page 60

PROPERTIES OF WATER

PLANT CONTENT

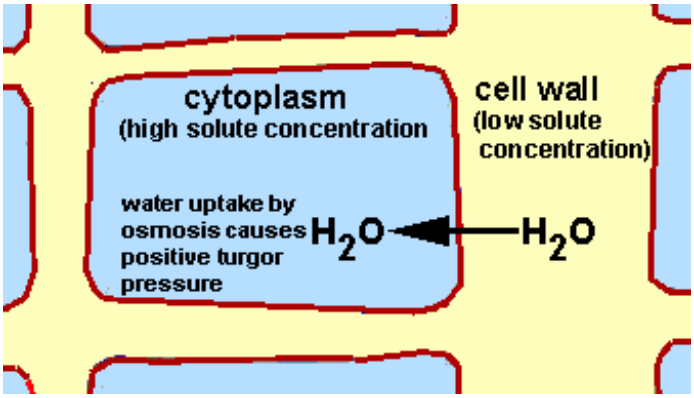
herbaceous plants - 85-95% water
woody plants - 75-85% water

FUNCTIONS OF WATER

1) solvent - dissolves solutes;
- the cytosol of the cytoplasm is a water solution of dissolved solutes.

2) reagent - water is used in biochemical reactions, such as photosynthesis.
3) translocation medium - water translocates solutes in xylem and phloem.
4) temperature relations - water is very important in regulating temperature.
a) stabilizes plants and environment (due to high specific heat)
b) evaporative cooling (due to heat of vaporization)
c) releases heat when freezes (due to heat of fusion)
d) constant temperature during phase change - freezing/melting water/ice stays at 32 ºF.
5) turgor pressure and growth

turgor pressure - the positive pressure inside of cells due to water uptake.
a) turgor pressure is due to osmosis.
b) turgor pressure keeps cells expanded
c) turgor pressure keeps herbaceous plants and plant parts erect
d) turgor pressure is the driving force for growth in size by causing cell expansion



growth - an irreversible increase in size or mass.
plasmolysis - shrinkage of individual cells due to loss of turgor pressure that causes a cell to become flaccid.
wilting - excessive water loss that causes loss of plant rigidity.
- caused by plasmolysis of enough individual cells to cause the organ to be limp.

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page 61

ATMOSPHERIC WATER

UNITS FOR EXPRESSING HUMIDITY

humidity - amount of water vapor in air; can be expressed as:

a)absolute humidity - amount of water vapor in air expressed as grams water per cubic meter of air (g/m^3)

b) specific humidity - amount of water vapor in air expressed as grams water per kilogram of air (g/kg)

c) relative humidity - amount of water vapor in air expressed as a percentage of the amount of water vapor that could be held at saturation.

d) vapor pressure - amount of water vapor in air expressed as the downward pressure exerted by the water vapor present in the atmosphere. (1-55 mm Hg).

RELATIONSHIP BETWEEN HUMIDITY AND TEMPERATURE

dew point - the temperature where relative humidity equals 100%.

condensation - conversion of water vapor to liquid or ice; condensation occurs when the temperature drops below the current dew point.

precipitation - loss of atmospheric water; occurs when condensation is extensive enough that the water or ice coalesce to form droplets/crystals that fall from the atmosphere due to the force of gravity.

Cold air can hold less water vapor than warm air, so as temperature decreases the absolute humidity or specific humidity that can be held at saturation decreases. Relative humidity is a percent of saturation. So as temperature decreases the absolute or specific humidity at saturation decreases, but the amount of water vapor present stays the same, thus relative humidity increases (conversely, as temperature increases relative humidity decreases). If the temperature continues to decrease (such as cooling over night or as air rises in the atmosphere), a temperature is reached where the relative humidity reaches 100% - this temperature is the **dew point**. If the temperature drops below the current dew point, the air becomes over saturated and **condensation** will occur. If this occurs in the upper atmosphere, a **cloud**forms or **precipitation** occurs. If this occurs close to the earth's surface, fog or dew forms

TYPES OF CONDENSATION

1) dew - condensation of water onto solid surfaces

2) fog - condensation of water into small droplets that stay suspended in air close to the earth's surface.

3) cloud - condensation of water into small droplets that stay suspended in air high in the atmosphere.

TYPES OF PRECIPITATION

l) condensation occurs above freezing (when dew point is above 32 ^{o}F)

a)drizzle - water droplets less than 0.5 mm

b)rain - water droplets greater than 0.5 mm.

2) condensation occurs below freezing (when dew point is below 32 ^{o}F)

a) snow - water condenses below freezing directly into small, loose ice crystals.

