Things to Consider

Transition from Flood to Micro-Irrigated Pecan

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How we have learned

- Irrigation is necessary for survival.
  - Technology underlying success of great civilizations (Egypt and China)
  - Areas of little to no rainfall
  - Rivers as source
- Egyptians
  - Great Nile
  - Carry water in vessels
  - Developed 4 styles of irrigation
    - Flat bottomed basins along river (sluice)
    - Diversion dams
    - Canals
    - Reservoirs

How we have learned

- Hohokam Culture (Arizona)
  - Flood irrigation – Salt, Gila, Santa Cruz, Verde Rivers
  - Independent of Middle East influence (200-775 A.D.)
  - 3-mile canal system developed
  - Complex networks

- Acequias (New Mexico)
  - Originated in Middle Eastern desert.
  - Introduced to Spain by the Moors in their 800 year occupation.
  - Spanish colonizers brought to New World.
  - Specific governance – “*mayordomo*” (watermaster)
  - Communal system in response to scarcity of water and key to survival of agriculture.

Flood irrigation vs. Other

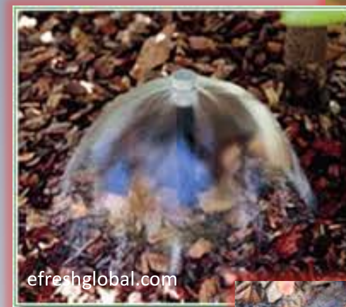
- Flood (furrow) irrigation - Method taught by our ancestors.
- Other methods
  - Romans, China, Middle East, Africa
    - "Ollas"
    - Unglazed clay pots
  - Drip irrigation
    - Idea developed (Germany, 1860)
    - Plastic tubing (Australia, ~1947)
    - Tubing with emitter (Israel, 1959)
  - Mexico
    - Sub-surface
    - The "Cadillac" in terms of water/nutrient delivery.
    - Not adequate in certain situations/locations.

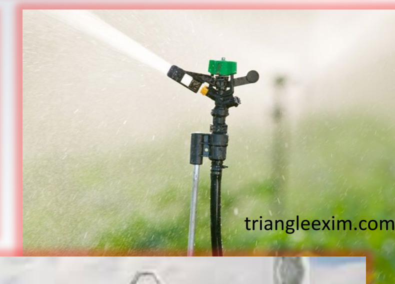
Micro-Irrigation

- Broad term
  - Surface Trickle (drip)
  - Bubbler
  - Spray (Micro-spray or sprinkler)
  - Pulse
  - Mechanical move (traveling trickle or drag) - pivot
  - Subsurface drip

- Focus here on Micro-spray or Micro-sprinklers
  - Difference is if they have moving parts.
  - Same as Micro-jet.

- Why?
  - Higher discharge rates.
  - Choice of emitter rates.





Scientific Literature

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Agricultural Water Management 46 (2001) 253–266
Agricultural water management
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Comparison of sprinkler, trickle and furrow irrigation efficiencies for onion production

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Accepted 7 February 2000

Abstract

In the Mesilla Valley of southern New
for growing onions. As the demand for w
limited resource. Water management wil
efficiency (IE) is an important factor int
Therefore, our objectives were to determ
(IWUE) and water use efficiency (WUE
different yield potential levels and to
application for a sprinkler and drip irrig
Maximum IE (100%) and economic re
State University's Agriculture Science C
80% obtained with the sprinkler irrigatio
irrigated with subsurface drip irrigation
nonstressed treatments, in which an extr
requirement was applied to keep the base
used for Et went to deep drainage water.
operated at a IE of 45 was 29%. Operatin
to surface irrigated onions and consequen
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Growth and Yield of Mature 'Valencia' Oranges Converted to Pressurized Irrigation Systems

