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Bracing for another Hot Summer

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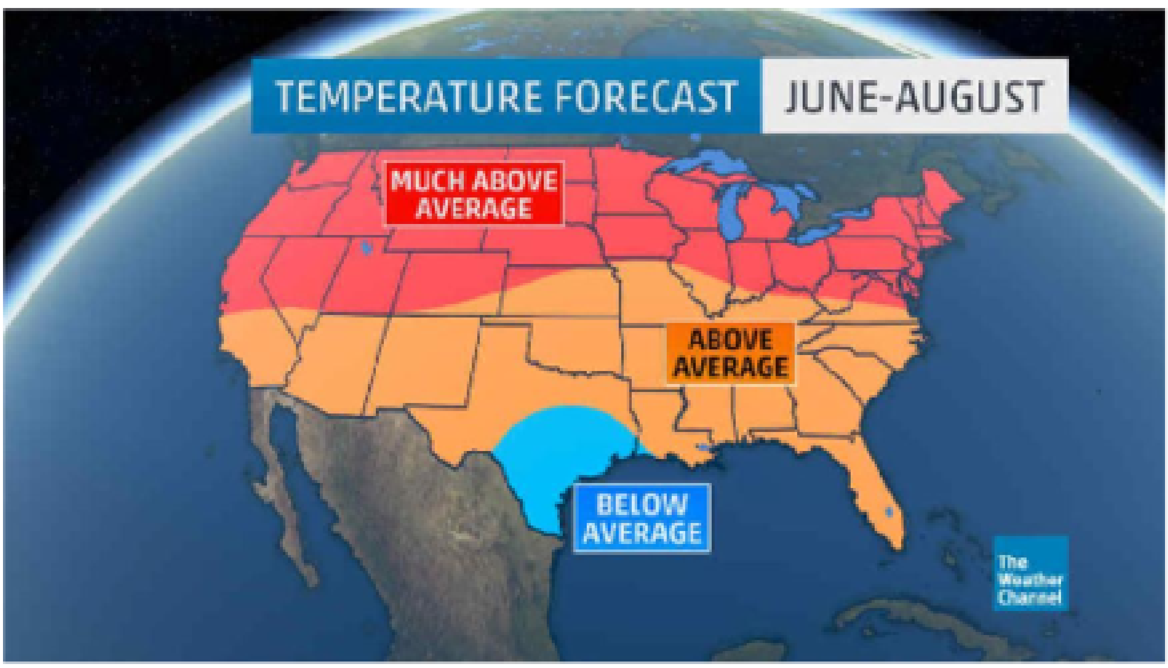
The old adage that "you can't do anything about the weather," is certainly true. Hot temperatures during the 2015 growing season caused heat and water stress symptoms to occur on potatoes in many production regions, including the Pacific Northwest. The symptoms of heat and water stress include: lower yield and tuber size, lower specific gravity, more external and internal defects, higher incidence of storage rots such as pink rot and Pythium leak due to heavy water applications, and reduced storability. Growers can't control environmental stresses, but they can compound these problems by making management decisions that increase the consequences of stress. Given the forecast for above average temperatures across the northern US in 2016 (see below), are there things growers should be doing during the season to reduce the impacts of stress? This article takes a step by step look at management strategies during each portion of the growing season.



Early season:
Research studies show that high soil temperatures (above the mid 70ºF range) reduce the activity of the enzyme that converts sucrose—the form of sugar transported from leaves to tubers—to starch. The damage to the enzyme system seems to be permanent, as even a transient stress during the period of early to mid-bulking, when tubers are up to the size of a golf ball, can result in a reduction in tuber quality due to sugar ends. The most effective way to cool the soil during a period of high temperatures is to take advantage of the soil shading provided by a full canopy. Therefore, planting to a full stand and controlling seed decay not only promote good stands, but also reduce heat stress-related disorders. Strive for early canopy cover of the soil.