3) condensation occurs above freezing, followed by freezing

a)sleet - liquid rain droplets fall through a layer of freezing air and then freeze.

b)hail - liquid rain droplets fall through a layer of freezing air and then freeze; air currents carry the frozen droplets back up into the upper atmosphere; they pick-up more water, then freeze upon falling through the layer of freezing air; each time the ice crystal circulates through the warm and freezing layer it gets larger until it finally falls to earth.

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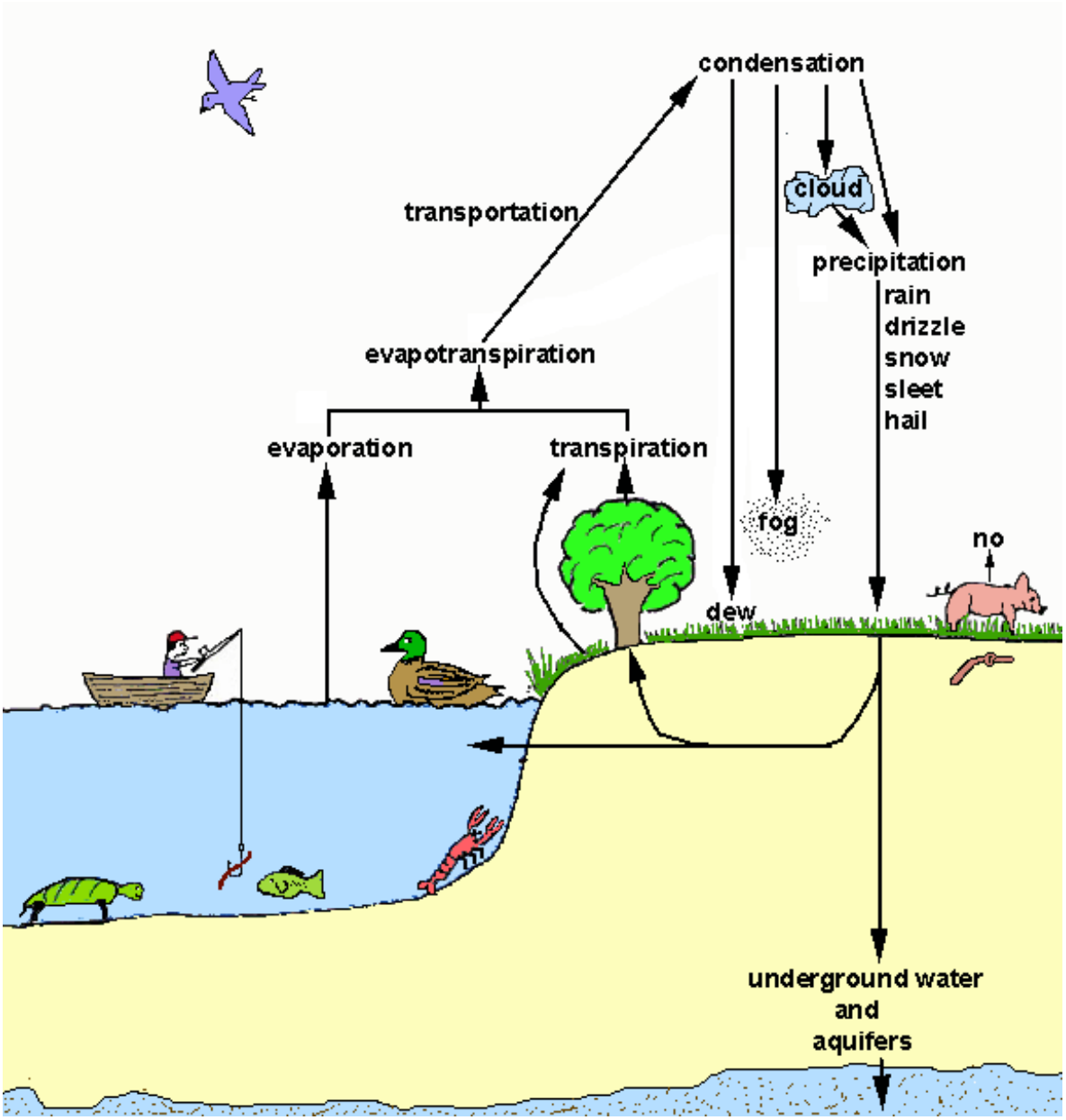
page 62

PRECIPITATION OR HYDROLOGIC CYCLE



Aquifers

An aquifer is an underground layer of porous rock, sand, or gravel, through which water can seep or be held in natural storage. Aquifers generally hold sufficient water to be used as a water supply. Many aquifers are enormous, with one of the largest being the Ogallala, which stretches from southern South Dakota to the panhandle of Texas. One of the largest within Texas is the Edwards Aquifer, which stretches from the Hill Country to the San Antonio area.

