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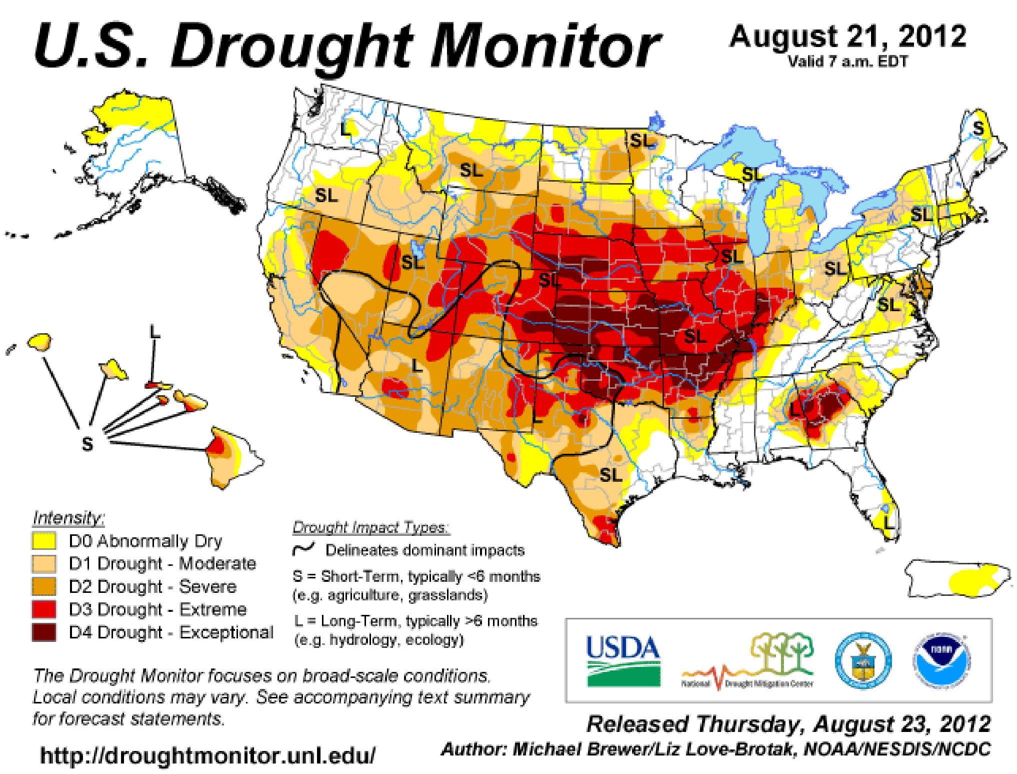
Special Drought Edition #2

Intermittent rainfall of varying amounts falling across the state and somewhat more seasonal temperatures has maintained the status quo without bringing relief to the drought situation in NY and the Northeast. The temptation is to relax irrigation schedules where berries have been harvested; now is not the time to relax your irrigation schedule however. Continue to irrigate berry crops 1-2" per week where no rainfall has occurred to maintain plant health and vigor going into the winter. It's an investment you can't afford NOT to make! If you don't have an irrigation system already in place and in use, take time to evaluate the impact the 2012 drought has had on your berry crop yields, plant vigor and survival. A system may pay for itself in a matter of 2-3 years when drought conditions occur, even for much shorter periods than those that occurred this season.

National Drought Summary -- August 21, 2012 - *[Michael Brewer, National Climatic Data Center, NOAA](#)*

The discussion in the Looking Ahead section is simply a description of what the official national guidance from the National Weather Service (NWS) National Centers for Environmental Prediction is depicting for current areas of dryness and drought. The NWS forecast products utilized include the HPC 5-day QPF and 5-day Mean Temperature progs, the 6-10 Day Outlooks of Temperature and Precipitation Probability, and the 8-14 Day Outlooks of Temperature and Precipitation Probability, valid as of late Wednesday afternoon of the USDM release week. The NWS forecast web page used for this section is: http://www.cpc.ncep.noaa.gov/products/forecasts/.



Dryness Categories

D0 ... Abnormally Dry ... used for areas showing dryness but not yet in drought, or for areas recovering from drought.

Drought Intensity Categories

D1 ... Moderate Drought
D2 ... Severe Drought
D3 ... Extreme Drought
D4 ... Exceptional Drought

