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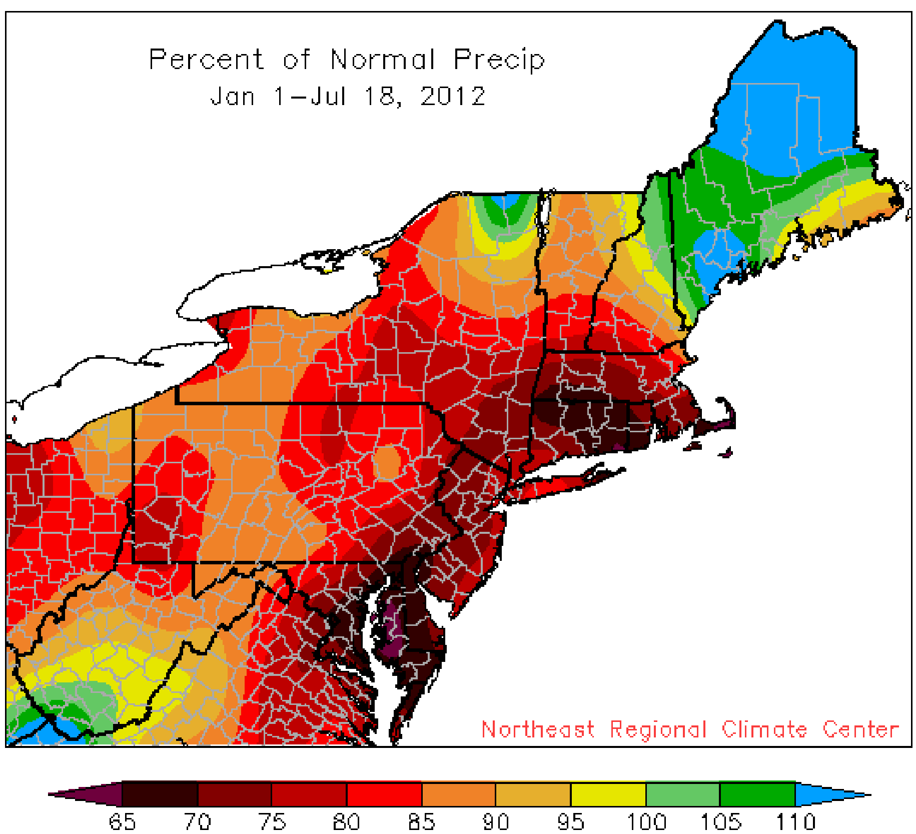
Special Drought Edition

Lack of winter snow cover and below average spring rains set the stage early for the hopefully short-term drought we are now experiencing. Recent weeks of warmer than average temperatures have exacerbated the problem across much of NY State. Many berry growers are asking questions about irrigation; some are wondering if they will have sufficient water to continue to irrigate until rains come. Much as with the early March heat wave and ensuing frost events we do not have hard and fast answers to offer but hope to provide some insights and reference information to help you make informed decisions for your operation.

Please note there is high risk of brush fires in face of this water deficit. Gov. Andrew Cuomo announced Friday 7/13/12 that the state had instituted a residential ban on burning for 90 days through emergency regulations and would suspend previously issued burning permits. A moratorium on new permits is also in effect through Oct. 10, 2012 "These conditions should not be taken lightly," Cuomo said. "The potential for disastrous wildfires is present in all areas of the state."

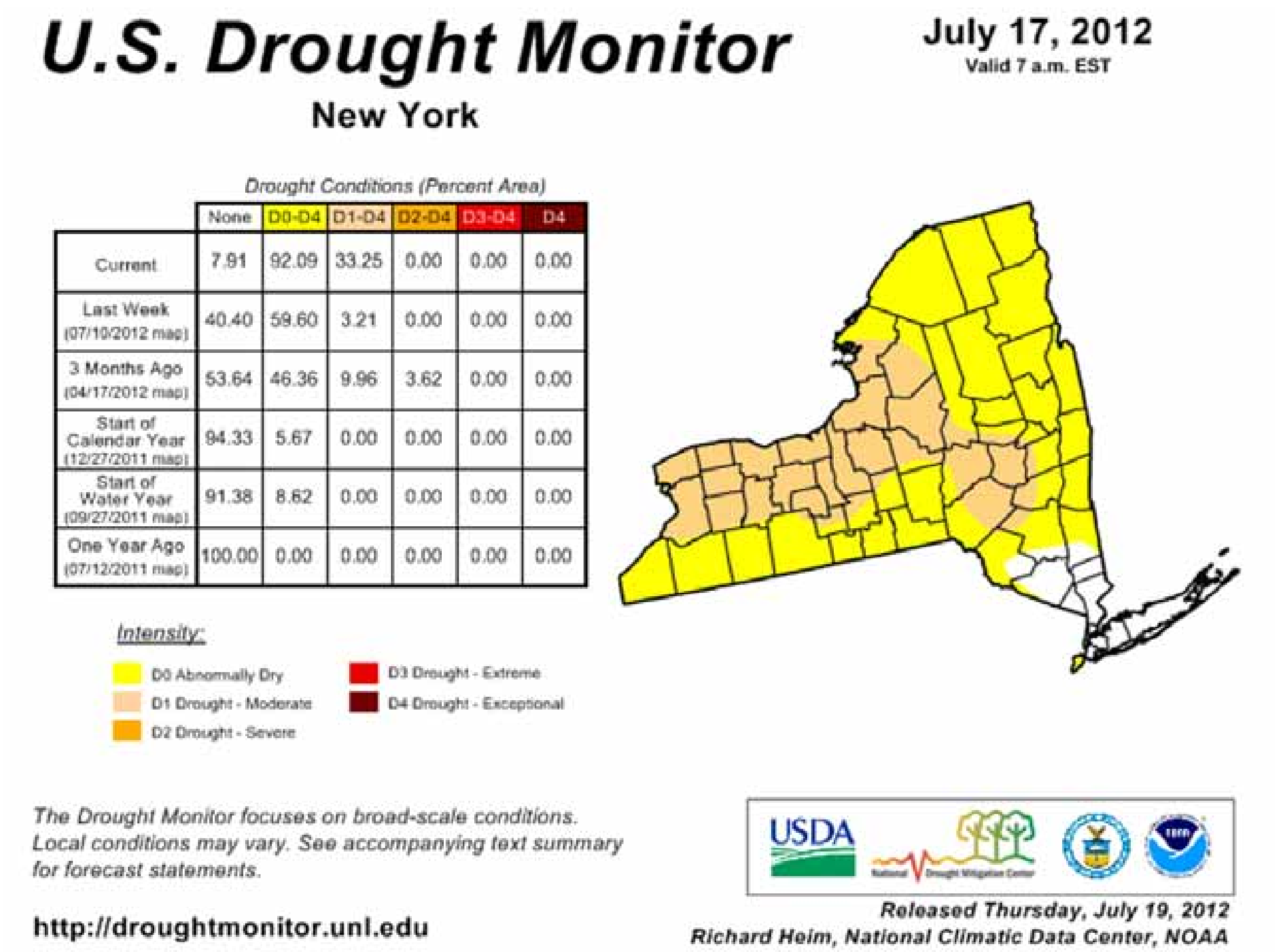
The Current Drought Situation in the Northeast and NY– *courtesy the Northeast Regional Climate Center*

Dry and Drought Conditions Expand



The first half of 2012 was dry for most of the Northeast. New York, Massachusetts, Pennsylvania, New Jersey, and West Virginia were below normal, Maryland and Connecticut were much below normal, and Delaware had its driest record. The Northeast as a whole had 89% of its normal precipitation for the 6-month period. The lack of rain has continued into July, causing abnormally dry and moderate drought conditions to spread across the Northeast. Year-to-date precipitation, through July 18th, is below normal at all of the First Order stations, excluding those in Maine. Thirteen of the 35 stations have had less than 80% of normal precipitation, the driest areas being Wilmington DE, Baltimore MD, and Philadelphia PA. Dry conditions are expected to persist in a band stretching from Lake Erie east through Albany as well as western Pennsylvania. The same holds for Maryland, Delaware, western Massachusetts and parts of Virginia, although conditions in those areas are expected to slightly improve.

