NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(Acre)
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

- To efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth.
- To prevent contamination of ground and surface water by efficiently and uniformly applying chemicals.
- To establish desired vegetation.
- To reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

On sites where the 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, nurseries, and residential and commercial landscape systems. Microirrigation is also suited to steep slopes where other methods could 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, 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.

Conservation Practice Standard 442, Irrigation System, Sprinkler 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

Plan all work to comply with all Federal, State, and local laws and regulations. Plans to utilize water resources may need to be approved or permitted by the appropriate water management district in accordance with Chapter 40-2 Florida Administrative Code (F.A.C.).

Design the system to uniformly apply water and/or chemicals directly to the plant root zone to maintain 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 emitters (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. Size and position appurtenances 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 Management Plan. An Irrigation Water Management (IWM) Plan meeting the requirements of Florida NRCS conservation practice standard, Irrigation Water Management, Code 449, shall be developed for this practice.

Water Quality. Test and assess the irrigation water supply for physical, chemical and biological constituents to determine suitability and treatment requirements for use in a microirrigation system.

Emitter discharge rate. Determine the design discharge rate of applicators based on manufacturer's data for expected operating conditions. The discharge rate shall not create runoff within the immediate application area.

For bubbler irrigation, a basin beneath the plant canopy is required for water control, with applications confined to the basin area.

Determine the discharge rate of applicators (orifices, emitters, porous tubing, or perforated pipe) from the manufacturer's data relating to discharge and operating pressure.

Number and spacing of emitters. The number and spacing of emitters along a lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). Procedures found in NRCS National Engineering Handbook (NEH), Part 623, Chapter 7, Trickle Irrigation, shall be used to calculate Pw.

Operating pressure. The design operating pressure shall be in accordance with published manufacturer recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter manufacturing variability. Obtain the manufacturers coefficient of variation (C_V) and use it to assess the acceptability of a particular product for a given application.

The C_V shall be less than 0.07 for point source emitters and less than 0.20 for line source emitters.

Allowable pressure variations.

Manifold and lateral lines. Design manifold and lateral lines, operating at the design pressure, to provide discharge to any applicator in an irrigation subunit or zone operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Internal pressure shall not exceed manufacturer recommendations during any phase of operation.

Main and submain lines. Design main and submain lines to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit. Provide adequate pressure to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.). Size pipe mains and submains to maintain flow velocities less than 5 ft/sec during all phases or operation, unless special consideration is given to flow conditions and measures taken to adequately protect the pipe network against surge.

Design and install mains, submains, and manifolds lines according to criteria in Florida NRCS conservation practice standard, Irrigation Pipeline, Code 430.

Subsurface Drip Irrigation (SDI). Tubing depth and spacing are soil and crop dependent. Place emitting lines at a depth while considering the need for irrigation for germination and initial development and leaching potential from the soil profile. Maximum lateral line distance from the crop row shall be less than or equal to 24 inches for annual crops and less than or equal to 48 inches for perennial crops. EU shall be designed for a minimum of 85 percent.

Emission Uniformity. Size main, submain, and manifold pipes, and lateral lines to maintain subunit (zone) emission uniformity (EU) within recommended limits as determined by procedures contained in NEH, Part 623, Chapter 7, Trickle Irrigation.

EU can be computed using the following equation:

$$EU = 100(1.0 - 1.27\frac{C_v}{\sqrt{e'}})\frac{q_n}{q_a}$$

C_V = manufacturers coefficient of variation

e' = minimum number of emitters per plant

q_n = minimum emission rate computed

q_a = average emission rate

Filters. Provide a filtration system (filter element, screen, strainer, or filtration) at the system inlet. Under clean conditions, design filters for maximum head loss of 5 psi. Base the maximum design head loss across a filter before cleaning on manufacturer recommendations. In the absence of manufacturer data, maximum permissible design head loss across a filter is 7 psi before filter cleaning is required.

Size the filter to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Design filtration systems to remove solids based on emitter manufacturer recommendations. In the absence of manufacturer data or recommendations, design filtration systems to remove solids equal to or larger than one-tenth the emitter opening diameter.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10% of the system operation time. Within this 10% time period, the pressure loss across the filter must remain within the manufacturer's specification and not cause unacceptable EU.

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0% of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter/strainer.

Air/Vacuum relief valves. Design and install vacuum relief to prevent ingestion of soil particles if there are summits in system laterals.

Install air/vacuum relief valves on both sides of all block or manifold water supply control valves.

Pressure regulators. Use pressure regulators where topography and the type of applicator dictate their use. Do not plan pressure regulators to compensate for improperly designed pipelines.