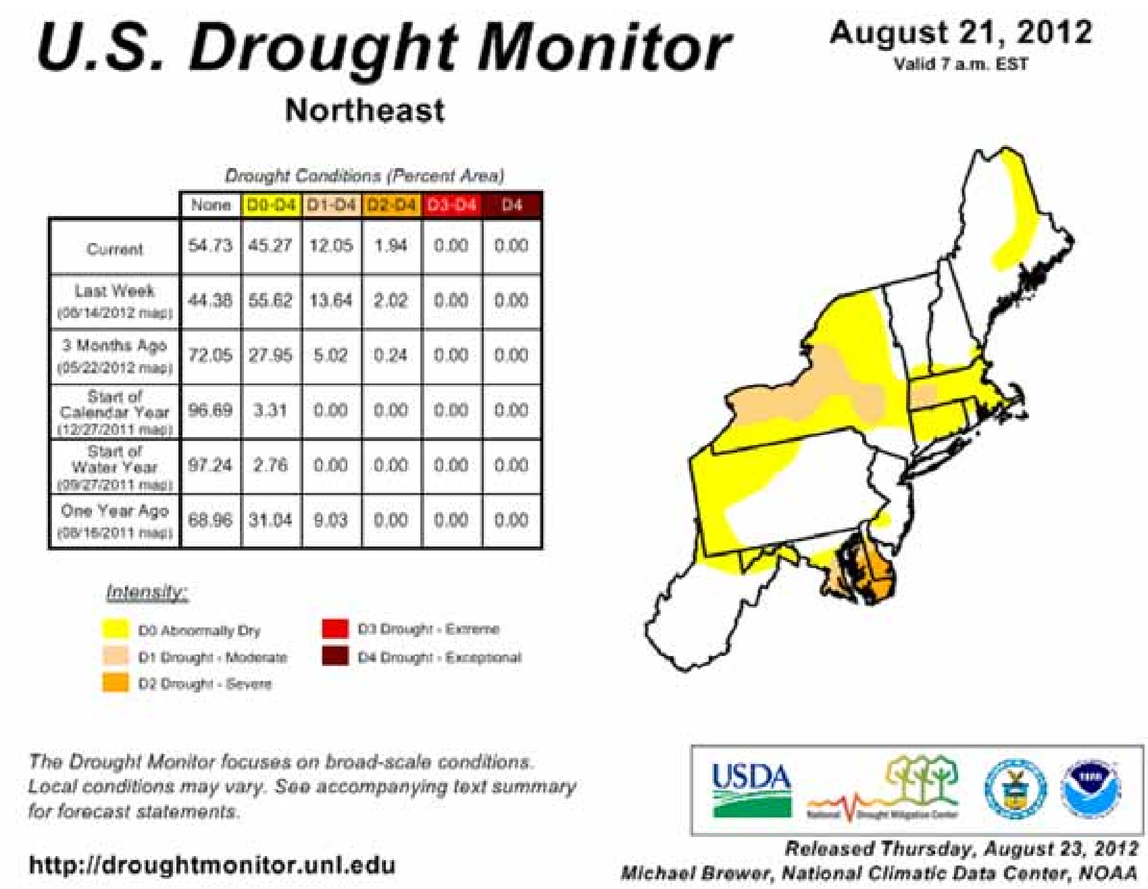
Drought or Dryness Types

S ... Short-Term, typically <6 months (e.g. agricultural, grasslands)
L ... Long-Term, typically >6 months (e.g. hydrology, ecology)

This U.S. Drought Monitor week saw a few notable improvements and some serious degradation. Temperatures have generally been below normal this week from the east side of the Rockies to the East Coast, with the exception of Texas, the Southeast Coast, and northern New England. This has helped ease drought impacts, particularly in those areas where beneficial precipitation fell. One such area is in the Ohio Valley where parts of Indiana saw more than five inches of rain. This is the second straight week of beneficial precipitation for some of these areas and this precipitation has largely alleviated Exceptional Drought (D4) from the state, despite lingering impacts still being felt. Last week, drought gripped slightly less of the agricultural land in the country with 85% of the U.S. corn crop, 83% of soybeans, 63% of hay, and 71% of cattle areas experiencing drought. Nearly half of the corn (49%) and soybean (46%) areas are experiencing Extreme (D3) to Exceptional (D4) Drought. This has led to both reduced yields and earlier harvests. Additional impacts this week include closing of an 11-mile stretch of the Mississippi River near Greenville, MS to barge traffic because of low water levels and wildfires expanding from northern California to Idaho.

The Southeast: Continued beneficial precipitation in the Southeast this week helped to improve drought conditions, particularly in northern Alabama and the upstate of South Carolina. Drought continues to strongly grip Georgia, eastern Alabama and western Tennessee and to a lesser extent areas of North Carolina and northern Mississippi where conditions remain relatively unchanged.

The Northeast and Mid-Atlantic: Most of this area received enough precipitation that drought conditions held status quo with minor reductions in Abnormal Dryness (D0) in Maine and Rhode Island and a reduction in Severe Drought (D1) in Massachusetts.



The South and Southern Plains: In Oklahoma, drought intensified to Exceptional Drought (D4) status in the northeast part of the state, which continues to miss out on beneficial precipitation falling to the south, just over the Texas border. Drought conditions in parts of eastern and extreme western Texas improved with the recent rains, while a lack of rain in the central and panhandle parts of the state led to expansion of Exceptional (D4), Extreme (D3), Severe (D2), and Moderate (D1) Drought as well as Abnormal Dryness (D0). In Louisiana, Extreme (D3) and Severe (D2) Drought expanded in the north.

The Central and Northern Plains and Midwest: More widespread rains in the Midwest alleviated some D1-D4 Drought as well as Abnormal Dryness (D0) through southern Wisconsin, Illinois, Indiana, and Ohio and into western Kentucky again this week. Lingering drought impacts remain in many areas, leaving devastated agriculture in its wake. Despite a much cooler week this week, Exceptional (D4) and Extreme (D3) Drought continue to expand in the area from northern Missouri and into Kansas and Nebraska where beneficial precipitation has been hard to come by. North Dakota saw a minor change in Moderate Drought (D1) and Abnormal Dryness (D0) in the north central part of the state.

The West: The drought in southeast California, Arizona, and New Mexico has begun to respond to the recent monsoon rains. Areas of Extreme (D3) and Moderate (D2) Drought were alleviated, largely across the southern part of the states. A slight expansion of Exceptional Drought (D4) took place in eastern Colorado while in Idaho, Moderate Drought (D1) and Abnormal Dryness (D0) continue to expand and contribute to wildfires.

Hawaii, Alaska and Puerto Rico: Drought conditions remained unchanged in Alaska and Puerto Rico this week. In Hawaii, drought intensified to Extreme (D3) levels in southern Lanai.

Looking Ahead: During the August 23 - 27, 2012 time period, there is an enhanced probability of precipitation in the Northern Plains and in the extreme South throughout the entire period, as well as in the Southwest and the south Atlantic Coast early in the period, and around the Great Lakes later in the period. Below normal precipitation is expected in the Northwest, New England, and into the Ohio Valley. The northern tier of the country is expected to see above normal temperatures.

For the ensuing 5 days (August 28 – September 1, 2012), the odds favor normal to above normal temperatures everywhere in the U.S. with the exception of the Pacific Coast. Normal to below-normal precipitation is expected from the West Coast, through the Southern and Central Plains and into the Ohio Valley and South. Above-normal precipitation is expected from the Northern Plains, through the Great Lakes, and all along the East Coast. In Alaska, temperatures are expected to be normal to above-normal over the entire state and precipitation is expected to be below normal in the south and above normal in the north.

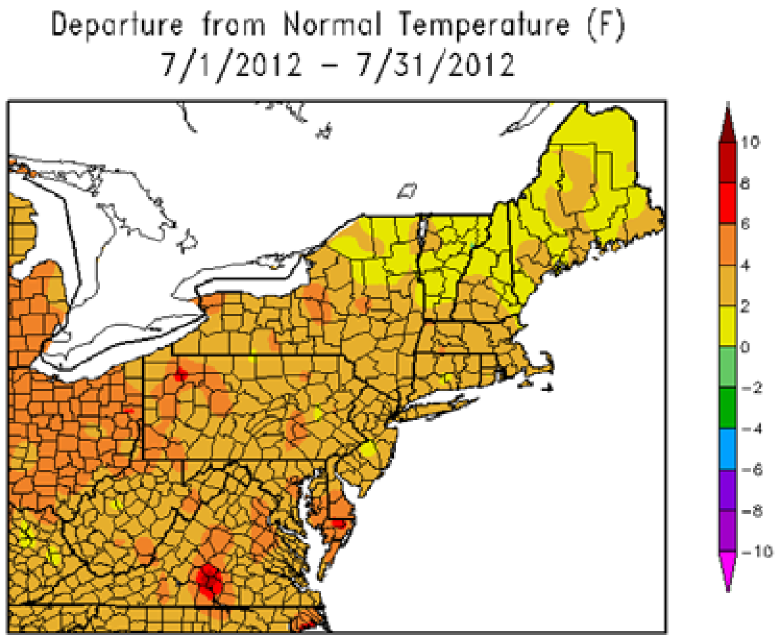
NE Regional Climate Center Report: July Hot and Dry – *courtesy the Northeast Regional Climate Center*

Dry and Drought Conditions Expand

Summary: July 2012 was the hottest month on record for the contiguous US. In the Northeast it was the 7th warmest July since 1895 and the warmest January through July on record.