The US Drought Monitor has expanded the abnormally dry conditions to cover most of New York State. New York State's January through June precipitation was 17.10", 87% of normal. Moderate Drought conditions cover the northwest portion of Tompkins County. Ithaca's year-to-date (through July 18th) is 13.31", 69% of normal. Possible impacts are damage to crops and pastures. Some corn crops in the area are seeing leaf curling and leaf edge burning as a result of drought stress.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	7.91	92.09	33.25	0.00	0.00	0.00
Last Week (07/10/2012 map)	40.40	59.60	3.21	0.00	0.00	0.00
3 Months Ago (04/17/2012 map)	53.64	46.36	9.96	3.62	0.00	0.00
Start of Calendar Year (12/27/2011 map)	94.33	5.67	0.00	0.00	0.00	0.00
Start of Water Year (09/27/2011 map)	91.38	8.62	0.00	0.00	0.00	0.00
One Year Ago (07/12/2011 map)	100.00	0.00	0.00	0.00	0.00	0.00

The data cutoff for Drought Monitor maps is Tuesday at 7 a.m. Eastern Standard Time. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time.

Water Requirements and Water Stress in Strawberry - *A.H. El-Farhan and Marvin Pritts, Dept. of Horticulture, Cornell University, Ithaca, NY 14853*

Water is usually a relatively inexpensive input in fruit production, and many producers have the luxury of supplying more water than is really necessary to obtain a full crop. This is particularly true in the Northeast where ample water is usually available, especially in spring. However, excessive irrigation (or overhead frost protection) can contribute to nutrient leaching and disease development. For example, researchers in Norway examined four levels of supplemental irrigation and a control over two years. In one year, there were no differences in yield among treatments, and in another year, the lowest yields were in the two treatments receiving the most supplemental irrigation, corresponding to low N levels in leaves. Clearly, water supplied in excess can be as detrimental as insufficient water.

In 2012, the Northeast is again experiencing a moderate to severe drought. It is possible that there will not be sufficient water reserves for some growers to irrigate adequately this summer. But even under "normal" conditions, irrigation is necessary for strawberries because they have shallow root systems and exhibit sensitivity to water stress. Only 5 days after a soaking rain, it is possible that strawberries will require irrigation. Strawberry yields with supplemental irrigation are often 40 to 60% greater than when no additional irrigation is provided.

How much water does a strawberry plant need?

In strawberries, a critical stage of growth is the establishment period of the transplants. For about two weeks, newly set transplants are susceptible to even mild water stress. This vulnerability is mainly because plants have not developed a good fibrous root system with fine root hairs for water absorption. In the fruiting year, yield reductions of 33% and size reductions of 17% have been documented under only moderately dry conditions without irrigation.

Strawberries grown on plastic beds in warm climates require about 18 in. of water over a 200 day growing season - after they have become established. This is the equivalent of about 22 gal per plant per season. (Actual water use by the strawberry plant is about 55% of this amount as more water is applied than what the plants actually use because of losses due to leaching, evaporation, inefficient application and an inadequate ability to assess water requirements on a daily basis.) Matted row growers often ensure that a minimum of 1 in. is applied as irrigation or rainfall during the growing season, mainly to replace soil moisture lost to evapotranspiration. However, this is only a "ballpark" figure and requirements can be greater under extended warm, dry conditions.

How do water deficits affect growth?

Water stress can interfere with photosynthetic activity and reduce the potential growth of the plant. Photosynthetic rates of non-stressed strawberry plants can be as high as 35 mg of $CO_2/dm^2/h$, but under droughty conditions, can drop to 16 mg of $CO_2/dm^2/h$.

Several experiments have been conducted to measure the responses of specific vegetative plant parts to water deficit stresses. Root systems of strawberry are affected by water shortages, with the root/shoot ratio increasing in response to water stress. Reductions in the number of leaves, runners, and crowns also have been observed when long and frequent droughts are experienced.

The rate of leaf expansion is greatest during a 5 hour period beginning one hour before sunset. Water stressed plants have a reduced rate of leaf expansion during this period, and these differences can accumulate over the season until well-watered plants have twice the leaf area as non-irrigated plants. With only moderate water stress (75% of required water), leaf area can be less than half that of the well-watered plants after a four month period. A portion of the difference in leaf area can be attributed to leaf death under droughty conditions, especially of older leaves.
The older the leaf, the more prone it is to senescence should stress conditions occur. Furthermore, under moderate water stress, younger leaves are able to maintain a higher relative water content than older leaves.

How do water deficits affect fruiting?

Water deficit has been shown to cause fruit yield reduction by decreasing flower numbers, fruit set, numbers of fruit per plant and fruit size. Differences in yield and fruit quality between well-watered and stressed plants have been demonstrated by many studies on various cultivars and in various production systems.

Numbers of fruit per plant can be decreased by more than 30%, and total fruit production can decline by about 80% when plants are severely stressed from the beginning of the growing season. Accelerated ripening and smaller fruit size occur in water-stressed strawberries.

'Surecrop' has a larger root system and is more tolerant to drought than 'Raritan' with a much smaller root system. However, when water is not limiting, 'Raritan' has higher yields, suggesting that there is a physiological cost associated with maintaining a large root system.

How to determine if irrigation is required?

The measurement of a crop's water needs in the field usually is estimated with tensiometers, electrical conductance tools, weather data or pan evaporation. Usually, these tools are used to trigger supplemental irrigation when soil moisture falls below a predetermined level.

Researchers achieved the maximum yield response when soil moisture was kept above 65% of field capacity in the top 60 cm of the soil. However, obtaining maximum yields may not be equivalent to achieving economically optimal yields, especially in areas where irrigation costs are high. Tensiometers can be used to assess field capacity of the soil, and take the guess-work out of estimating irrigation needs based on rainfall or how wet the soil feels. A rule of thumb is to not let the soil moisture fall below 50% field capacity. Charts are available showing tensiometer readings at field capacity for a given soil type.

By setting a bucket over a strawberry plant in the evening and examining the plant the next morning, one can estimate the need for irrigation by seeing if beads of water have formed on the edges of younger leaves during the night. "Guttation" is a phenomenon by which xylem sap is exuded through the pores of the hydathodes in the leaves as the result of root pressure. Guttation usually takes place at night when transpiration is low, and humidity and soil moisture are high. Research suggests that guttation only occurs in well-watered plants. (Only young leaves exhibit guttation; older leaves have more resistance to water flow.)

How to Apply Water?

Researchers have found that drip irrigation is much more efficient (requiring about 50% less water) than overhead for meeting the water requirements of the strawberry. However, studies suggest that the use of water in many strawberry fields is not optimized. Evidence of this inefficiency was found in a comprehensive survey of strawberry growers in the Huelva region of Spain. Although soil type, cultivar and climate were the same for these growers, and 78% of the growers considered their water use sufficient, the variation in water use/area was as much as 96% for some irrigation systems. These researchers calculated an index of uniformity, with 100% indicating that each emitter in the field is providing the same amount of water per unit time. Within fields, the irrigation uniformity index averaged 49%, despite the fact that the majority of systems were only between 3 and 5 years old. These data suggest that growers are not optimizing their use of irrigation water, partially because of uneven distribution of water within a field.

In a nutshell, if the dry conditions of 2012 continue, you will need to ensure that your strawberry plantings are receiving 1-2inches of water per week as new plantings are highly susceptible to drought stress. Older renovated plantings will also require the same amount of water on a weekly basis.

Develop a method of assessing plant water needs, whether it be using tensiometers, looking for guttation, or using electrical conductivity meters. Finally, determine if your irrigation system is applying water uniformly. If not, make necessary adjustments. Drip irrigation systems tend to be more uniform and efficient than overhead systems.

Heat and Drought Stress in Blueberries and Raspberries – *Laura McDermott, Capital District Vegetable and Small Fruit Program*

At the end of June I thought we were going to see the biggest and best crop of summer raspberries and blueberries **EVER** – and then the July heat kicked in. It is still an excellent production year – but mostly because many growers have done a good job setting up for this type of event.

Blueberries show drought stress when parts of leaves or whole shoots turn brown – first at the edges and then the entire leaf. If this has happened to your plants in the last few days or weeks, it is most likely drought and heat stress. Blueberries are very sensitive to drought as they do not have root hairs to help maximize the root surface area. Adequate, but not excess irrigation is necessary to improve fruit size and to maintain a good leaf to fruit ratio during fruit development. Mulch will also help a great deal as blueberry roots are present right at the soil surface, so even a shallow layer of mulch will protect those roots from heat and drought stress.

