs listed for questions that were answered NO. Select specific BMPs from those indicated by a NO answer that are appropriate for application to the grove unit surveyed. These BMPs to be implemented should be listed in Section VIII (BMP's to be implemented). (Note: Implementation of all BMPs indicated blank with a NO answer is not required.)

Use the comment section at the end of this document (Section VI) to explain why certain BMPs from questions that were answered NO will not be implemented. The comment section can also be used to elaborate on any items or questions that may be unclear or ambiguous, or to explain particular grove conditions. Comments should be referenced to the specific section and question number of the survey. N/A may be used if the question or section does not apply to that particular grove.

Numbers listed next to the answer box refer to specific BMPs referenced in "Best Management Practices for Citrus Groves in the Peace River and Mannasota Basins".

Property Owner Name: _____ Evaluator's Name: _____

Grove Name: _____ Evaluation Date: _____

A. WATER RESOURCE MANAGEMENT

YES NO N/A BMP

Irrigation Practices

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------|
| 1. Are irrigation events scheduled based on evapotranspiration, rainfall events, water table wells, or other scientific data? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2, D15 |
| 2. Have all irrigation sources been analyzed for water quality? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |
| 3. Have high salinity irrigation sources been offset by lower salinity irrigation sources to the greatest extent practicable? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |

Infrastructure

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|-------------------|
| 4. Can on-site detention or storage be provided using the present system of canals, ponds and/or ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A6, A7, A9 |
| 5. Are the grove off-site drainage outlets (pumps or discharge structures) adequately maintained to allow safe and efficient operation? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A8 |

Drainage Management

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|------------------------|
| 6. Are pumps and/or discharge structures set up to achieve uniform drainage throughout the grove? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2, A3, A8, B15 |
| 7. Following intense rainfall events are drainage rates and volumes considered when releasing water minimizing off site impact? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A3, A6 |
| 8. Is the irrigation system periodically evaluated to determine efficiency and uniformity? If deficiencies are noted, are the problems corrected? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2 |
| 9. Are bottom slope on furrows maintained between beds to achieve uniform drainage? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B15, B16 |

Water Table Management

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|-------------------|
| 10. Are water table wells and/or soil moisture sensors (i.e. tensiometers) used to avoid excess water depletion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2, A5 |
|--|--------------------------|--------------------------|--------------------------|-------------------|