July 2012 was filled with hot temperatures and dry conditions for most areas of the Northeast. Of the 35 First Order stations, 16 ranked in their top 5 warmest July's. Elkins, WV had their warmest July on record! All but one station recorded temperatures in the 90's. Washington, DC had 22 days of 90 or hotter, more than any other First Order station this month, but Philadelphia tied their July record for 21 days of 90 or hotter with 2011. There were also 14 First Order stations with at least one 100-degree day! Washington, DC again had the most, with 7 days, which broke their previous record of 6 days in 1930. Dulles Airport tied 2011 for their record with 3 days in the 100's. Rainfall amounts varied widely across the Northeast, from only 27% of normal in Buffalo, NY to 195% of normal in Elkins, WV. Some areas did get much needed rain, but all states excluding Maine continue to have abnormally dry conditions.

Discussion: It was the seventh warmest July since 1895 in the Northeast. The average temperature was 72.8 degrees F, which was 2.9 degrees above normal. Each of the twelve states in the region averaged warmer than normal, with departures that ranged from +1.5 degrees in Rhode Island to +4.0 degrees in Delaware. It was the second warmest July since 1895 in Delaware and the third warmest in Maryland. All twelve states in the region ranked within the top 24 warmest since recordkeeping began in 1895. New maximum temperature records were set at many of the region's first order stations during the month as the mercury soared into the upper 90's and low 100's. The sensor at Washington's National Airport recorded 105 degrees on the 7th, surpassing the record of 102 degrees set just two years ago. Baltimore, MD's new record temperature of 104 degrees on the 18th broke the long-standing record of 102 degrees set in 1887. The Northeast's seven-month average (January - July) of 49.9 degrees was the warmest such period since 1895. It was the 2nd warmest January through July in Pennsylvania and West Virginia and the warmest first seven months of the year in the rest of the Northeast states. The most recent twelve months (August 2011 through July 2012) was the warmest August through July in 117 years in the Northeast and in all of the states except West Virginia. It was the second warmest August through July in West Virginia where the average temperature of 54.7 degrees missed tying the record set in 1932 by 0.1 degree F.



With a regional precipitation total of 3.70 inches, the Northeast averaged 87 percent of normal in July. Three states, Pennsylvania, (107 percent), Rhode Island (116 percent) and West Virginia (125 percent) had totals that were wetter than normal. Departures in the drier-than-normal states ranged from 87 percent in Connecticut to 51 percent in Maine. Interestingly, last month, Maine saw its 4th wettest June since 1895; this month the state had its 5th driest July on record. And last month's dry state, West Virginia, which ranked 11th driest in June ended up having its 10th wettest July in 118 years. The year-to-date totals averaged 88 percent of normal in the Northeast. It was the driest January through June since 1895 in Delaware and the 5th driest in Maryland. While drought conditions in the Northeast were not as bad as some parts of the country, there were areas of concern according to the July 31, 2012 U. S. Drought Monitor. Western Massachusetts, a small area in north central Connecticut, and parts of upstate New York were experiencing moderate drought (D1) conditions while areas of severe drought (D2) expanded in Delaware and eastern Maryland. Areas of abnormally dry (D0) conditions expanded in most of the states in the region, the exception was West Virginia, where conditions improved by month's end.

Severe storms on the 26th produced five EF1 tornadoes, two in Steuben County, NY, one in Chemung County, NY, one in Luzerne County, PA and one in Susquehanna County, PA. The Chemung County tornado ripped through Elmira, downing power lines and trees, resulting in damage to about 300 homes and businesses. The other tornadoes formed over more rural areas, causing minor structural damage from fallen trees or wind blown debris. In addition, several microbursts resulted in straight-line damage near Orwell and Harford, PA. Over 600 trees were downed near Orwell and minor structural damage was reported in Harford.

What is Evapotranspiration and Why It Matters- *Jeff Andresen, and Aaron Pollyea, MSU Extension, Department of Geography*

Under drought conditions, plants may not be able to extract water fast enough to keep up with evapotranspiration

July 25, 2012. Among the many problems associated with extended periods of drought is the inability of plants to extract water at a rate fast enough to keep up with the rates of evapotranspiration (the combined loss of water from plant transpiration and soil evapotranspiration) that atmospheric conditions will allow. The rate of **potential evapotranspiration** (PET), the amount of water that *could potentially* be lost to evaporation over a vegetated surface given meteorological conditions at the time, is dependent on the intensity of solar radiation, air temperature, humidity and wind speed. Of these meteorological factors, solar radiation and air temperatures are most important here in Michigan, with somewhat less influence from humidity and wind speed.

Three of the factors (solar radiation intensity, air temperature and wind speed) are positively correlated with PET (i.e., the greater the intensity of solar radiation, the greater the PET), while humidity is negatively correlated (i.e., the greater the amount of water vapor already in the atmosphere, the less that can evaporate). PET also depends on the amount of crop type and its leaf area, the phenological stage and the amount of plant-available soil moisture in the rooting zone.

As should be apparent, there are an almost infinite number of combinations of these factors, which complicates the estimation of PET rates for a given crop of interest. For simplicity and by international convention, PET rates are typically estimated for a specific set of circumstances including a 4-inch high, unshaded, grass-covered surface with no soil water limitations. This special case is generally referred to as **reference potential evapotranspiration** (sometimes seen labeled as ET_0), which can be related statistically to a specific crop type and growth stage of interest (i.e., an 8-foot high corn crop during early grain fill stage) to provide an ideal estimate of crop water needs.

ET_0 is a primary input variable for most irrigation scheduling systems. The Enviro-weather information system provides ET_0 on a daily basis for a weather station site and time period of interest. Once at the site, select a station of interest then choose "More weather" up at the top, located in the horizontal green bar. Scroll down the page to the "Water-use tools" section. The ET_0 values are available under "Potential Evapotranspiration" application. Further information to help adjust the daily ET_0 values into water need estimates for a specific crop and growth stage can be found in the "Water-use tools" section under "Irrigation Scheduling" and "Irrigation Scheduling Checkbook" menu options. See examples of PET given for many crops at different growth stages and how this concept is used in irrigation scheduling.