R. L. Roth, C. A. Sanchez, B. R. Gardner

Abstract. *A study was conducted during four seasons to evaluate the performance of mature 'Valencia' orange trees converted to pressurized irrigation systems. Trees irrigated by trickle, bubbler, spray, and sprinkler systems were compared to trees irrigated by the traditional border-flood irrigation method used in the southwestern Arizona desert region. During the first year only trees irrigated by the sprinkler system grew significantly less than trees irrigated by border-flood. During the second year after conversion, trees irrigated by border-flood grew significantly more than trees irrigated by any of the pressurized systems. However, there were no differences in tree growth during the third and fourth years, suggesting that the trees adapted to the new irrigation systems. Effects of irrigation treatments on leaf concentrations of N, P, Fe, Zn, Mn, and Cu were minimal. There were significant differences in orange yields from trees among the different irrigation treatments within years. However, average or total tree yields over the four-year period did not vary due to irrigation treatment. Similarly, there were no consistent differences in fruit or juice quality. Overall, results from this study indicate that mature 'Valencia' orange trees can be converted to pressurized irrigation systems with minimal effects on fruit yield and quality. Under the conditions imposed in the studies, 33% less irrigation water was utilized with the pressurized systems compared to border-flood.* **Keywords.** *Citrus, Efficient irrigation, Sand.*

Historically, flood irrigation has been used to irrigate citrus on coarse textured soils in southwestern Arizona. Borders (soil dikes) are used to direct water down fields 200 to 400 m (660 to 1320 ft) in length. Water is generally directed across fields having zero slope with irrigation heads ranging from 0.28 to 0.42 m^3 s^{-1} (10 to 15 cfs). These systems are generally inefficient on coarse textured soils. Typical amounts of water applied exceed 2.5 m (8.2 ft) when the estimated consumptive use for citrus in Arizona has ranged from 1.2 to 1.5 m (3.9 to 4.9 ft) (Erie et al., 1963; Hoffman et al., 1982). Higher efficiencies could be obtained with larger heads of water and/or shorter field lengths. However, most current water delivery systems will not accommodate larger heads and are not designed for shorter field lengths. Additionally, shorter field lengths would compromise the efficiency of performing cultural operations.

Several investigations have shown improved irrigation efficiency with low-volume, pressurized systems. Previous work in Arizona demonstrated that, in addition to improved irrigation efficiency, trickle-irrigated young trees grew more vigorously than trees irrigated by border-flood (Roth et al., 1974; Rodney et al., 1977). However, limited information exists on the performance of mature orchards converted from border-flood to low-volume, pressurized systems. The objective of this research was to evaluate the yield and quality of mature 'Valencia' oranges converted from border-flood to pressurized irrigation systems.

Materials and Methods

This study was initiated in 1976 on a mature 'Valencia' (*Citrus sinensis* L. Osbeck) orange grove planted 12 years previously. The trees were Campbell budwood grafted on 'Rough lemon' (*C. jambhiri* Lush.) rootstock and planted on a 6.7 × 4.9 m (22 × 16 ft) spacing. The grove had been border-flood irrigated during its entire 12-year history. The soil was a Dateland loamy sand (Coarse-loamy, mixed hyperthermic Typic Camborthid) which is typical of the sandy soils used for citrus production in southwestern Arizona. Individual plots consisted of 12 tree blocks. The experimental design was randomized complete block with eight replications. The pressurized systems evaluated included trickle, bubbler basin, spray, and sprinkler systems. Details of the four pressurized irrigation systems follow.

Trickle

Six 3.8 L/h (1 gal/h) emitters were located under the canopy of each tree. Three emitters were equally spaced on opposite sides of each tree. Irrigations were made daily on Monday through Friday.

Bubbler Basin

The bubbler basin system consisted of a single bubbler head located under the canopy of each tree which discharged water at 3.8 L/min (1 gal/min). Since this water application rate exceeded infiltration rate, the water was contained inside a dike built around each tree which was located near the skirt line (outer most boundary of canopy) of the tree. Irrigations were applied once each week.

Article was submitted for publication in July, 1993; reviewed and approved by the Soil and Water Div. of ASAE in June 1994.

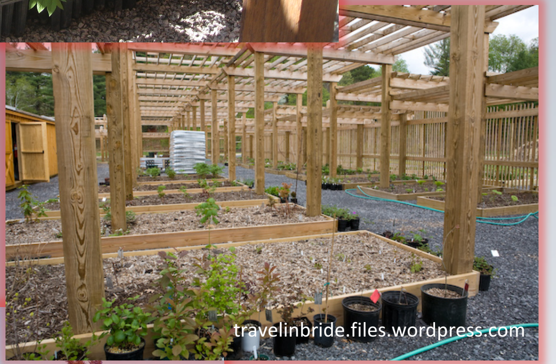
The authors are **Robert L. Roth**, ***ASAE Member Engineer***, Superintendent and Irrigation Engineer, Maricopa Agricultural Center, **Charles A. Sanchez**, Associate Research Scientist, and **Bryant Gardner**, Retired Research Scientist, Soil and Water Science Dept., Yuma Agricultural Center, Yuma, Ariz.