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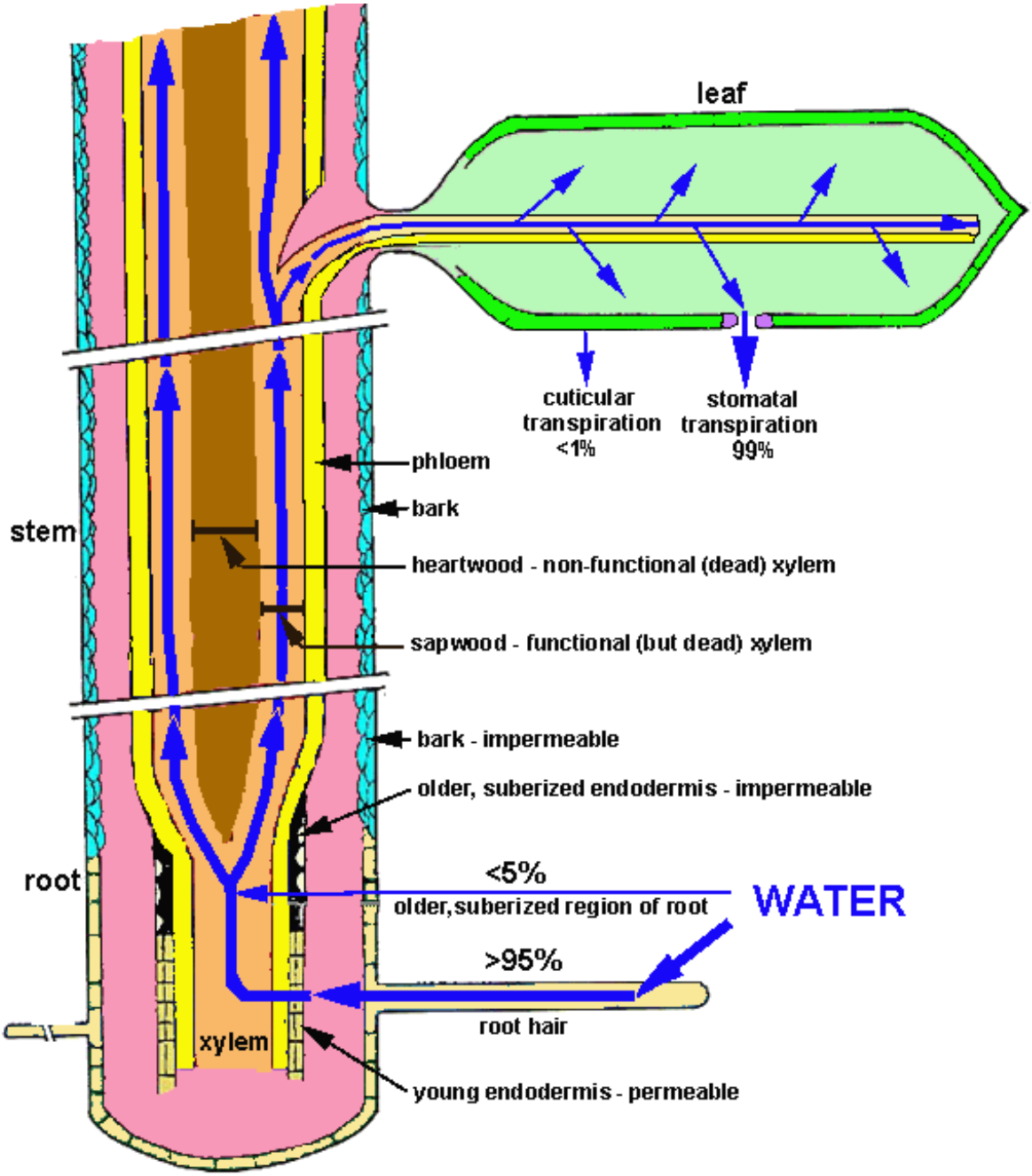
page 63

PATHWAY OF WATER THROUGH PLANTS



page 64

ABSORPTION, TRANSLOCATION AND TRANSPIRATION OF WATER

TERMINOLOGY

absorption - uptake of water by roots.
translocation - movement of water through plants, mainly through xylem.
transpiration - loss of water vapor from leaves and other above ground plant parts;
- mainly occurs through the stomata.

guttation - loss of liquid water from leaves;
- occurs through **hydathodes** (similar to stomata, but they do not close).