The other critical factor in this discussion is the amount of water actually lost by the vegetated surface, referred to as **actual evapotranspiration** or ET. Actual rates of evapotranspiration only reach potential rates when water is not limiting (i.e., after a series of heavy rain events, soil at or above field capacity). However, when the amount of plant-available water in the soil decreases, the actual rate of ET quickly falls to a fraction of PET. After long stretches of dry weather, the ratio of actual to potential evapotranspiration rates commonly falls to values below 0.50, and the accumulated frequency of this ratio over the course of a growing season is strongly correlated with yields of many (dry land) types of crop.

During the 2012 drought, rates of PET have exceeded both actual evapotranspiration rates and normal PET rates. Accumulated PET during the 2012 growing season versus the long-term average is depicted in Figure 1 for East Lansing, Mich., which is generally representative of conditions across the southern half of Lower Michigan. As can be seen in the figure, rates of PET have been abnormally high ever since the middle of May (the first half of that month was wetter and cloudier than normal), with a difference of 2.85 inches (21.6 percent above normal) by July 24. The difference during this period is due to several meteorological differences, including greater than normal solar radiation levels (8.5 percent greater than normal), higher air temperatures (3.1 degrees Fahrenheit higher than normal) and lower humidity (10.6 percent lower than normal).

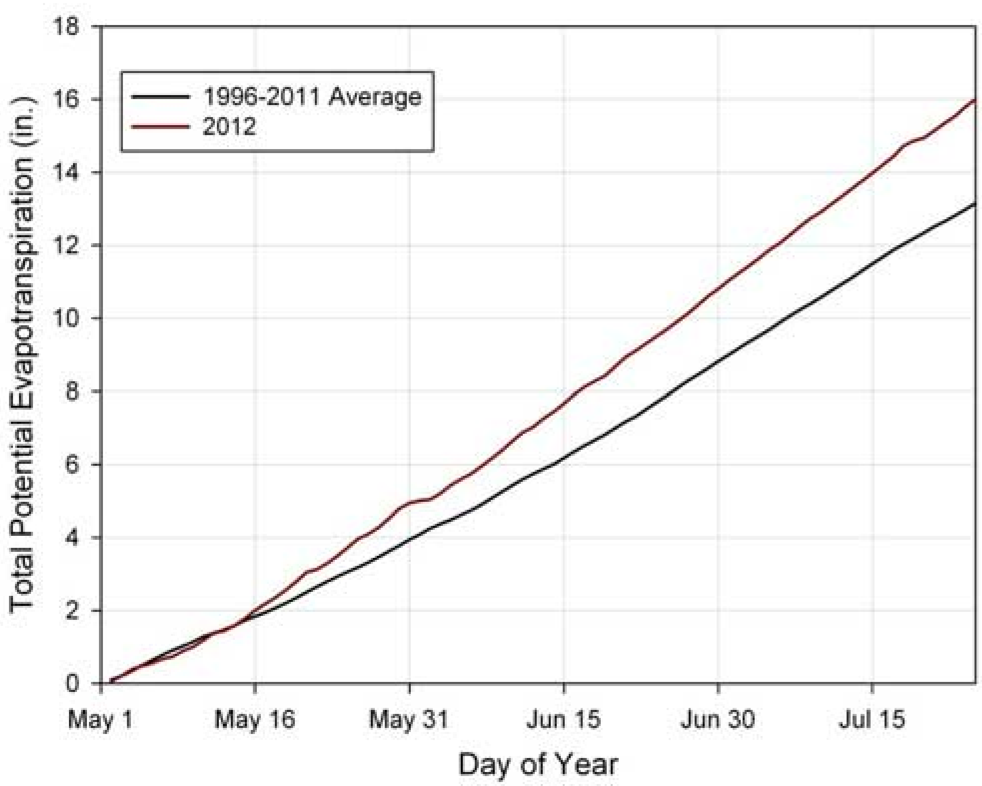


Figure 1. Observed potential evapotranspiration (PET) from May 1 to July 24, 2012 (red line), versus the long-term average (1996-2011, black line) at East Lansing, Mich. Data courtesy MSU Enviro-weather.

Overall, in terms of crop water needs, this has resulted in a “double whammy” this growing season. Not only have soils generally not been able to supply sufficient water to meet crop needs due to the extended dryness, but rates of PET based on atmospheric conditions have been significantly greater than normal this year, which has exacerbated the effects of the drought.

Understanding the Drought through the Evaporative Stress Index - *Jeff Andresen, and Aaron Pollyea, MSU Extension, Department of Geography*

A look at the Evaporative Stress Index explains patterns of water availability and moisture stress across large areas.

August 9, 2012. In the previous article, we discussed the role and importance of evapotranspiration in crop production systems and the impacts on water use this year because of the drought conditions. To better understand patterns of water availability and moisture stress over large areas, the USDA ARS's Hydrology and Remote Sensing Lab has recently developed a new Evaporative Stress Index which depicts cumulative evaporative stress across the continental United States. See Figure 1 for an image of cumulative evaporative stress during the past 30 days.

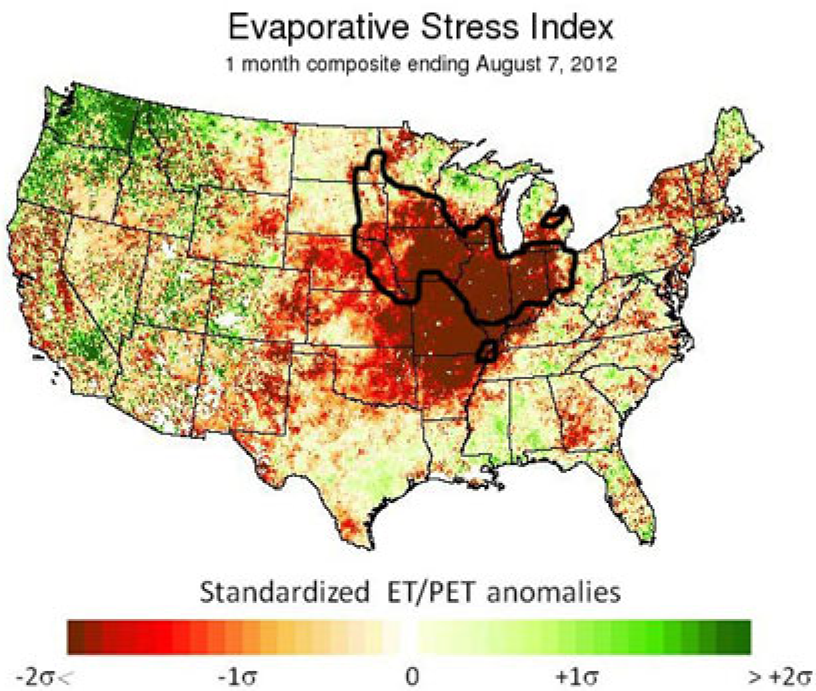


Figure 1. Evaporative stress index averaged over the period July 8 through August 7, 2012. Brown-colored areas signify higher levels of water stress while green denotes areas of relatively low water stress. Major corn-producing areas (as defined by USDA NASS) are outlined in a thick, black line. Figure courtesy of the USDA ARS Hydrology and Remote Sensing Lab.