If your blueberries are exhibiting drought stress similar to the photo, don't start pruning now. There is a good chance that those shoots are still fine, and the weather may change and rain and cooler temperatures will prevail.

Photo courtesy Oregon St. Univ.

If you are using drip irrigation, check emitters to make sure they aren't clogged. You may want to consider 2 drip lines on your most mature plants. If you are using overhead irrigation on raised-beds, make sure the beds are not shedding the water which can happen if they are not flat topped. This is especially important for new plantings since most of the plant root system sits near the top of the bed.

Sunscald on raspberries and blackberries can be a real problem in this type of weather. If the drupelets are filled out, but are white and not colored, this is sunscald, which can be caused by high temperatures and lots of direct sun. It might be especially prevalent on the upper berries or the berries on the west side of the row.

According to Dr. Kerik Cox, Cornell University, periods of drought may injure plants or predispose them to winter injury or diseases. Drought for even a few weeks can cause young leaves to wilt and developing fruit to shrivel. Fine roots may die off and impaired root function may cause the plants to appear as if they are affected by a root disease. In addition, the use of fertilizers, herbicides, and pesticides (e.g. captan) during a drought may result in unexpected injury either from the association of drought conditions with heat, or the excessive need for the plants to uptake the water often used as a carrier in chemical applications. When excavated, a plant suffering from drought will have roots that are dry and sinewy, but still have white vascular tissues and cortex.

The biggest immediate problem for berry growers may be just that the pickers are not showing up and the berries are ripening so fast that lots of great quality fruit will be left in the field. This weekend should be a big one as the weather predictions indicates cooler temperatures with less humidity.

(Reprinted with permission from: Capital District Vegetable and Small Fruits Program Weekly Update, Vol. 4 Issue 17, July 18, 2012)

Soil Type Influences Irrigation Strategy - *Ron Goldy, Michigan State University Extension*

Soil characteristics play an important role in application of soil amendments, pesticides, fertilizers and water. Irrigation strategy for clay-based soils is much different than the strategy for sand-based soils.

February 9, 2012. When it comes to irrigation, many growers question how much, how long, how fast and how often they need to irrigate. The answers usually involve a combination of soil characteristics, plant growth stage and weather, however, how fast to apply water is based solely on soil type.

Clay-based soils have small, flat, compact particles with large surface to volume ratios. These soils are often difficult to prepare for planting since they are slippery when wet and hard when dry, making timing for field operations critical to avoid damaging soil structure and getting proper soil tilth for planting. Sand-based soils are at the other end of the spectrum having comparatively large particles with small surface to volume ratios. They are generally easier to prepare for planting and can be worked shortly after significant rainfall. There are good and bad points for each soil type (Table 1).

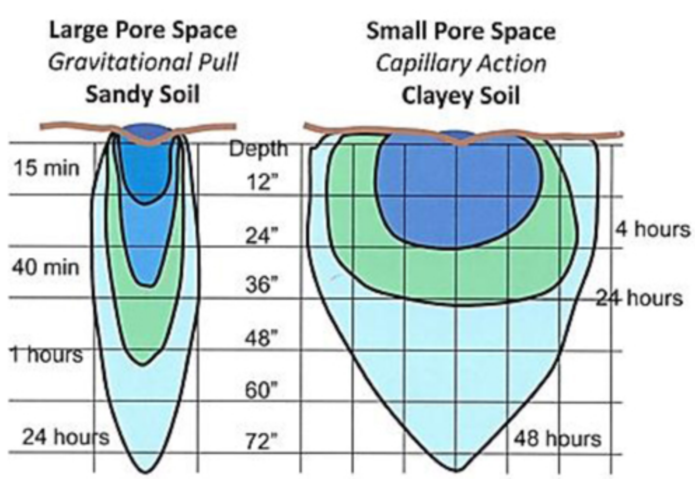
Table 1. Characteristics of sand, silt and clay soils. Brady and Weill, 2008.

Property/Behavior	Sand	Silt	Clay
Surface area to volume ratio	Low	Medium	High
Water-holding capacity	Low	Medium to high	High
Ability to store plant nutrients	Poor	Medium to high	High
Nutrient supplying capacity	Low	Medium to high	High
Aeration	Good	Medium	Poor
Internal drainage	High	Slow to medium	Very slow
Organic matter levels	Low	Medium to high	High to medium
Compactability	Low	Medium	High
Suceptibility to wind erosion	Moderate	High	Low
Suceptibility to water erosion	Low	High	Low if aggregated, high if not
Sealing of ponds and dams	Poor	Poor	Good
Pollutant leaching	Poor	Medium	Good

(After Brady and Weil, 2008)

For irrigation purposes, it is important to remember water is absorbed and moves **slowly** through clay soils, but once wet, they retain significant amounts of moisture. Water is absorbed and moves **quickly** through sandy soils, but they retain very little. This means water applied quickly to clay soil has a tendency to run off rather than move into the soil. Therefore, when irrigating clay soils, water should be applied slowly over a long period but then the site may not need irrigation for several days. Irrigation on sandy soils should be applied quickly but for short periods. Irrigation times on sandy sites should be shorter, otherwise water moves beyond the root zone, becoming unavailable to the plant and contributing to soil leaching. For efficient water use under certain weather conditions, sandy sites may need daily irrigation for short periods. Clay soils have greater capillary (sideways and upward) movement than do sandy soils (Figure 1). Quick water application on sandy soils will contribute to a broader wetting area, providing more soil volume for roots to exploit.

Figure 1. Water spread and penetration time and distance in sandy and clay soils. David Whiting, 2011.



Michigan soils can vary considerably within the same field. Drip systems can be zoned to account for this variation and each zone irrigated according to the predominant soil type. Emitter flow rate can also be selected to accommodate different soil types; with high flow emitters used on sandy sites and low flow emitters on clay sites. Emitter spacing can also be changed with larger spacing on clay soils and shorter spacing on sandy sites. Growers using drip systems should take advantage of these options to maximize water use while minimizing environmental concern. Overhead irrigators do not have this option, so they need to be more aware of the weather and be sure to not saturate the soil, especially if there is a chance of rain. They also should avoid large applications of water shortly after fertilizer or pesticide applications.

Paying attention to soil type and how it should be irrigated will make water applications more efficient and more environmentally safe.
*(This article was published by **MSU Extension**. For more information, visit http://www.msue.msu.edu.)*

Maintaining Drip Irrigation Systems - *Bill Lamont (**wlamont@psu.edu**), Penn State Horticulture and Extension*

Drip irrigation systems are becoming more widely used for horticultural crop production, especially vegetable crops. The system must function efficiently during the entire growing season. Failure at a critical point in the crop production cycle can cause loss of the entire crop. System failures are often due to inadequate maintenance of the system especially if fertigation is being utilized to supply nutrients to the plant's root zone. Maintenance of the drip irrigation system does take time and understanding; however, maintenance is critical for successful use of drip irrigation systems. This article should help one understand how to maintain drip irrigation systems.

Water Quality

Water for drip irrigation can come from wells, ponds, rivers, lakes, municipal water systems, or plastic-lined pits. Water from these various sources will have large differences in quality. Well water and municipal water is generally clean and may require only a screen or disc filter to remove particles. **However, no matter how clean the water looks, a water analysis/quality test prior to considering installation of a drip irrigation system should be completed to determine if precipitates or other contaminants are in the water.** This water quality analysis should identify inorganic solids such as sand and silt; organic solids such as algae, bacteria, and slime; dissolved solids such as iron, sulfur, and calcium; and pH of the water. Water testing can be done by a number of laboratories in the state. Your local Cooperative Extension Service (CES) County Agent can supply a list of laboratories or suggest a local lab that can do water quality analysis. Check with the lab first to obtain a sample kit containing a sampling bottle that is clean and uncontaminated.

Table 1: Criteria for Plugging Potential of Drip Irrigation System Water Sources

	Plugging Hazard		
Factor	**Slight**	**Moderate**	**Severe**
	[in parts per million (ppm)* except pH]		
Physical			
Suspended Solids (filterable)	<50	50-100	>100
Chemical			
pH	<7.0	7.0-7.5	>7.5
Manganese	<0.1	0.1-1.5	>1.5
Iron	<0.1	0.1-1.5	>1.5
Hardness	<150	150-300	>300
Hydrogen sulfide	<0.5	0.5-2.0	>2.0

*Some water reports list results as milligrams per liter - mg/L which is equal to parts per million-ppm

In addition to these factors, it is desirable to ask for any additional tests that might be necessary. If the water is also to be used as a household supply or might be used as a drinking water source, the analysis should also include the basic drinking water analysis which includes bacterial counts, nitrates, or other suggested tests. Also salts, Chlorides, Sodium, Calcium (for general irrigated water quality).