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|--------------|
| 11. Do you follow a well written drainage management plan that provides specific directions based on levels of rainfall? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A2, A6 |
| 12. Are groundwater levels monitored to meet tree water demands and prevent root pruning? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A1, A2 |
| <i>Drainage Structures</i> | | | | |
| 13. Are culverts with functional riser/sinker boards installed on appropriate lateral and side ditch connections? If so are they being maintained properly? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B1 |
| 14. Are settling basins maintained in front of drainage pipe inlets in water furrows? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B14 |
| <i>Ditch Infrastructure</i> | | | | |
| 15. Are there settling basins or sumps to trap sediment at field ditch connections to laterals and other main canals prior to discharge? If so are they being maintained? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B2 |
| 16. Are ditches and canals constructed with proper side bank stabilization methods; i.e. sloping or shoring? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B3 |
| <i>Ditch Management</i> | | | | |
| 17. Are ditches maintained to prevent aquatic plants from clogging discharge structures or moving off-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B3, B9 |
| 18. When selecting aquatic herbicides for target species is mode of action, residual toxicity, and potential for offsite movement considered? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B9, C22 |
| 19. Is vegetative cover maintained near canal or ditch banks to stabilize bare soils and prevent erosion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B4, B6 |
| 20. Are techniques such as herbicides or maintenance mowing used to decrease the growth of shade producing shrubs; i.e. Brazilian Pepper? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B6 |
| 21. When mechanically removing vegetation from ditch bottoms are operators trained to do these practices without disrupting grass slopes? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B6, B7, B8 |
| 22. Are water furrows and drain pipes maintained to reduce the velocity of water flowing into drainage ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B15, B16 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|--|--------------------------|--------------------------|--------------------------|-------------------|
| 23. Is there a management plan for removing sediments from canals and farm ditches on a regular basis? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B10 |
| 24. Are ditch bank top edges contoured or bermed to divert water and avoid side bank erosion? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B5, B7 |
| 25. Are riprap, concrete headwalls, sandbags, or wingwalls used to protect canal banks from erosion, and are they contoured properly to prevent over flow of storm water directly down the ditch bank? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B7 |
| <i>Bed/Furrow Management</i> | | | | |
| 26. Are water furrows properly shaped and grassed to prevent erosion, rutting, and other problems that may result in excess sediment transport off-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | A4, B16 |
| 27. Is PVC or flexible pipe used to connect all water furrows or field ditches to lateral ditches? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B15 |
| 28. Is precaution used during construction and all other land-altering events to reduce sediment transport? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B4, B10, B13, B17 |
| 29. Are herbicide bands maintained at the minimum width appropriate for the size of the trees? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | B11, B12 |
| <u>C. PEST MANAGEMENT</u> | | | | |
| <i>Equipment Maintenance</i> | | | | |
| 30. Is all pesticide application equipment properly calibrated and maintained? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C15 |
| <i>Educational Training</i> | | | | |
| 31. Are regularly scheduled training sessions held for spray applicators and others responsible for applying, handling, mixing/loading, calibrating and recommending pesticides? If so, does it accommodate speakers of other languages? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3 |
| 32. Are applicators trained to control and contain spilled pesticides? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3, C9 |
| <i>Pollution Prevention and Preparedness</i> | | | | |
| 33. Is the purchase of crop protection products scheduled to avoid the risk of having to store the products for extended periods? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C4 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|-------------|
| 34. Are routine inspections of the pesticide storage area conducted to check for leaks and spills, and are there well-charged fire extinguishers kept on-site? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C3, C5 |
| 35. Do you consider weather, equipment and operator capabilities, and grove conditions to avoid disposing of excess material? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C5, C10 |
| 36. When possible, do you return unopened, unused pesticides in their original container to your local agrichemical dealer? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C13 |
| <i>Application Methods</i> | | | | |
| 37. Are appropriate measures taken to reduce spray drift (i.e nozzle selection, spray pressure, drift reducing adjuvants, and/or other drift control materials)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C20, C21 |
| 38. Are practices taken that prevent over-spray of non-target areas (i.e. wrapping)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C21 |
| 39. Is the efficiency of pesticides maximized by selecting target-specific active ingredients that complement epidemiological cycles? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C1, C2, C22 |
| 40. Are all of the required records for pesticide applications, including date, time, location of treatment, target site, crop, total area, brand name, EPA Registration number, total amount, and method of application recorded by a certified applicator? Are they posted? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C19 |
| 41. Are pesticide labels reviewed with employees with special attention given to the "Environmental Hazards" section? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C12 |
| <i>Mixing and Loading Activities</i> | | | | |
| 42. Is application equipment washed on a concrete pad with a sump, and is the wash-water collected and reused in other applications? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C14 |
| 43. Are anti-siphoning devices, artesian pressure, or other measures utilized to prevent back siphoning of pesticides into ditches, canals, or wells? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C11 |
| 44. If pesticides are mixed at or near the same site year after year, is there a concrete pad with a sump to minimize contamination from small spills and leaks? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C7 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|---|--------------------------|--------------------------|--------------------------|------------|
| 45. When permanent mix-load station(s) are not available or feasible, do you utilize portable mix-load stations to minimize contamination from small spills and leaks? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C8 |
| 45. Are wellheads properly elevated or grouted to prevent contamination of wells during pesticide mixing/loading operations? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C11 |
| 47. Are appropriate measures taken to rinse and dispose of pesticide containers? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C13 |
| <i>Integrated Pest Management</i> | | | | |
| 48. Are a combination of control measures used targeting specific pests and diseases, including mechanical, cultural, biological, and chemical systems (i.e. Integrated Pest Management)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C1, C22 |
| 49. Are precision application techniques, such as global positioning systems, infrared imaging, or other advanced sensing devices used when applying crop protection products? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C18 |
| 50. Is soil pH maintained at a level that reduces the solubility of free copper ions to reduce off-site movement? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C17 |
| 51. Are specific factors of both the target area, such as the soil type, and the leaching and runoff potential of the pesticide to be applied considered when selecting a chemical for a specific pest? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C2 |
| 52. Is the efficiency of pesticides maximized by timing applications based on anticipated weather conditions and irrigation events | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | C16 |
| <u>D. NUTRIENT MANAGEMENT</u> | | | | |
| <i>Pollution Prevention</i> | | | | |
| 53. Is proper education and training given to employees concerning handling, loading, and application of nutrients? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D1 |
| 54. Is the machinery used to make applications consistent with the form and source of the nutrients? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D4 |
| 55. Is machinery calibrated and operated so as to achieve precise and desired placement at the specified rate? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D5, D6, D7 |
| 56. Are nutrients applied to the target area within the root zone or dripline as to avoid placement in areas prone to runoff (i.e. furrows)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D7 |