- Not much in literature!
- Still room for research on pecan orchard irrigation and comparing methods.
- Stay tuned though!
  - Curt Pierce
    (NMSU PhD. candidate)
  - Drip irrigation of pecan.

Changes in Environment

- Extreme changes cause dramatic affects
- Light intensity
  - Shade to full Sun
  - Low light exposure to High light exposure
- Same with water availability.

Gradual Processes



- Common terms in industries:
  - Acclimate
  - Harden off
  - Naturalize
  - Ween off
- Ultimately
  - Establishing a new regimen.
  - Careful process.

Considerations from Experience

- Farmer's Investment Co. (FICO)
  - After an initial small pilot plot test
  - 2008
  - Transitioned 20 year old pecans
  - 40 acre plot
  - Quick transition

- Concerns:
  - Water delivery (volume/depth)
  - Soil compaction
  - Salinity
  - Yield

Considerations from Experience

- Quick transition
  - Nozzle to nozzle delivery though.
  - Irrigation coverage over same area as that of flood.
  - 48 hour run time for volume/depth
    - Targeted 48 inches
    - Recommended sufficient at 20 inches
  - Some water conservation, not much, but more efficient delivery.
    - Flood – 65% efficient
    - Sprinkler – 80 – 85% efficient

Considerations from Experience

- Soil compaction
  - Usually rip in flood irrigation.
  - Use of cover crops stabilizes soil aeration.
  - No issue!

- Salinity
  - Keep an eye on the salts.
  - Frequent soil analysis.
  - Extra irrigation per season.
  - Or, use of bigger nozzles (40gal/min/acre) for more volume is option.
  - Same method to minimize a late freeze event.
  - No issue!

