USDA Natural Resources Conservation Service

Irrigation Toolbox Chapter 1

Lesson Plan 3

Soil-Water-Plant Relationships

TITLE: Plant-Water-Soil Relationships

OBJECTIVE : To provide the participants with the basic knowledge on plant-water use relationships.

METHOD: Lecture and demonstration.

A knowledge of the rooting characteristics of plants and how plants use moisture is basic to the development of skills in irrigation water management. A continuous supply of readily available moisture is necessary for good plant growth. The irrigation system supplying a crop must deliver an adequate amount of water during crop's peak-use period. To determine the amount of soil moisture available to that crop, it is necessary to know from what depths of soil the plants get their moisture and how fast they use the moisture available to them. The size of the soil reservoir that holds water available to a plant is determine mostly by that plant's rooting characteristic. The distribution of its roots determines its moisture extraction pattern.

How Plants Get Moisture

Key Points :

- Root hairs on roots and rootlets.
- Taken from soil by osmotic and other forces.
- Water moves to root by capillary action.
- When moisture is reduced –
    - tension increases
    - water moves in by capillary action.
- Capillary action is limited in most soils.
- Deep root system
    - stretches water supply
    - lengthens irrigation period.

Kinds of Root System

Key Points:

- Peculiar to species.
- Fixed by heredity.

Teaching Aid:
Transparency of Figure 1-14.

Soil Effects on Root Development

Plants will develop normal rooting pattern if there are no soil effects and ample moisture is available. Soil restrictions limit root patterns.

Teaching Aid:
- Transparency of Figure 1-15.

Key Points:
- Shallow soils
- Dry soils
- Water table
- Hardpans

Effect of Climate on Root Development

Dry climates have deeper, more porous soils. Roots develop deeper. In humid areas, lower roots are drowned out and soil nutrients are leached out.

Moisture Extraction Pattern

Teaching Aid: Transparency of Figure 1-16.

Moisture extraction pattern is greatest in area of maximum root development.

Key Points:
- Top layers of soil or top of root zone.
- Decreases proportionately downward.
- 40-30-20-10 pattern.
- Develop from representative moisture extraction pattern of a number of crops.
- Stratified soils
    - Any one layer may be restrictive
    - Teaching Aid:
        - Transparency of Figure 1-17.

Consumptive Use

Consumptive use, often called evapotranspiration, includes water used by plants in transpiration, cell growth, evaporation from soil, evaporation of intercepted rainfall; generally expressed as depth in inches/day, inches/month, inches/season.

Teaching Aid:

- Transparency of Figure 1-19

Key Points:

- Transpiration - leaf.
- Evaporation - soil.
- Transpiration - big use by plants.
- Limited by plant's ability to transmit water.
- Evaporation increases with decrease in amount applied each irrigation.
- The wetter the soil is the more evaporation.
- Shading reduces evaporation.
- Transpiration and evaporation
    - increases with increase in temperature
    - wind movement.
- Relative humidity.

Daily Consumptive Use

Teaching Aid:

- Film of ET charts.

Key Points:

- Consumptive use varies with
    - state of plant growth (season)
    - temperature
    - wind movement
- Cutting alfalfa or pasture crop may not affect consumptive use if crop is irrigated immediately after cutting.

Seasonal Consumptive Use

Key Points:

- Total consumed during season varies from year to year.
- Directly related to difference in annual cropping season temperatures.

Peak Period Consumptive Use

Teaching Aid:

- Film of line chart.
- Film of Peak Use Tables.
- Film of chart in TR21.

Key Points:

- Average daily use during maximum use period (1-15 or more days)
- Used in determining irrigation system capacities.

- Varies by crop and depth of application.

Irrigation Water Requirements

Key Points:

- Net equals seasonal C.U. requirement - weighted for crops and soils.
- Gross equals net plus unavoidable losses
    - $gross = \frac{net}{efficiency}$
    - efficiency may be field, farm or project.

Effect of Different Soil Moisture Levels on Consumptive Use

Key Points:

- Consumptive use increases with
    - Increase in soil moisture if accompanied by increase in available plant nutrients (fertilizers)
- Consumptive use decreases with decrease in moisture below optimum because plant cannot supply water to meet potential ET.
- Consumptive use estimates are based on maintenance of optimum moisture levels.

Critical Moisture Use Periods

The periods when consumptive use rates and moisture level maintenance is critical are shown in the accompanying table.

Teaching Aid:

- Transparency of revised table on page 1-42 of Ch. 1.