SITE OF WATER ABSORPTION

1) **young roots** - most absorption, mainly through root hairs due to:
- **a)** very numerous - 14 billion on a typical rye plant.
- **b)** large surface area -14,000 ft^2 (1310 m^2) on a typical rye plant
- **c)** rapidly and constantly produced - 975 linear ft (300 m) per day on a squash plant

2) **older roots** - little absorption due to:
- **a)** suberization of endodermis

b) periderm (bark) formation

COHESION THEORY OF TRANSLOCATION IN THE XYLEM

1) **Transpiration** occurs and is driving force
2) Causes **negative pressure** in leaves
3) **Column of water is pulled up** in the xylem and translocated due to:
a) H-bonding (hydrogen-bonding)
b) small size of xylem pores
c) negative charges on xylem walls

FUNCTIONS OF TRANSLOCATION

1) **driving force for translocation:** transpiration causes a negative pressure in leaves, which "pulls" the water up the xylem.
2) **evaporative cooling of leaves:** 540 cal of heat energy is dissipated for every gram of water that evaporates from leaves, which is a major contributor to the cooling of leaves.

Transpiration is usually much greater than is needed to satisfy these two functions. Thus, many horticultural practices attempt to minimize excessive transpiration.

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page 65

FACTORS THAT AFFECT TRANSPIRATION

PLANT FACTORS

1) **leaf area** - smaller leaf area decreases transpiration
2) **leaf orientation** - vertically orientated leaves decrease transpiration
3) **leaf surface** - waxy, hairy or shiny leaf surfaces decrease transpiration
4) **stomata** - when stomata are closed, transpiration decreases

ENVIRONMENTAL FACTORS

1) **humidity**- high humidity decreases transpiration
2) **temperature**
a) low temperature decreases transpiration.
b) high temperature increases transpiration, but when it gets too hot the stomata close, then transpiration may decrease
3) **light intensity**
a) darkness decreases, because stomata close, (except for CAM plants open at night)
b) high light intensity increases temperature which increases transpiration, until stomata close then transpiration may decrease; occurs midday during heat of summer
4) **wind**
a) as wind increases transpiration increases
b) if wind gets too high, then stomata close and transpiration may decrease
5) **soil water**
a) when soil is moist, transpiration occurs according to the above factors
b) when soil is too dry, stomata close causing transpiration to decrease (over rides above factors)

TECHNIQUES TO DECREASE TRANSPIRATION

1) **mistor spray foliage**
a) in propagation an intermittent mist system is used
b) mid-afternoon sprinkler irrigate plants in greenhouses/nurseries
2) **decrease light intensity** - grow plants under shade
3) **harden-off seedlings**
a) decrease watering,
b) decrease temperature, or
c) decrease fertilizer, especially N.
4) **antitranspirants** - chemicals that close or clog stomata.
Two Types
a) physiologically cause stomatal closure

b) wax, resin or latex that clogs stomata

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page 66

METHODS OF IRRIGATION

Types	Uses	Advantages	Disadvantages
OUTDOOR SYSTEMS			
1)Surface Irrigation			
a) flood	rice, orchards, cranberry	1) good wetting 2) frost protection	1) need level land 2) uses lots of water 3) some plants sensitive
b) basin	rice, orchards, cranberry	1 & 2) same as flood 3) irrigate sections	1 & 2) same as flood 3) upkeep of levees 4) slightly unleveled land
c) furrow	row crops	1) less water used 2) ideal for rows	1) uneven distribution 2) supervise for erosion
2)Sprinkler Irrigation	container plants, turf, high value fruits and vegetables	1) irrigate section 2) can be automated 3) evaporative cooling 4) frost protection	1) high cost 2) wind disrupts 3) nozzles clog
3)Drip or Trickle Irrigation	fruit (2.5 gal/hr/tree) row crops (300-400 gal/acre/day)	1) most water efficient 2) less plant stress 3) low pressure equip	1) high cost 2) emitters clog
GREENHOUSE SYSTEMS			
1) Manual	anything	1) personal monitoring	1) high labor costs
2) Chapin Tube or Spaghetti Tube	container plants	1) keeps foliage dry 2) can be automated	1) must use fine medium 2) gets tangled 3) high costs
3) Capillary Mat	container plants	1) constant moisture, maximum growth 2) keeps foliage dry 3) can be automated	1) need fine medium 2) 6" or less pots 3) too wet for some 4) algae growth on mat
4) Subirrigation or Ebb & Flow	container plants	1) keeps foliage dry 2) can be automated	1) high cost 2) disease may spread
5) Spray Nozzles	bench crops	1) can be automated	1) moderate cost
6) Sprinkler	container plants, bench crops	1) can be automated 2) evaporative cooling	1) high cost 2) nozzles clog

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