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|----------|
| 57. Are anti-siphoning devices, artesian pressure, or other measures utilized to prevent back siphoning of nutrients into surface water and/or groundwater? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D13, D18 |
| 58. Are fertilizer trailers parked away from canals, ditches, or wells (as much as is practical) to avoid contaminating adjacent water bodies during loading operations? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D11 |
| 59. Is spilled fertilizer transferred to application equipment and applied to the target area? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D10 |
| 60. Is the site used to load and unload fertilizer moved frequently? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D12 |
| 61. Is fertilizer always stored in an area protected from rainfall? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D9 |
| 62. Are fertilizer applications managed to protect environmentally sensitive areas by using: controlled release fertilizers, frequent low concentration fertigation events, multiple applications, and variable rate technology? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D2, D19 |
| 63. Are organic matter amendments (i.e. Class A sludge or other approved organic matter sources) an integral part of the nutrient management program? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D3, D17 |
| 64. Have you developed a nutrient management plan based on analyses of soil, water, and plant tissues? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D2 |
| 65. Are there conservation buffers and setbacks that are generally effective for reducing or preventing nonpoint source pollution? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D15 |

Sampling and Analysis

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------|
| 66. Is there a nutrient management plan that allows for optimum crop production based on soil, water, and plant sample analyses? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D2, D4 |
| 67. Is there a program of annual soil, leaf tissue and irrigation water sampling, analysis and interpretation to formulate a nutrient recommendation based on crop response? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D4 |

Application Methods

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|---------|
| 68. Are "high risk" fertilizer applications avoided? (such as prior to a storm, on bare soils with a high potential for erosion, or when the water table is at or near the surface) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D8, D14 |
| 69. Are a combination of liquid, dry, or foliar feeding used to maximize plant uptake and minimize losses of nutrients? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D2, D19 |

| | <u>YES</u> | <u>NO</u> | <u>N/A</u> | <u>BMP</u> |
|--|--------------------------|--------------------------|--------------------------|------------|
| 70. Are erosion control practices considered to minimize soil loss? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D15 |
| 71. When irrigation practices take place, is water applied so as to limit the wetting to only the root zone? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D16 |
| 72. Are low salt index fertilizers used to the greatest extent practicable? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | D19, D20 |

VII. CONCLUSION AND RESOLUTION:

Assessment conducted by (print name): _____

Signature: _____

Grove representative (if different from above): _____

Signature: _____

Date: _____

Comments: _____

VIII. BMPs TO BE IMPLEMENTED

BMPs selected from those indicated by NO answers that grove management agrees to implement with year of anticipated implementation (i.e A6-2006, B9-2005, and D16-2007, etc.):

Appendix 6. PRMSB Citrus BMP Rule.