The index is based on the ratio of actual to potential evapotranspiration rates. If water available to plants on a given day is limited, the actual rate quickly falls below the potential rate and the ratio for the day is relatively low. If water is freely available, the actual rate approaches or is close to the potential rate and the ratio is high.

The index expresses this cumulative ratio in a standardized form, relative to a 10-plus year historical data record. Thus, in the figure for the period July 8 through August 7, 2012, brown-colored areas (low negative σ values) signify relatively higher levels of water stress while green denotes areas of relatively low water stress.

The pattern of serious water stress across the central United States as a result of the drought and relatively moist conditions across the Pacific Northwest is striking. Interestingly, in Michigan, the major differences between relative abundance of moisture across northern areas and shortages in the south are also visible.

For reference, we have outlined major corn-producing areas of the country (as defined by USDA NASS) in thick, black lines. The standardized form of the index also allows some information about how often this level of stress would be expected to occur, which in this case suggests less than 5 percent of the time across much of the central Corn Belt.

In terms of the growing season for corn, these unusually high levels of moisture stress generally occurred from late vegetative to pollination to early grainfill crop development stages. From the strong spatial correlation of high stress levels with major production areas, it is easy to understand why grain prices have skyrocketed during the past several weeks.

Additional information:

- MSU Extension's Drought Resources

Dr. Andresen's work is funded in part by *MSU's AgBioResearch*.*This article was published by* ***MSU Extension****. For more information, visit http://www.msue.msu.edu.*

Trickle Systems: Basic Components, Design and Installation Considerations - *Larry D. Geohring, Senior Extension Associate Agricultural & Biological Engineering Cornell University, Ithaca, NY 14853*

Trickle (drip) irrigation is the frequent application of small quantities of water which is slowly and precisely applied to the soil as drops, small streams, or miniature sprays through emitters which are spaced to supply the evapotranspiration(ET) demands of each plant. The basic components necessary for a drip irrigation system are a source of water, a means for pressurizing the water (usually a pump), a filtration device if the water is not clean and pure, a network of pipes (mains, submain headers, and laterals) to transport and distribute the water, and the emitters.

Depending on the site characteristics and irrigators objectives, other components may be necessary or desirable for the proper operation and management of the system. For example, where the water comes from an already pressurized municipal water main, a pressure reducing and backflow prevention device may be essential to reduce line pressures to the desired operating pressure of the emitters and prevent reverse flow of the irrigation water into the municipal line. If the irrigator would also like to distribute fertilizer, an injection device would be necessary. Flow meters and pressure gauges are not necessary components but are often desirable for monitoring and managing the drip system.

Water Source: Water quality and water quantity are the major design considerations regarding the water source. Many sources of surface and groundwater, from drinking water to reclaimed wastewater quality, have been successfully used with drip irrigation. The water quality will influence which type of emitter should be used and determines the filtration requirements. Emitters with larger, turbulent, or flexible type diaphragms (self-flushing) orifices will have less clogging problems when poor quality water is used.

Water contaminants are separated into physical, chemical and biological fractions. Physical contaminants are suspended inorganic and organic solids such as sand, leaves, mice and snails; and are usually removed with centrifugal type separators\filters and ordinary screen and disc type filters.

Chemical contaminants are the dissolved solids (calcium, iron, magnesium, carbonates, sulfates, etc.) and the pH of the water. These become a problem when dissolved ions interact with each other or with fertilizers to form precipitates or promote slime growth. Screen, disc or sand filters are placed after a fertilizer injector to minimize movement of any precipitates. However, chemical reactions can occur anywhere in the pipe network so it is often recommended to add extra screen filters in-line at the beginning of laterals when dissolved constituents are prevalent.

Biological contaminants are bacteria, algae, fungi, slimes and filamentous materials associated with suspended and organic sediments in surface water supplies. Groundwater can also contain slime-forming organisms which when combined with iron and hydrogen sulfide can cause clogging. Sand media filtration is the most effective way for removing biological contaminants.

The quantity of water required on a per acre basis for drip irrigation is less than for other irrigation methods because it is the most water efficient method of irrigating. Drip irrigation should be designed and operated to replace only evapotranspired water, and since the water is delivered directly to the plant, little water is wasted. It is difficult to give a rule-of-thumb quantity in the number of gpm/acre required because this varies widely according to plant density/acre and the discharge patterns and requirements for the selected emitter(s). Nevertheless, one should plan on having enough water available to make up the ET deficit during a growing season, about 4 to 12 inches here in NY.

Pumps: Although there are exceptions, in most cases a pump will be needed to deliver some quantity of water to the drip system at a pressure high enough to operate the emitters. The primary design considerations for pumps are what flow rate is required, how much pressure is needed, pump location and type of power unit. The pressure at the pump must be adequate to move water up the hill(1psi for every 2.31 ft. of elevation), compensate for friction losses in all of the piping and filter components, and still meet the design operating pressure of the emitter (typically ranges from 4 to 40 psi). The emitter discharge rate at the system operating pressure, and the number of emitters (or length of tape) operating at the same time determines the required flow rate. Pump size should also be increased accordingly to provide some reserve operating pressure and capacity for backwashing filters and flushing drip laterals. Given the variety of site conditions, layouts, and selection of emitters, every pump selection is unique.

Pumps can be either centrifugal or submersible depending on the location of the water supply and the desired location of the pump. A centrifugal pump cannot be used if the pump must be installed approximately 15 ft. or more above the drawdown water level. Different pump casing designs and impeller combinations will have different pump efficiencies. Pumps can be driven and powered using a variety of connections and power units. The most efficient is directly coupling an electric motor to the pump. Using flat belts, pulleys, gear cases and gas engines are all less efficient combinations. Electric pumps are also more easily adapted to automated control systems. Efficiency, as used here, means the cost of operating the pump (input fuel or electric energy) relative to the amount of water energy (flow rate times pressure) produced.