System flushing. Install appropriate fittings above ground at the ends of all mains, submains, manifolds, and laterals to facilitate flushing. A minimum flow velocity of 1 ft/sec is considered adequate for flushing. During flushing submain and manifold (pipelines located downstream from a control valve) velocities shall not exceed 7 ft/sec velocity. Include a pressure gauge and/or Schrader valve tap in each flushing discharge outlet.

Additional Criteria Applicable To Efficiently and Uniformly Apply Irrigation Water

Depth of application. Net depth of application shall be sufficient to replace the water used by the plant during the plant peak use period or critical growth stage without depleting the soil moisture in the root zone of the plant below the management allowed depletion (MAD). Determine the gross depth of application by using field application efficiencies consistent with the type of microirrigation system planned. Include adequate water for leaching to maintain a steady state salt balance in all application depths.

Refer to the National Engineering Handbook, Part 652, Irrigation Guide, Chapter 6, to calculate the net depth of application, F_n. Express the net depth of application as inches per day per unit of design area.

$$F_n = 1.604 \frac{QNTE}{AF}$$

Where: F_n = net application depth, in/day/design area

Q = discharge rate, gal/hr/emitter

N = number of orifices or emitters

T = hours of operation per day, 22 hours maximum

E = field application efficiency, expressed as a decimal

A = ft^2 of field area served by N (number of emitters)

F = the design area as a percentage of the field area, expressed as a decimal

1.604 = units conversion constant

System capacity. The system shall have either (1) a design capacity adequate to meet the intended water demands during the peak use period for all plants to be irrigated in the design area, or (2) enough capacity to meet water application requirements during critical crop growth periods when less than full irrigation is planned. The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Field application efficiency (E) for design purposes shall not exceed 90 percent. Include an allowance for reasonable water losses (evaporation, runoff, and deep percolation) in the design capacity during application periods.

The system shall have the capacity to apply a specified amount of water to the design area within the net operation period. The system should have a minimum design capacity sufficient to deliver the peak daily irrigation water requirements in 90% of the time available, but not to exceed 22 hours of operation per day, expressed as T.

For non-orchard crops, the design area may be less than 100 percent of the field area (A) but not less than the mature crop root zone area.

Additional Criteria Applicable To Preventing Contamination of Ground and Surface Water.

Chemigation and Chemical water treatment. System EU shall not be less than 85 percent where fertilizer or pesticides, or treatment chemicals are applied through the system.

Provide backflow prevention devices on all microirrigation systems equipped for chemical injection.

Locate injectors (chemical, fertilizer or pesticides) and other automatic operating equipment adjacent to the pump and power unit, place in accordance with manufacturer's recommendation and include integrated back flow prevention protection. Back flow prevention equipment shall be as required by Chapters 487.064 F.A.C. (pesticides) and 567.087 F.A.C. (fertilizers).

Accomplish chemigation in the minimum length of time needed to deliver the chemicals and flush the pipelines. Limit the application amounts to the minimum amount necessary, and do not allow the rate to exceed the maximum rate recommended by the chemical label.

Follow proper maintenance and water treatment to prevent clogging based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

Use irrigation water supply test to plan for addressing or avoiding chemical reactions with injected chemicals to prevent precipitate or biological plugging.

Follow the pest or nutrient management plan on the timing and rate of application, according to Florida NRCS conservation practice standards, Nutrient Management, Code 590 and Pest Management, Code 595.

Additional Criteria Applicable To Establishing Desired Vegetation

System capacity. The system shall have design capacity adequate to provide supplemental water at a rate that will provide survival and establishment of planned vegetation for a period of at least 3 years. The system shall have the capacity to apply the specified amount of water to the design area within the net operation period.

Determine the gross application volume per plant using field application efficiency consistent with the type of microirrigation system planned. If a need is indicated by water test results, include adequate water for leaching to maintain a steady state salt balance in the application.

Design microirrigation systems that are installed solely to deliver supplemental water for establishment of windbreaks or riparian vegetation, to deliver a minimum of eight gallons per tree or shrub per week to assist in the establishment process. Net application volumes per plant are dependent on the species of tree or shrub and the age (first, second, or third year)

Place drip lateral lines that are installed on the ground surface along the plant row(s) in a serpentine pattern to allow for expansion and contraction of the line while keeping the emitter close to the tree or shrub. Pin or anchor above ground drip line to prevent the line from being dislodged or moved away from the trees or shrubs.

Plan, design, and install windbreaks according to Florida NRCS, conservation practice standard, Windbreak – Shelterbelt Establishment, Code 380.

When lateral emitter spacing or capacities vary with each row, design the laterals separately.

Operation and maintenance items specific to vegetation establishment are included in Chapter 6 of NEH, Part 652, Irrigation Guide.

Additional Criteria Applicable To Reduce Energy

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

Provide analysis to demonstrate reduction of energy use from implementation of a microirrigation system.