Hydrogen sulfide can often be detected by a bad “rotten egg” smell. If a review of your water test indicates factors that may cause potential plugging (Table 1), then special care in drip system maintenance needs to be practiced. High levels of a factor might not render a well unsuitable for drip irrigation but will make appropriate water treatment a requirement before successful use in a drip irrigation system.

Any surface water such as streams, ponds, lakes, rivers, or pits will contain bacteria, algae or other aquatic life. Sand media filters are absolute necessities. **Even though sand media filters will be more expensive than screen or grooved-disk filters, they are highly recommended for water sources that have high levels of suspended organic and inorganic materials.**

Maintenance of the System

Filters

Both screen and sand media filters in a drip irrigation system should be checked during or after each operating period and cleaned if necessary. A clogged screen or grooved-disk filter can be cleaned with a stiff bristle brush or by soaking in water. A sand media filter should be backflushed when pressure gauges located at the inlet and outlet sides indicate a five psi difference. Check drip irrigation lines for excessive leaking, and look for large wet areas in the planting area indicating a leaking tube or defective emitter. It is also a good practice to flush submains and laterals periodically to remove sediments that could clog emitters. Systems can be designed with automatic backflushing devices and automatic end line flushing devices, but still require manual checks.

Chemical Control Measures

Unfortunately, filtration alone is not always adequate to solve all water quality problems. Chemicals are necessary to control algae, iron and sulfur bacteria, and disease organisms. Chemicals can cause some materials to settle out or precipitate out of the water while causing other materials to maintain solubility or stay dissolved in the water. Chlorine is a primary chemical used to kill microbial activity, to decompose organic materials, and to oxidize soluble minerals, which causes them to precipitate out of solution. Acid treatments are used to lower the water pH to either maintain solubility or to dissolve manganese, iron, and calcium precipitates that clog emitters or orifices. Potassium permanganate also is used to oxidize iron under some conditions. It is recommended to place the filtration system after the chemical treatment to remove any particles formed. Chemigation protection and injection equipment requirements vary with toxicity class of the injected chemicals.

Bacterial Slimes/Precipitates

Bacteria can grow in the absence of light within the system or in a contaminated well. The bacteria can live on iron or sulfur and produce a mass of slime that quickly clogs emitters and filters. This slime can also act as an adhesive to bind other solids together to cause clogging. They also can cause soluble iron and sulfur to precipitate out of the water.

Bacteria cause iron precipitation by oxidizing soluble ferrous oxide to form insoluble ferric oxide. Iron concentrations as low as 0.1 ppm can be troublesome, whereas levels of 0.4 ppm can be severe. The iron precipitate forms as a red filamentous sludge, which can attach to PVC and polyethylene tubing and completely block emitters.

Sulfur in amounts over 0.1 ppm of total sulfides can be troublesome in irrigation water. Bacteria that live on sulfur can produce white stringy masses of slime, which can completely block the emitting devices. Interactions of soluble iron and sulfur can lead to a chemical reaction forming insoluble iron sulfide. Stainless steel filter screens used in high sulfide water can cause iron sulfide precipitation.

Chlorination is the usual treatment to kill bacteria or inhibit their activity. A continuous residual rate of 1 to 2 ppm of free available chlorine at the distant end of the irrigation system or an intermittent rate of 10 to 20 ppm for 30 to 60 minutes per treatment cycle should be effective. The initial injection rate may need to be higher to achieve the desired residual level in the system. Treatment cycles may be required at the end of each irrigation cycle for severe water sources or after every 10-20 hours of irrigation for cleaner water sources.

Sometimes, wells are contaminated with bacteria and shock chlorination is necessary to reduce or solve the problem. This is done by injecting chlorine at a rate of 200 to 500 ppm into the well. The volume of water to be treated must be estimated from the diameter and depth of the well. Consult a local well driller for exact procedures and regulations prior to attempting this activity.

Algae and Aquatic Plants

Algae and aquatic plants in surface waters can be great nuisances’ because they reproduce rapidly during summertime blooms. They have a tendency to become entangled in screen meshes and clog the surface of sand media filters, resulting in frequent filter backflushing. Algae can be controlled in surface waters by adding copper sulfate or other chemicals in an approved manner. Care must be taken to avoid harming fish. Green algae can grow only in the presence of light, so they do not cause a problem in buried pipelines or black polyethylene. However, algae can grow in the white PVC pipe or fittings used to assemble aboveground pipelines and then be washed into laterals and emitters to cause clogging.

Chlorine is used to kill algae within the irrigation system. A chlorine concentration of 10 to 20 ppm for between 30 and 60 minutes is suggested. It is advisable to work section-by-section through the pipeline and flush the dead algae out of the pipes immediately after treatment, to prevent emitters clogging. If significant emitter clogging occurs, a higher concentration may be needed to decompose the organic matter in the emitter.

Chemical Precipitation of Iron
Water with over 0.1 ppm of iron is quite likely to cause a problem in irrigation systems. The problem can be solved by either removing the iron from the water or by retaining the iron in solution. Several techniques are available:

Aeration and Settling. A reliable way of removing iron from irrigation water is to pump the water from the well and to spray it in the air over a pond or tank. During aeration of the water, iron is oxidized into its insoluble form, which can be settled out in the pond. The disadvantage is that the water must be double-pumped, requiring a second pump after the settling basin to re-pressurize the water. Energy costs are not increased, but two pumps must be purchased.

Chlorine Precipitation. Free chlorine will instantly oxidize ferrous iron to ferric iron and take it out of solution as a solid. The iron concentration must be determined, and chlorine must be injected at a rate of 1 ppm for each 0.7 ppm of iron. Some additional chlorine may be needed for other contaminants, such as iron bacteria and bacterial slime. Complete mixing of the chlorine and water is necessary and can be accomplished by creating turbulence in the system before the filter. A sand media filter is the most appropriate choice and should be backwashed frequently, preferably automatically.

If manganese is present in the water source, caution must be exercised, because oxidation of manganese by chlorine occurs at a much lower rate. Care must be taken to precipitate the manganese before the filter, or clogging problems could occur.

pH Control. Iron is more soluble at lower pH values. Acid can be continuously injected to keep the pH low in the irrigation system or can be used periodically to dissolve iron deposits. To dissolve the iron, the pH must be reduced to approximately 2.0 or less for a period of 30 to 60 minutes. The system must be flushed to remove the iron after treatment.

Iron precipitation can be caused by raising the pH. A solution to increase the pH can be prepared by mixing 3 pounds of soda ash (58 percent light grade) with 4 gallons of water. This neutralizing solution can be injected into the water system and can be mixed with chlorine solutions.

Iron Sulfide Precipitation. Sulfur-bearing minerals are common in most sedimentary rocks. A soluble form of sulfate is carried by water. Sulfates are difficult to precipitate and generally remain in solution. Sulfate can be used as a food source by bacteria which produces hydrogen sulfide gas as a by-product. If sufficient iron is present under moderate reducing conditions, iron sulfides can be precipitated, and a sand media filter is suggested to remove the precipitate.

Precipitation of Calcium Salts
Calcium salts, particularly calcium carbonates, precipitate out as a white film or plating in the system. The salts are soluble at low pH. Acid can be used to maintain a pH of 4.0 or lower for 30 to 60 minutes which dissolves calcium deposits to clean emitters and pipelines. Hydrochloric (muriatic) acid is recommended for treating calcium blockages although sulfuric and phosphoric acid can also be used. Temperature, pH, and calcium concentration are all factors influencing calcium solubility, so conditions can vary throughout the irrigation system. Water sources differ in the amount of hardness and/or pH requiring different amounts of acid to lower the pH. The most common acid that growers will find available is muriatic acid (20% hydrochloric acid) at hardware and farm supply stores. It will require about 0.5 to 1 gallon in 100 gallons of water of this strength muriatic acid material to lower the pH to approximate 3.5 for several well and tap waters tested. Make sure that you flush and clean the injector after acid application since the acid may be corrosive to internal parts. Allow the acid treated water to remain in your lines for 30 minute to 1 hour, and then flush with water. **Use extreme care in handling acids and always add acid to water.**

If the water hardness is excessive water softening equipment can be used to remove calcium and magnesium. Zeolite water conditioners soften hard water by removing dissolved calcium and magnesium by ion exchange in a tank, where they are placed in a deep bed. As hard water flows downward through the bed, the calcium and magnesium ions are withheld by the mineral and replaced by sodium ions. When the sodium ions are exhausted, the system must be regenerated by a flow of salt water through the exchange material. A backwash procedure is used to remove the calcium and magnesium ions. If the water contains iron, an iron-removal filter should precede the water softener.