Considerations for pump installation are should it be fixed or portable, does a shelter need to be provided for the pump and any controls, pump alignment and minimizing pump vibration.

Filters: The selection of filter type, size, and capacity are the primary design considerations and these depend upon water quality, the system flow rate and the emitter design. The general practice is to filter one-tenth the diameter of the emitter's smallest opening, and to size the filter with at least 20% extra capacity. Manufacturers usually specify the allowable flow rates for a filter.

Centrifugal type filters and settling basins are used to filter water with high amounts of suspended materials, particularly where these materials are also dense such as sand. Sometimes a centrifugal filter will be used on the suction side of a pump to protect the pump impeller and seals from sand being pumped from a well or dirty surface water body.

Screen and disc type filters are similar in their construction and appearance in that the filtering screen or discs are placed inside a housing made of steel or plastic. The filtering action and path of water movement inside the filter differs, however, for different types and manufacturers. Some screen filters also use a conical shaped screen to create a combination centrifugal and filtering action. The screen material is made of stainless steel, plastic or synthetic cloths and comes in various mesh sizes. Mesh sizes of 100 or 200 (equivalent to 0.006 and 0.003 inches respectively) are commonly recommended. Screen filters are either taken apart and manually cleaned or some have automatic wash down, back flush features.

Sand media filters consist of an inlet diffuser pipe, some type of sand, crushed silica, or crushed granite, and an underdrain inside of a closed stainless steel or fiberglass housing so the filtration process can occur under pressure. The selection of the sand media particle size and the flow rate per square foot of media determines the degree of filtration achieved. Thus, the quality of the water and the flow rate will determine the number and sizes of filtration units needed. Sand media filters are usually specified in pairs and equipped with valves for automatic backwashing.

Basic considerations for filter installation are should they be portable or fixed and providing a set-up for easy cleaning and disposing of backwash water. Screen and disc filters which need to be manually cleaned should be plumbed so this can be done easily without having to shut down the pump. Many installation precautions are necessary with sand media filters such as washing the media before putting it into the housing, placing it to the proper depths, and backwashing. There are also several back flush adjustments or decisions such as setting the proper back flush flow rate, and setting the frequency and duration of the backwash.

Pipes: The concept of drip irrigation became economical with the introduction of plastic piping (and emitter) components. Design considerations for piping primarily involve decisions on type, size, friction losses, and layouts. Although steel, aluminum, and PVC type piping is frequently used in the main and submain portions of drip systems, flexible polyethylene plastics are typically used for the laterals.

Appropriate sizes of pipe are determined from flow rate and allowable friction losses which can be determined from friction loss tables. The trade-off is bigger diameter pipes cost more, but the energy cost to pump the water through bigger pipes is less (initial capital cost vs. operating cost). Perhaps a good rule-of-thumb for poly pipe is to use 0.5 inch diameter for flows less than 4gpm, 0.75" for flows between 4 to 8 gpm, 1" for 8-13 gpm, 1.25" for 13-22 gpm,1.5" for 22-30 gpm, 2" for 30-50 gpm, 3" for 50-115 gpm, and 4" for 115-200 gpm. For example, a flow of 4 gpm through a 0.5" poly pipe will result in a friction pressure loss of 6.4 psi for every 100 ft. of pipe, a loss the pump would have to compensate for. If this pressure loss is occurring in a lateral, it will also significantly affect the emitter discharge from one end to the other. For good water (and fertilizer) uniformity, the pressure loss from one end of the lateral row to the other should not be more than 10 to 20 %.

The best (and most economical) pipe layout depends on the field shape, the cropping practice, and balancing the friction losses described above. Generally, row lengths for the drip tapes should be kept under 500 ft. Square to slightly rectangular blocks usually provide the best water uniformity while still allowing smaller pipe diameters to be used.

Pipe installation considerations typically involve decisions regarding surface or subsurface placement, provisions for flushing lines, making secure connections, and providing thrust blocking and air or vacuum relief components. Careful attention to these aspects will likely save valuable maintenance time and cost.

Emitters: There are many types of emitters and drip tapes. Emitters have different flow and pressure ratings depending on the style of orifice design (simple orifice, long path, pressure compensating, etc.). Individual emitters can be installed where ever you want or bought preinstalled (at various spacings)in the lateral tubing. Drip tapes are available in different diameters, come indifferent plastic mil thickness, come in various orifice designs and spacings, and also have different flow and pressure ratings. Design considerations primarily involve spacing and wetting patterns, flow/pressure characteristics, and determining layouts for uniform water delivery.

The wetting pattern of an individual emitter is primarily a function of soil type and the discharge rate. The pattern will be circular in appearance at the surface with the diameter of the circle growing larger with finer textured soils and with higher discharge rates. An emitter is likely to wet a circle about 2ft. in diameter on a sandy soil expanding to 3 to 4 ft. on a loam and silt clay soil. Emitters spaced close enough will wet a narrow, continuous strip which is the case with drip tapes. These wetting patterns are important to determining proper emitter placement and water application depths.

The Heat Equation - *Arleen Clark, RN, COHN-S*

Farmers often take for granted the adverse health effects that stress from physical work in hot weather can produce. Continual exposure to high temperature and humidity can cause several specific heat related illnesses.

Heat Exhaustion results from prolonged exposure to heat combined with an inadequate intake of water and salt. Symptoms of heat exhaustion include: headaches, dizziness or light headedness, weakness, thirstiness, mood changes such as irritability, confusion or not being able to think straight, feeling sick to your stomach, vomiting, dark colored urine or decreased urine production, fainting and pale clammy skin.

Heat Cramps can occur when a large amount of water is consumed without replacing salts (sodium). Low sodium levels can change muscle reactions which can result in weakness or muscle spasms. Additional symptoms of heat cramps include: dizziness, tiredness and vomiting.

Heat Stroke is a life-threatening emergency in which an individual has a high body temperature along with the loss or strongly reduced capacity to sweat. Heat stroke typically results from heavy work in a hot environment when the individual is not able to adjust to the high temperatures. Symptoms include: dry pale skin (no sweating), hot red skin that looks like sunburn, mood changes such as irritability, confusion or not being able to make any sense, seizures and collapse or not being responsive.

With all heat related illnesses there are a number of things that should be done to treat an individual's symptoms. Move the individual to a cool, shady area to rest. If the person is dizzy or light headed they should lie down on their back and elevate their feet. Clothing should be loosened and heavy clothing should be removed. The person needs to drink some cool water; a small cup every 15 minutes if they are alert enough and not feeling sick to their stomach. Individuals that are nauseous need to lie on their side. Attempts should be made to cool the person by fanning them or cooling the skin with a wet cloth or cool spray mist of water. For heat stroke victims if ice is available, ice packs should be placed under the arm pits and groin area. Call 911 for all heat stroke victims and when individuals with heat exhaustion or heat cramps do not begin to feel better after a few minutes of treatment.