CONSIDERATIONS

In the absence of local experience, use field application efficiency (E) of 90% to estimate system capacity.

Where natural precipitation and/or stored soil water is not sufficient for germination, make special provisions for germination, or utilize the microirrigation system to apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. Limit the depth of a subsurface system for use on annual crops by system's ability to germinate the seeds, unless it is stated in writing that other provisions will be made for this function.

Consider potential rodent damage when selecting materials and deciding on above or below ground system installation.

Water quality is usually the most important consideration when determining whether a microirrigation system is feasible. Well and surface water often contain high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. Properly test the irrigation water to determine feasibility and treatment needed for use in microirrigation systems.

Microirrigation can influence runoff and deep percolation by raising the soil moisture level and decreasing available soil water storage capacity, increasing the probability of runoff or percolation below the root zone from storm events. Surface water quality may be affected by the movement of sediment, soluble chemicals, and sediment attached substances carried by runoff. Ground water quality may be affected by the movement of dissolved substances below the root zone.

Microirrigation may affect downstream flows or aquifers and the amount of water available for other water uses.

Consider alternate sources of irrigation when wetting the field planting and for germination.

Chemigation may or may not be required at the same time the plant requires irrigation, which may affect the economics of chemigation. Consider weather conditions before applying chemicals.

Do not apply chemicals if rainfall is imminent. Pest or nutrient management planning should address the timing and rate of chemical applications.

On systems where chemicals are injected, take care so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging. Microirrigation will affect a change in plant growth and transpiration because of changes in the volume of soil water.

There may be a potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

Field shape and slope frequently dictate the most economical lateral direction. Whenever possible, lay laterals downslope for slopes of less than 5% if lateral size reduction can be attained. For steeper terrain, lay lateral lines along the field contour and specify pressure compensating emitters or use pressure control devices along downslope laterals.

For orchard crops, it is desirable to wet the entire area under the canopy of the mature tree. The percent of the total crop area wetted (P_w) shall be a minimum of 33% for citrus trees.

P_w is not required on high water table soils when the water table is managed at a depth where capillary action (upflux) will supply a portion or the entire daily consumptive use rate.

Economic assessments of alternative designs should include equipment installation as well as operating costs.

Longer, less frequent irrigations of windbreaks during establishment are recommended to encourage deeper root development that increases drought tolerance.

Installation and operation of microirrigation systems have the potential to save energy as a result of reduced seasonal irrigation application, and in some situations reduced operating pressures.

PLANS AND SPECIFICATIONS

Keep plans and specifications for the microirrigation system with this standard and include a description of the requirements for properly installing the practice to achieve its intended purpose.

Plans and specification shall include, but not limited to, the following:

- Location Map.
- Plan map of the system on forms FL-ENG-441A, FL-ENG-441B, standard drawings FL-ENG-441, or other appropriate standard form. The detail shown on the plan map should be adequate to define the limits of the work and locate all the components of the system. A sufficient number of reference points need to be shown so that any qualified person other than the designer can layout the work.
- Size, type, and quality of all emitters, laterals, and components.
- Location and details of filters required.
- Location and details of flushing system.
- Location of utilities and notification requirements.

OPERATION AND MAINTENANCE

Prepare a site specific operation and maintenance plan (O&M) for use by the owner or others responsible for operating the system. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and prompt repair or replacement of damaged components. Frequent maintenance is essential to keep emitters functioning at design flow. Typical maintenance items include, but are not limited to, the following:

- Install flowmeter and monitor water application.
- Clean or backflush filters when needed.
- Flush lateral lines at least annually.
- Check applicator discharge often; replace applicators as necessary.
- Check operating pressures often; a pressure drop (or rise) may indicate problems.
- Check pressure gauges to ensure proper operation; repair/replace damaged gauges.
- Inject chemicals as required to prevent precipitate buildup and algae growth.
- Check chemical injection equipment regularly to ensure it is operating properly.
- Check and assure proper operation of backflow protection devices.
- Perform all operations in a safe manner and in accordance with all applicable safety regulations.

REFERENCES

ASABE EP405.1, Design and Installation of Microirrigation Systems, February 2003.
Keller and Bliesner, Sprinkle and Trickle Irrigation, 2000
Chapter 487.064 F.A.C.
Chapter 567.087 F.A.C.
FL Supplement to NEH Part 652, Irrigation Guide
NEH, Part 623, Irrigation, Chapter 7, Trickle Irrigation (formerly NEH, Section 15, Chapter 7).
NRCS Florida Conservation Practice Standards:
Irrigation Pipeline Code 430
Irrigation Water Management, Code 449
Nutrient Management, Code 590
Pest Management, Code 595