Chlorination
The common practice of chlorination is the addition of chlorine to purify drinking water supplies. Chlorine acts as a powerful oxidizing agent in water and vigorously attacks organic materials. Free available chlorine also reacts strongly with readily oxidizable substances such as iron, manganese, and hydrogen sulfide.

To be effective, a residual of active chlorine in parts per million of available chlorine should be measurable near the end of the lateral lines of the irrigation system. The amount of chlorine added to the system will be the residual desired plus the amount needed by the water to oxidize the materials present. This amount can vary considerably over a season. Contact time between chlorine and the water should be maximized to get the most benefit.

Table 2: Common chlorine compounds used in microirrigation

Compound	Form	Percent Available
calcium hypochlorite	dry	65 - 70
sodium hypochlorite	liquid	5.26 - 15
chlorine gas	gas	100

The gas and liquid forms of chlorine are more commonly used (Table 2). Common household bleach, 5.25% sodium hypochlorite, is used in many small operations. Chlorine gas is more dangerous (very poisonous and very corrosive). A commercial dealer should install the gas metering device called a chlorinator and train the operators. Chlorine gas is heavier than air, so adequate ventilation is recommended.

The pH of the water greatly affects the effectiveness of chlorination. Acidic water causes greater availability of hypochlorous acid (HOC), which has an efficiency for killing microorganisms that is 40 to 80 times greater than that of hypochlorite (OC-). When chlorine is dissolved in water, HOC and OC-, which together are referred to as "free available chlorine", co-exist in an equilibrium relationship influenced by temperature and pH.

A general formula for calculating the amount of chlorine to inject in liquid form (sodium hypochlorite, NaOC) is:

$$IR = Q \times C \times 0.006/S$$

where:

IR = Chlorine injection rate (gal/hour)

Q = Irrigation system flow rate (gal/min)

C = Desired chlorine concentration (ppm)

S = Strength of NaOC solution used (percent)

Example: A grower wishes to use household bleach (NaOC at 5.25% active chlorine) to achieve a 3 ppm chlorine level at the injection point. The flow rate of his irrigation system is 90 gpm. At what rate should he inject the NaOC?

IR = 90 gpm x 3 ppm x 0.006/5.25

= 0.31 gallon per hour

At an irrigation flow rate of 90 gpm, the grower is pumping (90 x 60) 5400 gph. The goal is to inject 0.31 gallon of bleach into 5400 gallons of water each hour that injection occurs.

If the injector is set for a 300:1 ratio, it will inject 5400/300 or 18 gallons per hour. Then, 0.31 gallon of bleach should be to 18 gallons of water in the stock solution.

Note: be careful to use the same time units (hours) when calculating the injection rate.

Iron Removal by Potassium Permanganate

Iron also can be removed from water by an oxidizing filter charged with manganese- processed sand. The filter retains oxygen when regenerated with potassium permanganate. As water flows through the oxygen-charged fiber bed, iron unites with the oxygen and is changed to rust or iron oxide. The sand retains the iron oxide until the filter is backwashed and recharged with potassium permanganate. The filter will operate for water with a pH value between 7 and 8. The iron should not exceed 20 parts per million.

Water containing more than 20 parts per million iron or water with organic complexed iron can be treated best by chlorination and filtration. Super chlorination plus pH adjustment may be necessary. Complexed iron causes a condition where humic acids or other organic matter make oxidation difficult.

Commercial Drip Maintenance Treatment Solutions

Several commercial solutions are available, which contain a mixture of ingredients to deal with pH, iron, and hardness water problems. These commercial products come with instructions on dilution concentrations for daily maintenance or “shock” treatment to unclog plugged lines. For small producers getting started with drip irrigation, these commercial products should be considered as a water treatment.

Summary

Drip irrigation is an extremely efficient method of controlling processes, such as availability and uptake of water and minerals. The correct use of a drip irrigation system requires different approaches or methodology than those used in conventional irrigation systems. This involves thinking in terms of frequent irrigation intervals, correct emitter selection and spacing for soil type and topography, control of irrigation depth, and **more exacting maintenance of the system.** It is important to consult an irrigation specialist in designing a drip irrigation system, so that the system will indeed perform as expected.

Correct use of a drip irrigation system can save water, reduce potential for groundwater pollution, improve water use efficiency, reduced disease pressure and any allow prescription nutrient applications.
(Reprinted with permission from: The Pennsylvania State University Vegetable and Small Fruit Gazette)

Editor's Note: *The next 3 blueberry articles that follow provide an in-depth discussion of irrigation of highbush blueberries under drought stress. The situation here in NY is not yet as severe as what our fellow growers in Michigan are currently experiencing but the information presented is applicable to our situation as well.*

Irrigating Michigan Blueberries - *Mark Longstroth, Michigan State University Extension*

Irrigated and un-irrigated blueberries are showing signs of heat and drought stress.

July 10, 2012. With all the early rain and irrigation that was used for freeze protection, it seemed that we would never need to irrigate blueberry fields. Unfortunately, we have received almost no rain since the beginning of June. In fact, according to Enviro-weather, we have almost an 8-inch water deficit since June 1, the last day most areas in Van Buren County received any significant rain.

Blueberries grow best in moist soils and perform best when less than half of the available water has been depleted. Blueberries are shallow-rooted and sensitive to drought stress, and most Michigan plantings are on sandy soils that hold very little water. Severe drought symptoms have been showing up in un-irrigated blueberry fields for several weeks as all the available water in the soil has been used by the plants. Many blueberry growers report that even running their irrigation systems continuously since the beginning of June, they have not been able to keep up with demand. Even planting over high water tables that normally do not need irrigation are beginning to show drought symptoms.

Drought-stressed blueberry bush (left) and close-up of fruit showing the least drought stress (right).


Irrigated blueberry bush (left) and close-up of fruit from irrigated plant (right).

Soil moisture

Soil water reserves depend on soil texture and plant rooting depth (Table 1). You can assume the rooting depth of a blueberry is 12 inches for young plants and 18 to 24 inches for older plants. Sandy soils hold less than 1 inch of available water in the root zone and half of this can be lost in two warm summer days. Loamy sands and sandy loams are common Michigan blueberry soils and hold about 1 to 3 inches in the top 18 inches of the soil. Many blueberry fields have slightly elevated areas that dry out more quickly than other areas. Hardpan or a shallow water table may limit rooting in other areas of fields. This can be seen in older fields where the plants on sandy high spots and wetter low spots are smaller than the rest of the field. These variables complicate irrigation scheduling. As a rule, you should irrigate to maintain the driest most drought-prone areas of your field.

Table 1. Available water in a blueberry root zone as affected by soil texture and rooting depth.

	Available water (inches)
Soil texture	**In root zone (12-24 inch depth)**
Sands	0.4 - 0.8
Loamy sand	0.8 - 1.6
Sandy loam	1.6 – 3.2
Loam	2.0 – 4.0

Evapo-transpiration (ET) is the evaporation from the field plus the water lost by the plant (transpiration). Under the hot, dry conditions in June and July, blueberry fields have lost 0.18 to 0.24 inches per day. Daily potential ET values are available on the Enviro-weather website. They are located by clicking the “More weather” link at the top right of the individual station home pages (Photo 1.).