It is best to prevent heat related illness by taking several steps to protect yourself as well as your co-workers. Become familiar with signs and symptoms of heat related illnesses as well as what to do to help someone. Perform the heaviest work chores in the coolest part of the day. Slowly build up tolerance to the heat and the work activity; this can take up to 2 weeks. Wear light, loose-fitting, breathable clothing such as cotton. Drink plenty of water, a small cup every 15 to 20 minutes. Remember to take short breaks in a cool shaded area on a frequent basis in order to give your body a chance to cool down. Avoid caffeine and alcoholic beverages while working as these beverages make the body lose water and can increase the risk of heat related illness. Eating large meals before working in a hot environment should also be avoided. In addition, some medications can affect you when working in a hot environment, be sure to check with your doctor to find out if you are taking any of these.

The key to maintaining your health starts with you; learn the signs and symptoms of heat related illnesses as well as how to prevent them from happening to you.

For more information about farm-related illnesses contact Arleen Clark at 800-343-7527 ext 229 or via email aclark@nycamh.com. Arleen is the Coordinator of Clinical Occupational Health Services at NYCAMH (the New York Center for Agricultural Medicine & Health).

For on-farm safety or youth farm safety services or information contact Sharon Scofield at 800-343-7527 ext 236 or via email sscofield@nycamh.com. A program of Bassett Healthcare Network, NYCAMH promotes safe and healthy farming.

Irrigating Small Fruits and Vegetables – Understanding When and How Long to Water Your Crops - *Steve Reiners, Cathy Heidenreich, and Marvin Pritts, Department of Horticulture*

Obviously, too little or too much water will have a big impact on the yield and quality of your small fruit and vegetables. When soils are droughty and water uptake limited, a series of events can result that have a big impact on yield. To conserve water, small pores on the leaves of the plant, called stomata, close. When these close, photosynthesis – the pathway that creates everything the plant needs -is shut down. Sugars, proteins, and structural components are reduced, and quality declines as fruit are less sweet, lack flavor and leaves and skins become thicker and less desirable. If water uptake is limited, so is the uptake of nutrients like calcium and boron. Calcium deficiency will lead to blossom-end rot in tomatoes, peppers, melons and any fruiting vegetables, as well as fruit softening in strawberries, raspberries and blackberries. It also causes tipburn in leafy crops and berries. Boron is essential for root growth in berry crops; without sufficient B for good root growth, uptake of other nutrients may be limited, causing plants to be stunted. Blueberries subject to drought stress experience delayed fruit ripening and small fruit; if drought conditions persist, fruit may abort. Dry weather followed by wet will result in fruit cracks in vegetables and strawberries. Drought may result in shorter ears of corn and poor fill of kernels.

Remember, drought equals reduced yield, quality, and flavor. Irrigation, especially trickle irrigation, allows us to maintain soil moisture at optimum levels producing the quality small fruits our markets demand.

Every crop has critical times when moisture stress is most damaging to yields. Table 1 outlines this. As you can see, these critical periods may last many weeks and a reliable irrigation system should be a top priority on every farm.

Table 1. Growth stage when moisture stress is most damaging to crops

Crop	Most Critical Stage of Growth
Asparagus	Fern growth
Blackberry	Flowering, fruit set and enlargement; primocane growth
Blueberry	Flowering, fruit set and enlargement, ripening
Beans, snap	Pod filling
Broccoli, Cabbage, Cauliflower	Establishment and head filling
Carrot	Establishment, root development
Cucumber	Flowering, fruit enlargement
Eggplant	Flowering, fruit development
Lettuce	Head development
Muskmelon	Flowering, fruit enlargement
Onion	Bulb enlargement
Pea	Flowering, pod filling
Pepper	Transplanting, fruit set and development
Pumpkin, squash	Flowering, fruit development
Raspberry	Flowering, fruit set and enlargement; primocane growth
Strawberry	Flowering, fruit set and enlargement, post-renovation root and leaf development
Sweet corn	Tasselling, silking, ear filling
Tomato	Flowering, fruit set and enlargement
Turnip	Root enlargement

Trickle irrigation is an extremely efficient way to water high value vegetables and small fruits. It delivers water exactly where it is needed, to the roots, which keeps leaves dry and helps reduce disease and not to weeds between rows. It saves considerable water compared to overhead irrigation, 60 to 80%. By carefully applying irrigation water containing nutrients, you can optimize soil moisture without the potential for leaching away nutrients. You can irrigate while workers are in the field. Finally, the entire system can be automated, freeing you up for other jobs.

The preceding article covered what you will need to set up a trickle system. This article will focus on how to know how much to apply. First, let's review a few terms.

Centibars (cb) – The unit that measures the moisture content of soil. Saturated soils will be close to 0 cb. The number will rise as soil moisture declines.

Evapotranspiration (ET) – Water lost from the soil though evaporation and transpiration from the plant. Depends on time of year, % ground cover, crop rooting depth and weather (temps and sunshine).

Saturated Soil – All soil pores are filled with water, ranges from 0 to 10 centibars (cb).

Field capacity – After all excess water from rain and irrigation has drained out with the largest pores filled with air, not water. Plants grow best at this level and just a bit dryer. 10-25 cb.

Water holding capacity – the total amount of water held by the soil at field capacity, depends on soil type.

So how do you know when to irrigate. Waiting for plant cues like wilting is not good. By the time you see wilting lots of other detrimental things have happened that impact yield and quality. Using soil monitors like gypsum blocks and tensiometers will help, but they cost money and require experience to get the most out of them. You can also develop a water budget, based on the typical evapotranspiration occurring at that time. Many growers will take a shovel and dig down a foot and examine the soil moisture, watering soon after field capacity is reached. .

Since the water holding capacity depends on soil type, one needs to know the type of soil you are irrigating to determine when and how long to run your system. A sandy soil will hold much less water than a more loamy soil. Table 2 summarizes the amount of water that is held in the top one foot of soil, when the soil is at field capacity. Remember 1 inch of water spread over 1 acre equals 27,000 gallons.