5M-5 BEST MANAGEMENT PRACTICES (BMPS) FOR PEACE RIVER AND MANASOTA BASIN CITRUS

- 5M-5.001 Purpose.
- 5M-5.002 Approved Citrus BMPs.
- 5M-5.003 Approved Cow/Calf BMPs
- 5M-5.003 Presumption of Compliance.
- 5M-5.005 Notice of Intent to Implement.
- 5M-5.006 Record Keeping.

5M-5.001 Purpose.

The purpose of this rule is to effect pollutant reduction through the implementation of non-regulatory and incentive based programs which may be determined to have minimal individual or cumulative adverse impacts to the water resources of the state.

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.

5M-5.002 Approved BMPs.

The document titled *Best Management Practices for Citrus Groves in the Peace River and Manasota Basins* (August 2004) is hereby incorporated and adopted by reference in this rule for DeSoto, Hardee, Sarasota, Manatee and that part of Charlotte County within the jurisdictional boundaries of the Southwest Florida Water Management District. Copies of the document may be obtained from the Peace River Manasota Basins Citrus BMP Steering Committee, c/o Peace River Valley Citrus Growers Association, 10 East Oak Street, Arcadia, Florida 34266.

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.

5M-5.003 APPROVED COW/CALF BMPS

The document titled *Water Quality Best Management Practices for Cow/Calf Operations in Florida (June 1999)* is hereby incorporated and adopted by reference in this rule for DeSoto, Hardee, Sarasota, Manatee and that part of Charlotte County within the jurisdictional boundaries of the Southwest Florida Water Management District. Copies of the document may be obtained from the _____

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.

5M-5.004 Presumption of Compliance.

In order to obtain the presumption of compliance with state water quality standards and release from the provisions of Section 376.307(5), F.S., for those pollutants addressed by the practices, the applicant must:

- (1) Conduct an assessment of the subject properties using the Citrus Grower Best Management Practices Checklist incorporated in the document titled *Water Quality/Quantity BMPs for Best Management Practices for Citrus Groves in the Peace River and Manasota Basins (August 2004)*.
- (2) Submit a Notice of Intent to Implement as outlined in Rule 5M-5.006.
- (3) Implement the non-regulatory and incentive-based programs identified as a result of the assessment of the subject properties and listed in the Notice of Intent to Implement.
- (4) Maintain documentation to verify the implementation and maintenance of the non-regulatory and incentive-based programs.

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.

5M-5.005 Notice of Intent to Implement.

A Notice of Intent to Implement Non-regulatory and Incentive Based Programs identified in the document titled *Best Management Practices for Citrus Groves in the Peace River and Manasota Basins (August 2004)* and/or *Water Quality Best Management Practices for Cow/Calf Operations in Florida (June 1999)* shall be submitted to FDACS, Office of Agricultural Water Policy, 1203 Governor's Square Boulevard, Tallahassee, Florida 32301.

- (1) Such notice shall identify practices the applicant will implement. The notice shall also include: the name of the property owner; the location of the property; the property tax ID number; a timeline for implementation; the gross acreage on which each practice will be implemented; the name and contact information of an authorized representative; and the signature of the owner, lease holder, or an authorized agent.
- (2) Once filed with FDACS, the Notice of Intent to Implement shall enable the applicant to apply for assistance with implementation as identified in Section 403.067(7)(d), F.S.

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.

5M-5.006 Record Keeping.

All participants must preserve sufficient documentation to confirm implementation of the non-regulatory and incentive based programs identified in the Notice of Intent to Implement. All documentation is subject to FDACS inspection.

Specific Authority 403.067(7)(d) FS. Law Implemented 403.067(7)(d) FS. History: New.