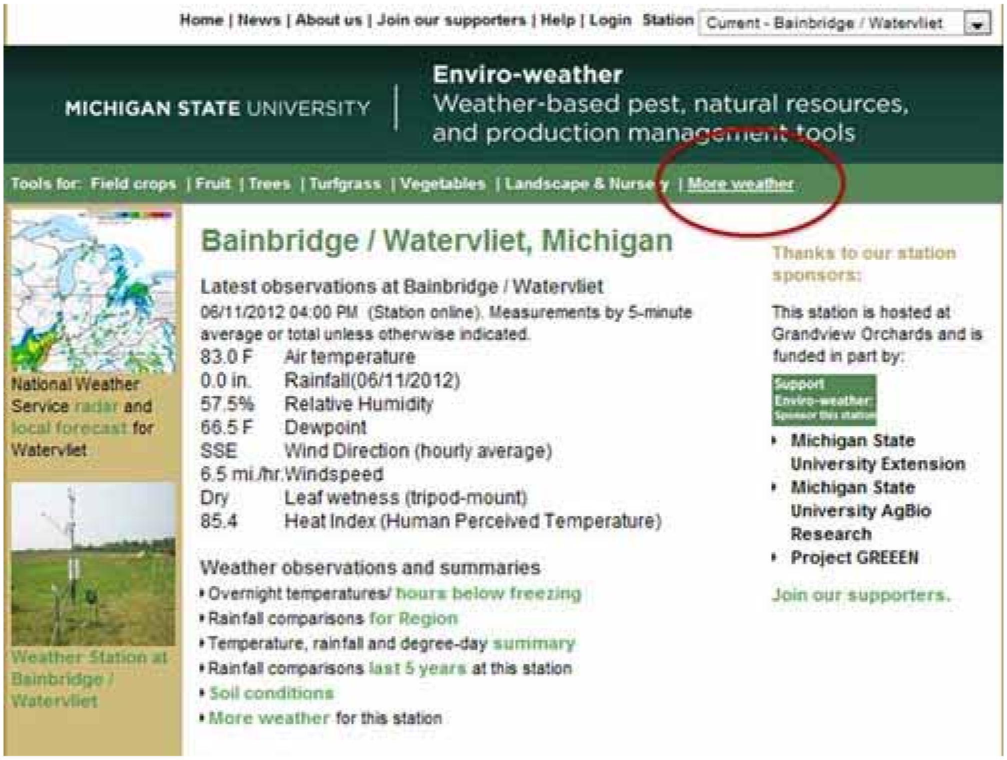


Photo 1. Click the "More weather" link to see daily potential ET values.

The "More weather" page has lots of weather information including irrigation tools at the bottom of the page (Photo 2). Maximum water use during the preharvest fruit growth stage is generally 0.20 to 0.25 inches per day.

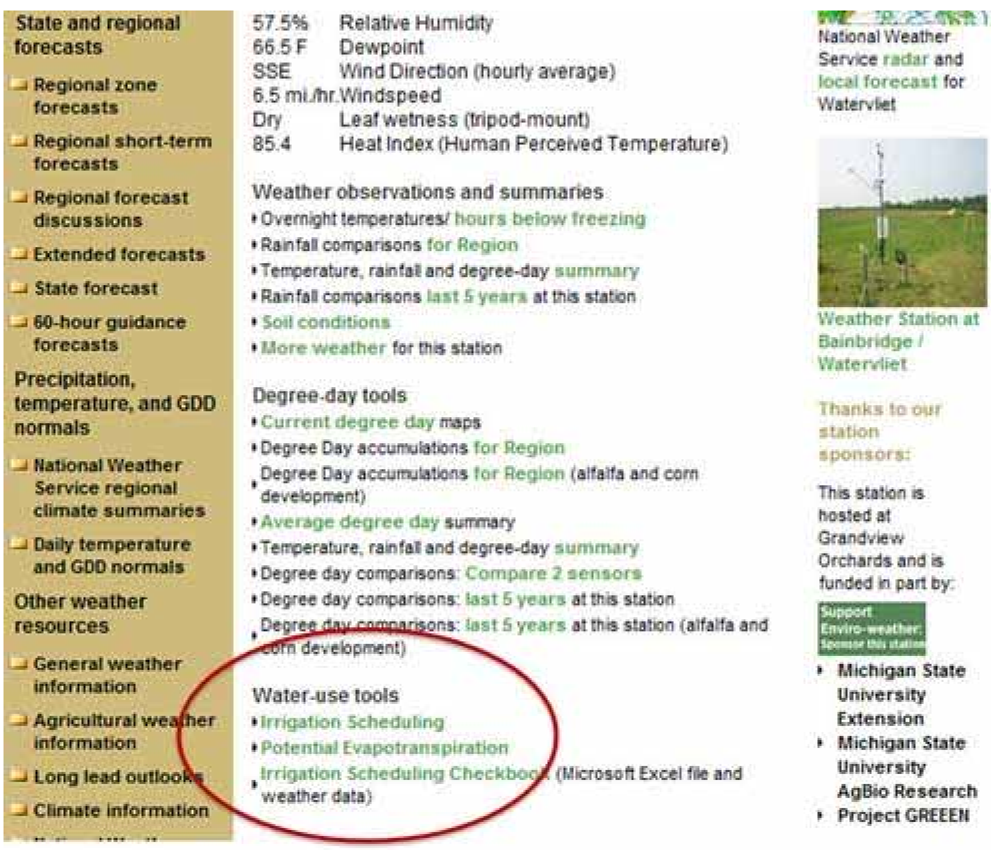


Photo 2. The "More weather" page has lots of weather information, including irrigation tools.

The evapotranspiration rate varies during the year depending on the amount of leaves on the plant and the heat and relative humidity. By June, when the plants are fully leafed out, the amount of leaves does not change significantly. Many people estimate the vegetation cover of the field to adjust the ET to the actual water loss. A field of mature blueberries with a cover crop will be using water at a rate close to the predicted ET. Younger fields or fields that do not have a cover crop will use less water. Weedy fields will use as much water as well managed fields and the weeds can out-compete the blueberry bushes for soil water because they have large root systems. Temperature is a very important factor; heat increases ET much more than humidity decreases ET.

Irrigation scheduling allows you to replenish the soil water while reducing the amount of water used and loss of nutrients. You need to know how much water the soil can hold. If you know how much water the plants are using, you should irrigate when the plants have used half the available water.

For example, a root zone of 18 inches on a loamy sand soil holds 1.2 inches of available water: If the root zone were depleted by 50 percent, you would need to apply 0.6 inches. This means that irrigation should be applied before 0.6 inches water is lost (three days of 0.20 inches ET) from sands and loamy sands, or 0.8 to 1.5 inches (four to seven days) are lost on sandy loam or loam soils. If the ET for the last several days was 0.25 inches, you would need to irrigate every two days; for 0.2 inches, every three days.

Sprinkler systems

The amount of water applied by solid set sprinkler systems is usually measured in acre inches (acre inch = 27,156 gallons). A system that delivers 0.15 inches water per hour delivers 0.6 inches in four hours. However, about 20 to 30 percent of water from overhead sprinklers may be lost to evaporation, so increase the operating time accordingly. Also, irrigation systems are not completely uniform; they apply more water in some areas than others. The uniformity of sprinkler systems can be measured, but they usually have only 70 (poor uniformity) to 90 percent (excellent uniformity). This means to recharge all areas of the field, even more water than calculated needs to be applied.

In our example, operating time should be increased 20 percent for evaporation losses, plus 30 percent if your system is only 70 percent efficient due to non-uniformity. So, increase the operating time of four hours by 50 percent to six hours to ensure that all areas receive 0.6 inches. With the importance of GAP inspections and certification, sprinkler systems are of increased concern. Because the irrigation water comes in contact with the fruit, GAP certifiers require tests of the irrigation water. Irrigation water from open ponds or other surface water sources can easily be contaminated with bacteria and if water tests indicate that the bacteria levels are higher than the levels in the grower's GAP plan, then irrigation should be delayed until after harvest or the problem is remedied.

Trickle irrigation

Trickle irrigation systems can be run daily or on the same schedule as sprinkler irrigation systems. The area wet by a trickle system is much smaller than the entire field wet by sprinkler systems. Since evaporation and uniformity are not significant in trickle systems, we do not need to increase the application time. These systems can be run at one to two hours every day to replace daily plant water use. Ontario, Canada, estimates that peak daily demand of a mature highbush blueberry is about 4.5 gallons per day (18 liters/day).

There are several rules of thumb for trickle irrigation systems.

- For young plants, apply 20 gallons/day per 100 feet of row.
- Mature plantings, apply 35 gallons/day per 100 feet of row.