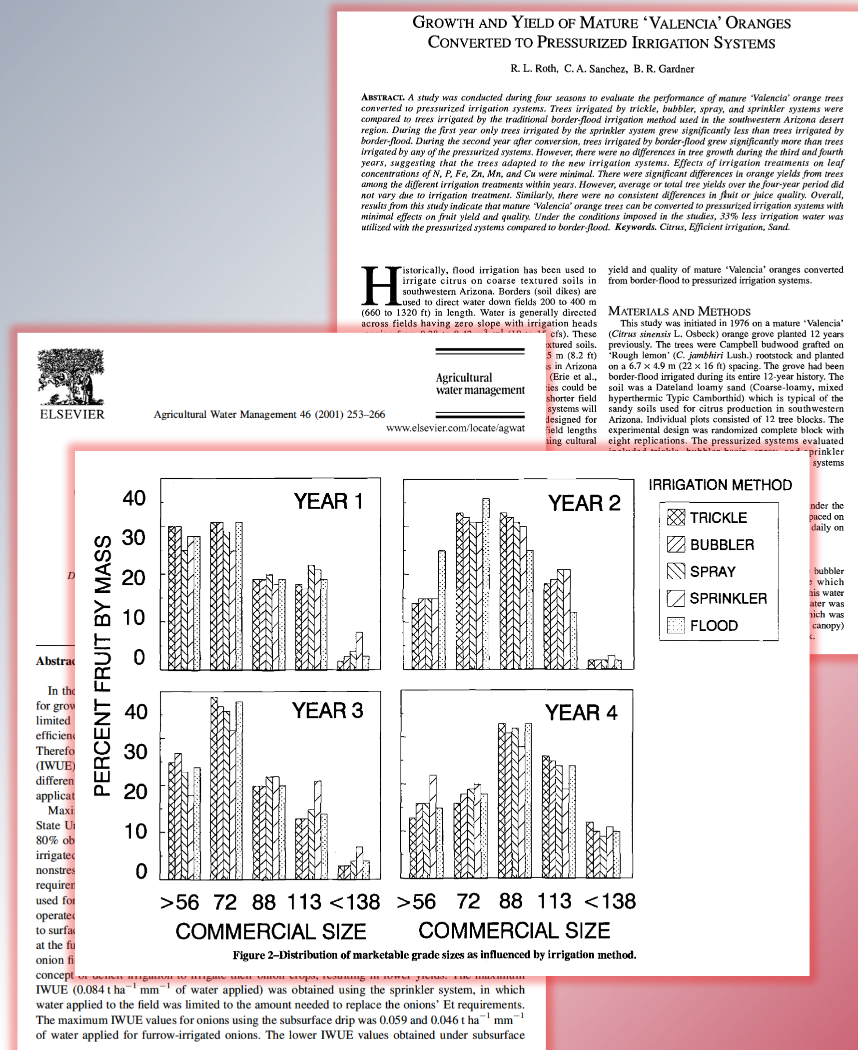
Considerations from Experience

- Sediment from river water
  - More filtration necessary
- Sloped Field
  - Use pressure compensating sprinkler heads.
- Weeds
  - More mechanical vs. hand labor.
- Labor costs much lower
  - No ditch labor for flood control.
  - Less mechanical energy inputs.
- Yield
  - Quality is more consistent.

In Other Research

- Citrus (Arizona)
  - Trickle, Bubbler Basin, Spray, Sprinkler
  - 33% less water than flood.
  - No significant differences in average or total tree yields over the four year period.

- Onion (New Mexico)
  - Sprinkler, Furrow, Drip
  - Sprinkler can increase yield and maintain high irrigation efficiency when compared to furrow or drip.



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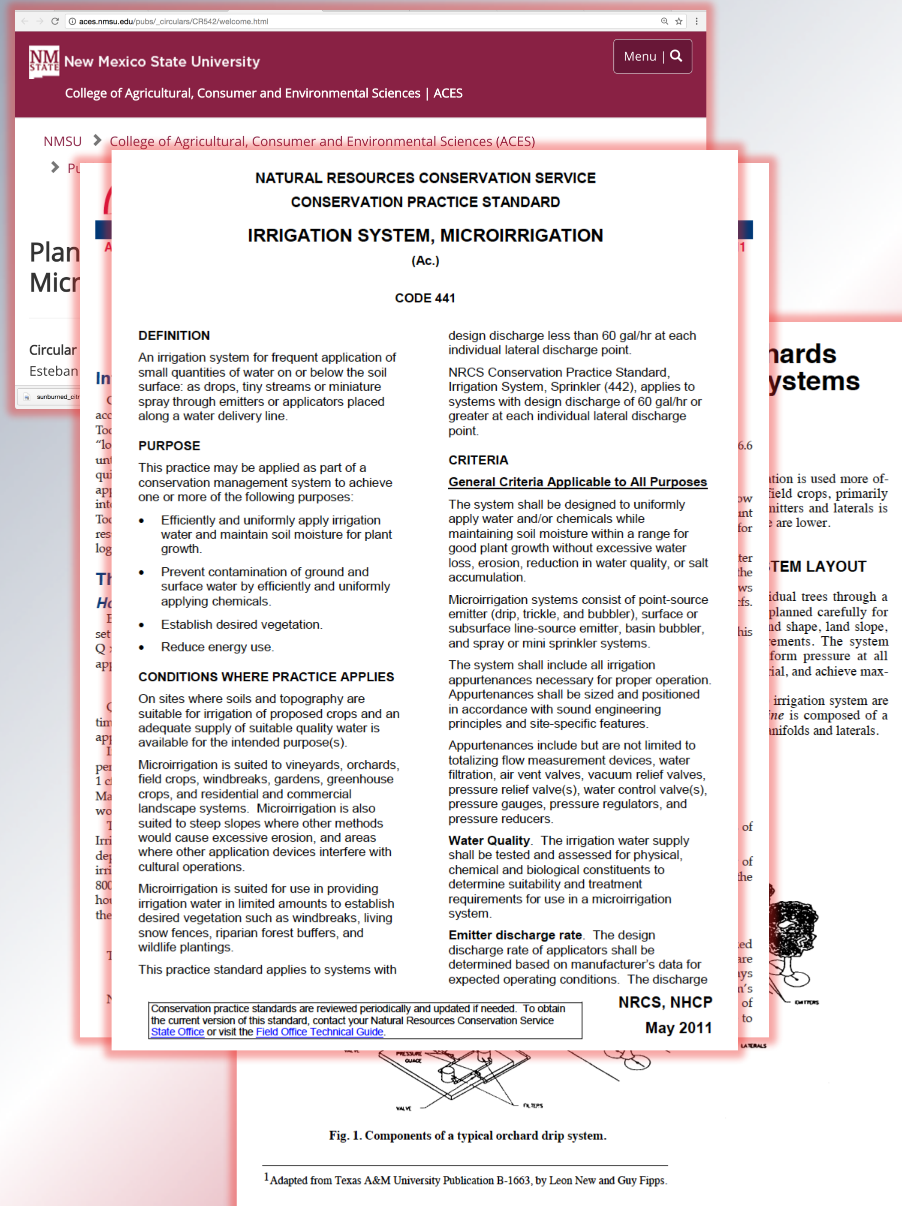
IWUE (0.084 t ha^{-1} mm^{-1} of water applied) was obtained using the sprinkler system, in which water applied to the field was limited to the amount needed to replace the onions' Et requirements. The maximum IWUE values for onions using the subsurface drip was 0.059 and 0.046 t ha^{-1} mm^{-1} of water applied for furrow-irrigated onions. The lower IWUE values obtained under subsurface