Table 2. Total available water of various soils at field capacity

Soil texture	Available water storage in acre inches per one foot depth and corresponding gallons	Gallons to replace 25% of depleted water
Gravelly sandy loams	1.0 (27,000 gallons)	6,750
Sandy loams	1.35 (36,500 gal)	9,100
Gravelly loams	1.75 (47,250 gal)	11,800
Loams/silt loams/silty clay loams	2.0 (54,000 gal)	13,500
Organic (muck) soils	2.5 (67,500 gal)	16,875

Irrigation should begin when 25% of available water is depleted

Table 3. Evapotranspiration rates for NY soils

	Evapotranspiration (inches of water/gallons lost per day/A)	
Month	**60-79% ground cover**	**80 to 100% ground cover**
May	0.08/2,160	0.12/3,240
June	0.11/2,970	0.16/4,320
July	0.13/3,510	0.18/4,860
August	0.13/3,510	0.18/4,860
September	0.11/2,970	0.16/4,320
October	0.08/2,160	0.12/3,240

To determine how and when to irrigate, we have to make some assumptions on the evapotranspiration rate. Based on weather records for upstate New York we can come up with some educated guesses as outlined in Table 3. This is the amount of water lost per acre in inches each day or gallons, depending if we have full or partial ground cover. Using this table we can see that in July, where we have a full canopy growing, 0.18 inches of water will be pulled from the soil over one acre. That's about 4,860 gallons lost on one day. This also assumes we are using no plastic mulch, which would reduce evapotranspiration by at least 50%.

Let's look back at Table 2 and use what we know about evapotranspiration to estimate when we would need to water. Assuming we are losing about 4900 gallons per day, in a sandy loam soil it would take about two days to reach the 25% depletion (9,112 gallons) when we would have to water again. In a silt loam, it would take about three days (13,500 gallons). Again, all these calculations are based on acres with no plastic mulch.

Plastic mulch changes all of our calculations. First, our losses to evapotranspiration are cut by 50%. Second, we are watering only the area under plastic and not concerned about the area between rows. Let's use as an example with peppers grown on plastic mulch with the mulch on 6 foot centers, on a sandy loam soil. With the plastic mulch stretched 3 feet wide, half the acre is covered with plastic or 21800 square feet (as compared to 43,560 square feet for an entire acre). In Table 2, we see that a sandy loam soil at field capacity holds 1.35 acre inches or 36,500 gallons. Since we only care about the 50% covered with plastic, which is the total our peppers can access, it is half that or 18,250 gallons. We want to start our irrigation when we lose 25% of the available water, so that would be 4,560 gallons (18,250 x 0.25). From our previous calculation we see that 4,900 gallons are lost from one acre of soil in July, when no mulch is present. Since we are dealing with only a half an acre under mulch that amount is reduced to 2,430 gallons. Let's assume that the mulch further cuts the loss by 50% to 1215 gallons total lost each day. We would probably want to water again in three days by which time we would have lost 3600 gallons (4560 gallons would be about 25% loss). Now we know to water every three days – how long do we run the system?

WHEN USING PLASTIC MULCH, MAKE SURE SOIL IS MOIST BEFORE BEDS ARE PREPARED. IF PLASTIC IS PUT OVER DRY BEDS, IT IS ALMOST IMPOSSIBLE TO PROPERLY WET THE BED WITH TRICKLE ALONE.

Trickle tapes are rated by the amount of water provided per minute per 100 feet of length. Let's assume we have a tape that provides 0.25 GPM per 100 feet. We have 7260 linear feet of trickle on our acre pepper field (43560 divided by 6 foot between row spacing). In one minute we will use 18.15 gallons over one acre (72.60 x 0.25). We need to apply 3600 gallons to come back to field capacity. That would take just over three hours (3600 divided by 18.15 = 198 minutes or 3 hours and 18 minutes). Running it for longer periods is wasteful as leaching can occur. Running it for shorter period can lead to drought stress.

Do the same calculation for a silt loam soil. According to Table 2, this soil can hold 2 acre inches or 54,000 gallons or half that ,27,000 gallons, under the plastic. We'd start our irrigation when we lose about 25% of that water or 6800 gallons. We're losing about 1215 gallons per day from our acre of peppers so we would want to irrigate the peppers on this heavier soils in about 5 days. Using the same trickle as above, it would take about 6 hours and 15 minutes to replace the depleted water. Of course you could water when only 10 to 15% of the water is depleted which would mean irrigating more frequently but for a shorter period of time. For the best yields, more frequent irrigation with a shorter run time is recommended.

When not using soil moisture meters, use these tables to estimate trickle irrigation run times based on soil types, row spacing, 1 foot rooting depth, and average loss through evaporation/transpiration in midsummer, using a trickle tape with 0.25 GPM per 100 feet. All values based on 1 acre. Run time will be half if using a 0.50 GPM/100 feet tape.

Table 4. Rows on 5 foot centers, assuming average summer temperature, and full crop load, 1 foot rooting depth, trickle flow rate of 0.25 GPM per 100 feet.

	1.5 Foot Wet Width			2.0 Foot Wet Width			2.5 Foot Wet Width		
Soil Type	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)
Gravelly sandy loams	2025	3	110	2700	4	150	3375	5	180
Sandy loams	2734	4	150	3646	5.5	200	4557	7	250
Gravelly loams	3543	5	190	4725	7	260	5906	9	320
Loams/silt loams/silty clay loams	4050	6	220	5400	8	300	6750	10	370
Organic (muck) soils	5062	7.5	280	6750	10	370	8437	12.5	460

Table 5. Rows on 6 foot centers, assuming average summer temperature, and full crop load, 1 foot rooting depth, trickle flow rate of 0.25 GPM per 100 feet.

	1.5 Foot Wet Width			2.0 Foot Wet Width			2.5 Foot Wet Width		
Soil Type	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)
Gravelly sandy loams	1687	3	90	2228	3	123	2835	4	156
Sandy loams	2278	4	125	3008	4	166	3828	6	211
Gravelly loams	2953	5	160	3898	6	215	4961	7	273
Loams/silt loams/silty clay loams	3375	5	180	4455	7	245	5670	8	312
Organic (muck) soils	4218	6	232	5569	8	307	7088	11	390

Table 6. Rows on 7 foot centers, assuming average summer temperature, and full crop load, 1 foot rooting depth, trickle flow rate of 0.25 GPM per 100 feet.

	1.5 Foot Wet Width			2.0 Foot Wet Width			2.5 Foot Wet Width		
Soil Type	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)	Gallons lost at 25% Field Capacity	Days between Irrigations	Irrigation Time (min)
Gravelly sandy loams	1418	2	78	1958	3	108	2430	4	134
Sandy loams	1914	3	105	2643	4	146	3281	5	181
Gravelly loams	2481	4	137	3426	5	189	4253	6	234
Loams/silt loams/silty clay loams	2835	4	156	3915	6	216	4860	7	268
Organic (muck) soils	3544	5	195	4894	7	270	6075	9	335

Questions or comments about the New York Berry News?

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