Here are some useful facts to consider when irrigating blueberries:

- Acre inch = 27,156 gallons, so 0.2 inches = 5,431 gallons.
- Blueberry plants planted in 10-foot rows with 3.5 feet between plants is 1,244 blueberry plants per acre.
- Water use by one of those plants if the ET is 0.2 inches is 4.37 gallons per day.
- If 1 inch shortage of water, then the plant is short 22 gallons water.
- For an 8-inch shortage of water, plant is short 176 gallons water.

It is little wonder blueberry plants are wilting in soils that only hold about a third of the water they need without rain or irrigation.

Additional information:

- MSU Extension's Drought Resources

(This article was published by MSU Extension. For more information, visit http://www.msue.msu.edu.)

Maintaining Irrigation on Michigan Blueberries - *Mark Longstroth, and Eric Hanson, MSU*
Strategies for irrigating under hot, dry conditions and limited water supplies.

July 18, 2012. Much of southwest Michigan blueberries have received almost no rain since the beginning of June. In fact, we have needed over 9 inches of water since June 1 to satisfy the demand for many crops. Blueberries grow best in moist soil and suffer in dry soils. Blueberry roots are shallow and sensitive to drought. Severe drought symptoms have been showing up in several un-irrigated blueberry fields. About 75 percent of Michigan's 22,000 acres of blueberries are irrigated, but even growers with irrigation are struggling to keep up with the very high temperatures and water demand by the plants and the ripening fruit.

It is important to give the plants water before they totally deplete the soil. Blueberries show stress when the available water reaches 50 percent. Allowing soils to dry beyond 50 percent can cause severe stress and reduce berry size. Under these hot conditions, soil water is depleted more quickly, so more frequent irrigations are needed. For sandy soils, smaller more frequent irrigations are the correct way to irrigate. Growers lucky enough to have heavy soils can apply more water less frequently.

This un-irrigated blueberry field shows where the soil water in a light sandy soil has been depleted as opposed to the wetter parts of the field that either have a water table close to the surface, or a heavier soil that retains more water.

A full-sized blueberry bush probably needs 3 to 4 gallons of water a day. It will survive with less. The first thing to suffer is fruit size with less water to pump up the berries. As the soil dries out, the leaves will burn when they get too hot and the leaf tissue dies and dries out. Also, the berries of this year's crop will shrivel. When the soils become very dry, this year's green stems shrivel. At this point, next year's crop is destroyed. When the green stems shrivel, that stem is dead.

Once a field has been harvested you can reduce the amount of water applied. Without the fruit there is less demand for water. I think you can reduce irrigation by a quarter, but keep a close eye on the bushes and if you see leaves begin to burn, you need to increase the amount of water. To ensure flowers for next year's crop, you need to maintain the bushes with as little stress as possible through September.

Available soil water in most un-irrigated fields is now gone. Our blueberries began to leaf out in April and were fully leafed out in mid-May. A field of mature blueberries with a cover crop uses water at a rate close to the predicted evapotranspiration (ET). Temperature is an important factor; heat increases ET much more than humidity decreases ET.

I have graphed the daily demand and rainfall for one site in southwest Michigan (Bainbridge, Mich., northern Berrien County) in Figure 1. Under the hot, dry conditions in June and July, blueberry fields have lost 0.18 to 0.24 inches per day. Maximum water use during the preharvest fruit growth stage is generally 0.20 to 0.25 inches per day, so our water use is not unusual. What is unusual is the lack of rain. The rains received this year have only been enough to replace a few days of demand. I have graphed the cumulative demand in Figure 2. You can see rainy days as days when the slope of the line dips. These graphs illustrate clearly that the soil water is totally depleted and the only water blueberries have is applied by irrigating.

Figure 1. Daily demand and rainfall for one site in southwest Michigan.

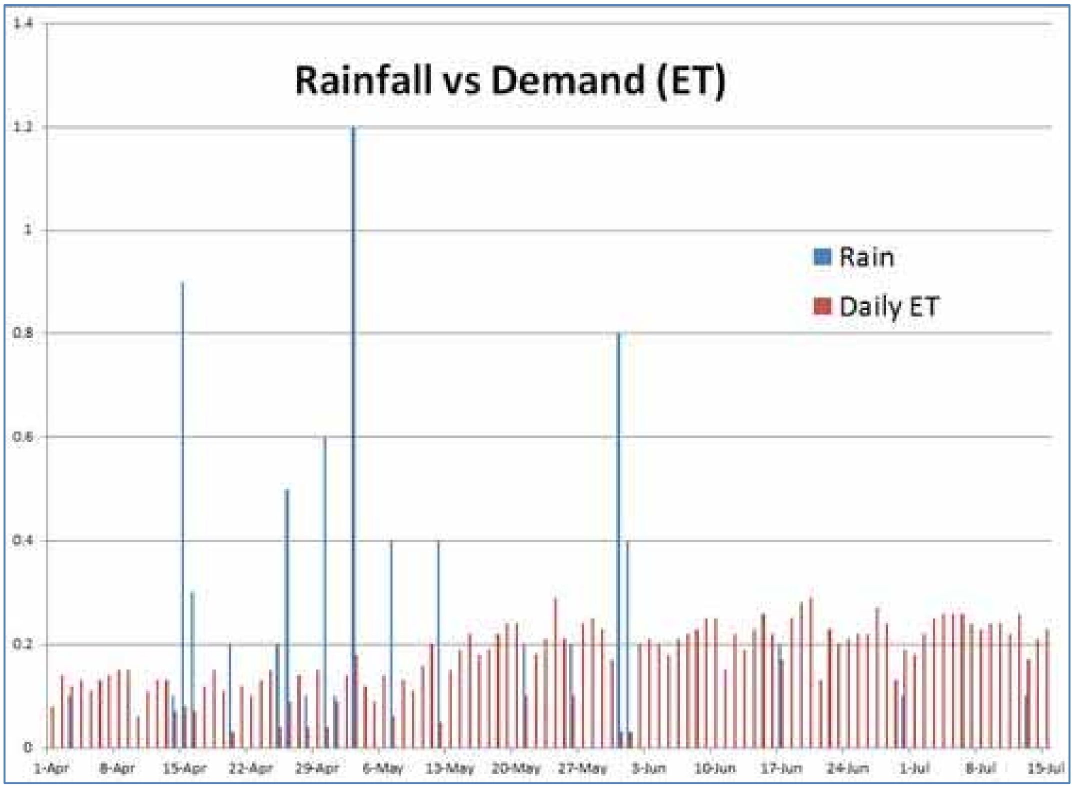
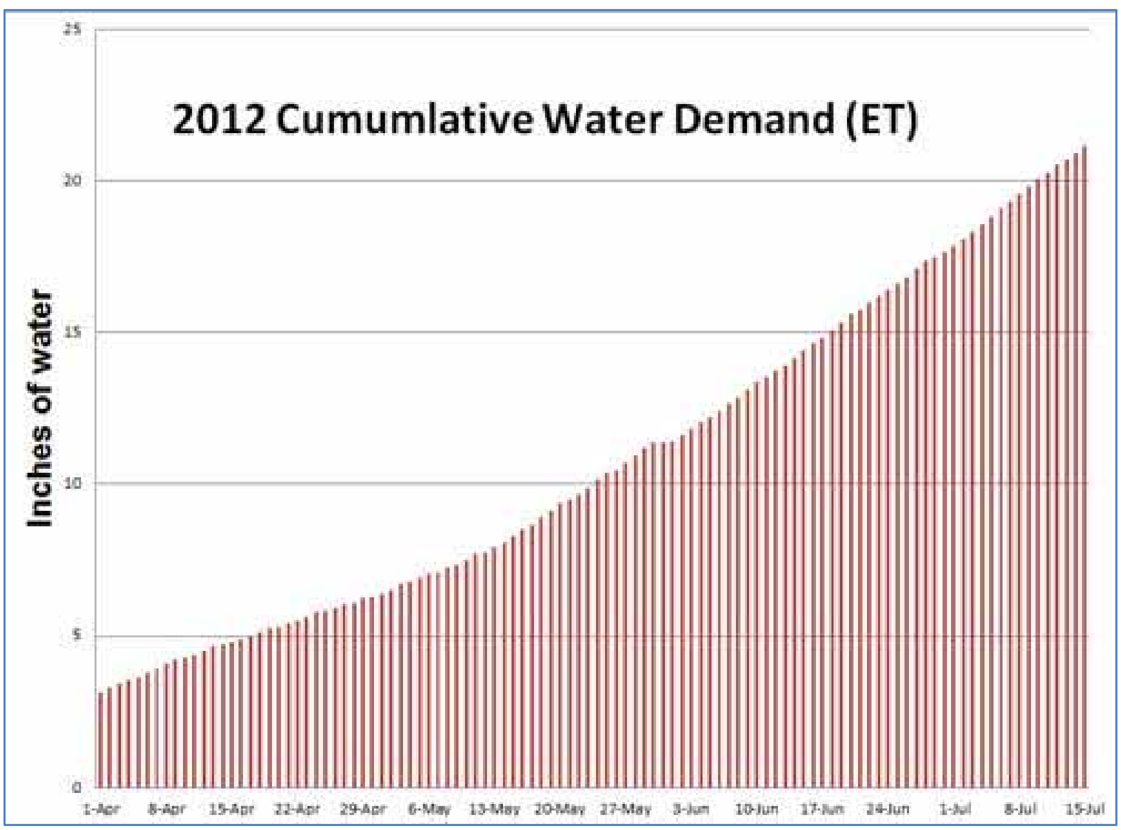