Figure 2–Distribution of marketable grade sizes as influenced by irrigation method.

Recommendation and Resources

- Recommendation:
  - 1st year transition – Alternate methods:
    - 1st irrigation – flood
    - 2nd irrigation – sprinkler
    - 3rd irrigation – flood
    - 4th irrigation – sprinkler
    - 5th … and 6th… and…so on.
  - Soil analyses (salinity focus)
  - 2nd year – full sprinkler ops.
- Resources:
  - NMSU Extension Publication
    - Circular 542
  - UA Extension Publication
    - AZ1157
  - Natural Resources and Conservation Services (NRCS) – also have pubs.
    - New Mexico - (505) 761-4400
    - Arizona - (602) 280-8801
    - Texas – (254) 742-9800



NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(Ac.)

CODE 441

DEFINITION

An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams or miniature spray through emitters or applicators placed along a water delivery line.

PURPOSE

This practice may be applied as part of a conservation management system to achieve one or more of the following purposes:

- Efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth.
- Prevent contamination of ground and surface water by efficiently and uniformly applying chemicals.
- Establish desired vegetation.
- Reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

On sites where soils and topography are suitable for irrigation of proposed crops and an adequate supply of suitable quality water is available for the intended purpose(s).

Microirrigation is suited to vineyards, orchards, field crops, windbreaks, gardens, greenhouse crops, and residential and commercial landscape systems. Microirrigation is also suited to steep slopes where other methods would cause excessive erosion, and areas where other application devices interfere with cultural operations.

Microirrigation is suited for use in providing irrigation water in limited amounts to establish desired vegetation such as windbreaks, living snow fences, riparian forest buffers, and wildlife plantings.

This practice standard applies to systems with design discharge less than 60 gal/hr at each individual lateral discharge point.

NRCS Conservation Practice Standard, Irrigation System, Sprinkler (442), applies to systems with design discharge of 60 gal/hr or greater at each individual lateral discharge point.

CRITERIA

General Criteria Applicable to All Purposes

The system shall be designed to uniformly apply water and/or chemicals while maintaining soil moisture within a range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Microirrigation systems consist of point-source emitter (drip, trickle, and bubbler), surface or subsurface line-source emitter, basin bubbler, and spray or mini sprinkler systems.

The system shall include all irrigation appurtenances necessary for proper operation. Appurtenances shall be sized and positioned in accordance with sound engineering principles and site-specific features.

Appurtenances include but are not limited to totalizing flow measurement devices, water filtration, air vent valves, vacuum relief valves, pressure relief valve(s), water control valve(s), pressure gauges, pressure regulators, and pressure reducers.

Water Quality. The irrigation water supply shall be tested and assessed for physical, chemical and biological constituents to determine suitability and treatment requirements for use in a microirrigation system.

Emitter discharge rate. The design discharge rate of applicators shall be determined based on manufacturer's data for expected operating conditions. The discharge

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the Field Office Technical Guide.

NRCS, NHCP

May 2011

Acknowledgements

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Allen Brandt
Rich Walden

Thank you for your attention!

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