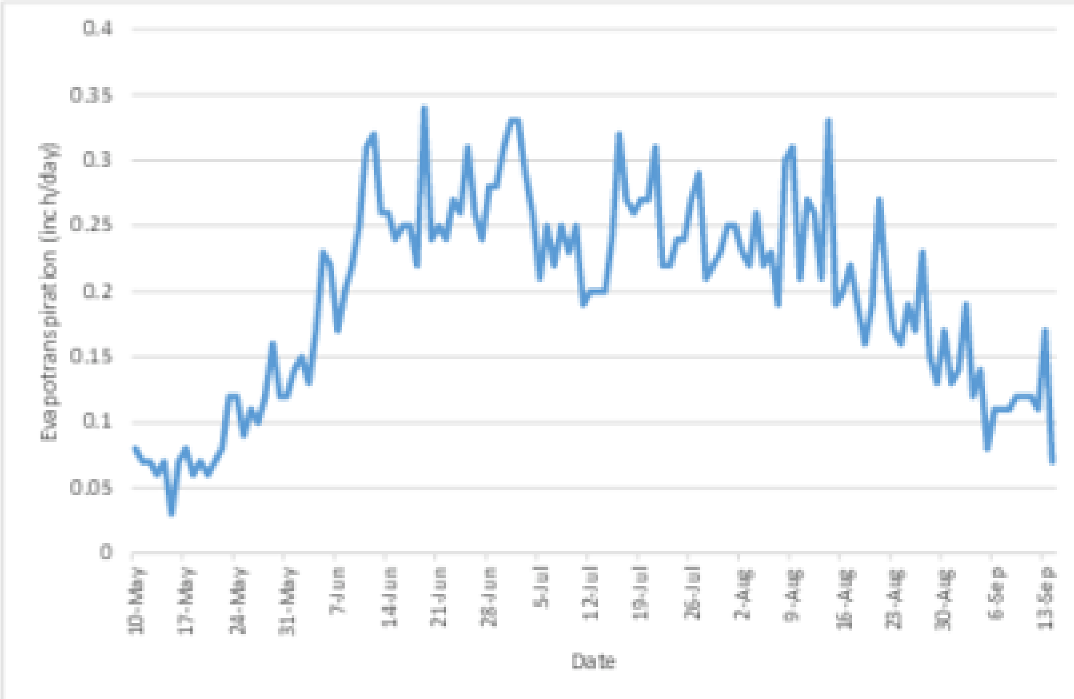
While high temperatures alone are enough to cause stress symptoms in potatoes, water stress combined with heat stress greatly compounds the problems. In fact, heat and water stress are so closely tied together that it is difficult to separate the two due to the fact that as temperature goes up, so does water use by plants through evapotranspiration. Therefore, you can't afford to make irrigation mistakes during periods of high temperatures. Avoiding water stress starts with maintaining the irrigation system (evaluating the pump, fixing leaks, checking for worn nozzles, etc.) so that it can supply peak crop water demand. Just as important is to do a system test to ensure that the water applied is distributed uniformly across the field to avoid wet and dry spots. The time to do this is before peak water use, not after the high temperatures hit and problems become apparent.

Likewise, if you have a system with marginal capacity to provide unusually high crop water use rates that come with hot temperatures combined with wind, it is extremely critical to monitor the soil moisture in the second foot of soil. Think of this moisture as part of the "savings account" to meet crop water use when withdrawals exceed the systems pumping capacity.

Avoiding irrigation management mistakes that result in water stress is only one piece of the equation. The plant also needs an adequate root system to extract enough water from the soil to supply its needs. Research shows that soil compaction has a much greater effect on early season root growth than previously thought. Anything that prevents full root system development—compaction, root pruning during tillage operations, or disease—will limit the plant's ability to get enough water during periods of high demand.

Mid-season:
Although water stress events during early tuber bulking are most detrimental to tuber yield and quality, potatoes continue to be sensitive during mid tuber bulking. Additionally, high daily water use rates are common during the middle part of the growing season, which can compound irrigation management mistakes. For example, daily water use rates for potatoes grown in Southwest Idaho during 2015 were often above 0.3 inches per day (Figure 1). During mid-season it is important to continue watering according to crop demand. Do not get behind as it is very hard for some irrigation systems to fully recharge the soil profile when crop water demand is high.

Figure 1. Daily water use rates for potatoes grown in Southwest Idaho during 2015. Values are provided by the Agrimet weather system (http://www.usbr.gov/pn/agrimet/).



Another management consideration at this point in the season is the nitrogen fertilizer program. Excessive nitrogen applications tends to stimulate vine growth, but have little impact on root development. The end result is a plant that has high demand for water, but no additional root system to supply that demand. A combination of high temperature with a high nitrogen program will cause an imbalance between shoot and root growth, increasing plants' susceptibility to stress injury.

Finally, consider the risk of storage decay problems due to pink rot and Pythium leak. If you are planning to use a mefenoxam or phosphite-based fungicide, the most effective programs include application at dime to quarter tuber size followed by an additional application after 2 weeks and a third application after an additional 2 weeks (phosphite based products only).