Figure 2. Cumulative water demand.



Many experienced blueberry growers have been irrigating continuously since the beginning of June. These same growers report that young plants are dying and berries are shriveling in irrigated fields. One of the problems is that blueberries have a small shallow root system for the size of the plant and it is almost impossible to suck enough water out of the soil to supply the leaves. As the soil dries, roots have harder and harder time extracting water. We are losing over an inch of water a week on soils that only hold 1.2 inches per foot of soil. Growers should be irrigating before 0.6 inches water is lost (three days of 0.20 inches ET) from sands and loamy sands, or 0.8 to 1.5 inches (four to seven days) are lost on sandy loam or loam soils.

Many growers are now being forced to choose which fields to irrigate since they cannot irrigate all their fields fast enough given their pumping capacity. If the water supply is adequate and the limitation is how much acreage can be irrigated at one time, try to cycle through the acreage more rapidly by irrigating each field for a slightly shorter time.

Other growers are running out of water and need to use limited supplies as efficiently as possible. Irrigate at night when evaporation losses are lower so more water gets into the soil. Try to irrigate long enough to replenish the top foot of soil. Although this will require you to extend irrigation intervals (irrigate less often), water is used more efficiently. Watering with small amounts more frequently wets only the top couple inches and more of this is lost to evaporation.

Additional information:

- MSU Extension's Drought Resources

(This article was published by MSU Extension. For more information, visit http://www.msue.msu.edu.)

What to do with Drought-stressed Blueberries - *Mark Longstroth, Michigan State University Extension*

Should growers cut back blueberries that appear to be dying from drought?

July 18, 2012. About 75 percent of Michigan's 22,000 acres of blueberries are irrigated and growers with irrigation are struggling to keep up with the demand for water and keep enough water in the soil to support the plant. That leaves over 5,500 acres of un-irrigated blueberries that have received almost no water since early June. As the soils have dried out, the fruit on these bushes has shriveled; the leaves have dried up and died, followed by shriveling of this season's stems. Severely affected bushes look dead or almost so. (For more information, read *Maintaining irrigation on Michigan blueberries.*)

Growers with severely drought-stressed bushes are now wondering what to do to save the plants. Some have asked if they should cut down plants in non-irrigated fields that are under severe stress where leaves are browning and dying. They think that cutting the tops off will conserve moisture so that the bushes can regrow once rains return.

We have started a research trial to test this, but we believe it is best to leave plants alone at this time. As the plant dies back, it loses more leaves and conserves more water for the remaining leaves and stems. If all leaves have died by now, the bushes may also die, but the crown may put out new shoots next spring or even in the fall after the fall rains begin. If some leaves remain green, these are an important source of sugars for the plant later in the season when rain occurs.

Un-irrigated blueberries burning up in the field. Do not cut these bushes back now. Wait and see what develops with the rest of the 2012 growing season before you decide on a course of action.

If plants are cut down now in the middle of the summer, they will be forced to produce new shoots with their limited stored reserves and water. This will use up limited reserves the plant could use to survive the rest of the summer. These new shoots will not have time to replace lost leaves and are unlikely to harden off in time for winter.

It is better to wait and see what happens in 2012 and then decide how to handle 2013. Many growers want to do something, but sometimes the best course of action is to wait and see.

Additional information:

- MSU Extension's Drought Resources

(This article was published by MSU Extension. For more information, visit http://www.msue.msu.edu.)

Bramble Irrigation Resources

Rubus Irrigation Management: http://www.hin.com.au/Associations/HSPN/Resources/Manual---Rubus-Irrigation-Management.aspx. Although written for Australian bramble producers (and in metric units) a very in-depth and useful publication in downloadable pdf format.

Other Irrigation Resources:

Soil Moisture

- **Measuring Soil Moisture for Irrigation Water Management** *(South Dakota State University)* http://pubstorage.sdstate.edu/AgBio_Publications/articles/FS876.pdf
- **Estimating Soil Moisture by Feel and Appearance** *(USDA)* ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/soilmoist.pdf. Great Descriptions and color photos.
- **Estimating Soil Moisture** *(Colorado State University)* http://www.ext.colostate.edu/pubs/crops/04700.pdf
- Soil Moisture Monitoring: Low Cost Tools and Methods – *ATTRA publication (fee)*
- Measuring and Conserving Irrigation Water – *ATTRA publication (fee)*
- Drought Resistant Soil – *ATTRA publication (fee)*

Maintaining Drip Irrigation Systems

- Maintaining Irrigation Pumps, Motors, and Engines - *ATTRA publication (fee)*
- Energy Saving Tips for Irrigators - *ATTRA publication (fee)*

Editor's Note: *Thinking about putting in a new berry planting? Check that preplant soil test for your soil organic matter content – it can have an impact on your irrigation costs down the road as Christina points out in the article that follows.*

Using Cover Crops to Decrease Irrigation Costs - *Christina Curell, Michigan State University Extension*

Traditionally cover crops were added to a farms rotation for soil building and erosion control. With the ever increasing cost of production and demand for higher crop productivity more attention is being given to value added qualities of cover crops.

March 27, 2012. Irrigation is a costly practice many farms use out of necessity. The demand for higher yielding acres has made irrigation inevitable. The cost in some cases has put a strain on the profitability of farms. If used in rotation, cover crops can offset some of those costs.

A typical irrigation system pumps 400-1200 gallons per minute at 0.25 inches per hour, five gallons per minute per acre of irrigation. The cost of irrigation annually varies depending on many factors ranging from $15,000-$50,000, according to Lyndon Kelley, Michigan State University and Purdue University Extension educator. System efficiency and environmental factors can decrease or increase irrigation costs. Cover crops especially ones that produce large amounts of biomass can increase soil organic matter. Soil organic matter acts like a sponge by absorbing and holding water. So the question is, how much water holding capacity can we rely on by increasing soil organic matter?

The United States of Agriculture, Natural Resources Conservation Service estimates that on average bare soil can hold 1.7 inches of water. Fields that has a continuous cover, such as a pasture situation, on average has a water holding capacity of 4.2-4.5 inches. If we could raise our soil organic matter by 1%, we have the potential of raising our water holding capacity by 1 acre inch according to Jim Hooreman, Ohio State University Extension water quality and cover crop educator. That equates to 27,154 gallons of water that plants can use that is stored in soil. Hooreman also states that every pound of soil organic matter holds 18-20 pounds of water. If we were to pencil out the economics, that would be $12.00 which could add up to real savings in the fall.

(This article was published by MSU Extension. For more information, visit http://www.msue.msu.edu.)

Cover Crop Resources

- Cover Crops for Blueberry Plantings
- Cover Crops for Raspberry Plantings
- Preplant Cover Crops for Strawberries
- Cover crop Decision Tool http://www.hort.cornell.edu/bjorkman/lab/covercrops/decision-tool.php. While designed with vegetable production in mind, still useful in helping select preplant cover crops for small fruits.

Questions or comments about the New York Berry News?

Ms. Cathy Heidenreich, Cornell University Dept. of Horticulture, 630 W. North Street, Geneva, NY 14456

Phone: 315-787-2367 *Email*: mcm4@cornell.edu