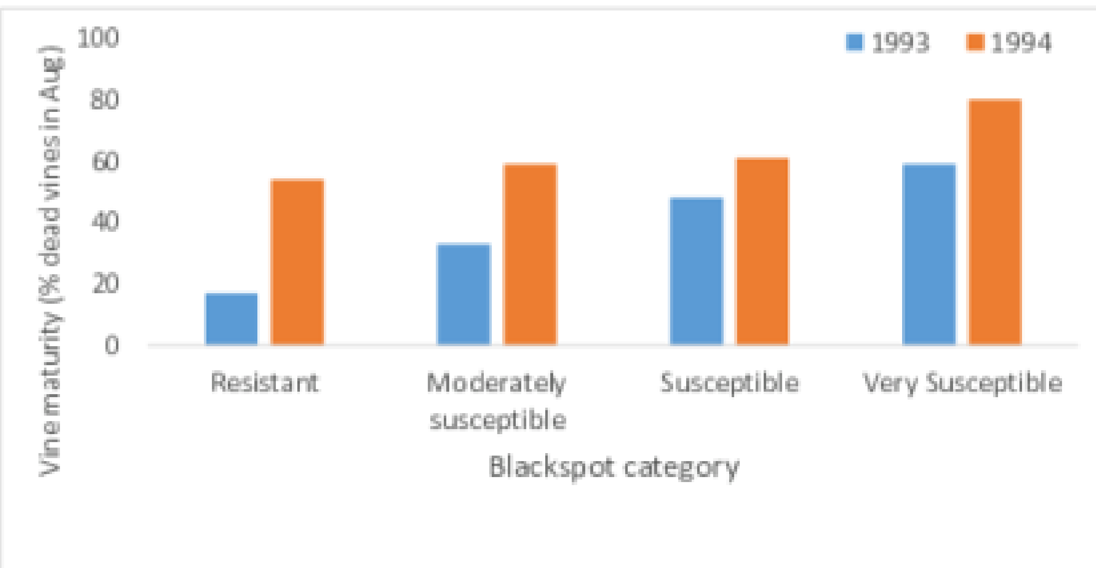
Late season:
As the crop enters late tuber bulking the daily water use rates decline, and the plants become much less sensitive to water stress. These are both good things in terms of managing stress-related disorders. However, at this stage it becomes very easy to overwater the crop which can lead to decay problems during storage. It is especially important to watch for areas of the field that remain wet for long periods following an irrigation or rain. You may want to flag those areas and place them at the end of the storage where they can easily be removed if problems start to develop. If these wet spots exhibit extensive decay at harvest, you may want to avoid harvesting them altogether.

Storage system maintenance and repairs– now is the time to do this in preparation for the upcoming storage season. A few things to consider:
- Repair all insulation materials to minimize the potential for condensation.
- Clean plenum, wall and ducts thoroughly.
- Replace worn humidity equipment and high-pressure nozzles.
- Service the air system and check all fans for proper balance.

- Check the air delivery system by adjusting all ports or ducts for optimum and consistent airflow.
- Repair or replace worn components on air louvers/doors, both fresh air and exhaust.
- Calibrate all computerized sensors used for control functions.
- Service the relative humidity supply systems—check for mineral deposits and eliminate clogged flow paths.
- Operate your storage for conditioning before the potato crop is delivered.

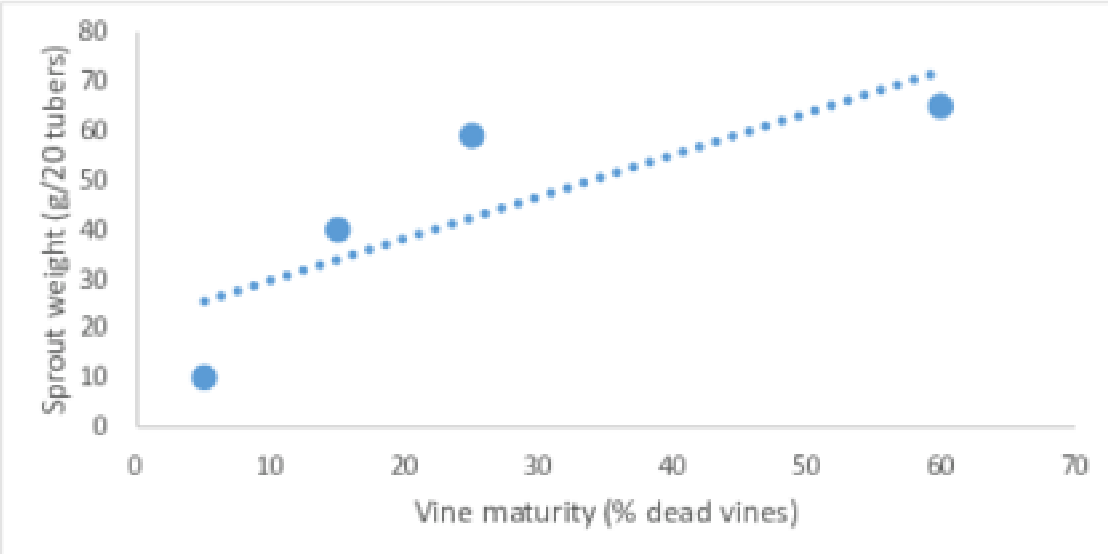
Harvest and storage:
Exposure to stressful conditions during the growing season tends to hasten maturity of the crop, and increases the incidence of diseases associated with the early die complex. Rick Knowles of Washington State University has outlined in previous articles the decline in processing quality due to sugar problems in over-mature tubers. This decline in quality occurs as the tubers sit under dead vines exposed to wide fluctuations in soil temperature. Likewise, this same situation can increase susceptibility of tubers to blackspot bruise during harvest and handling, and reduce the length of dormancy in storage. A survey of commercial Russet Burbank fields during 1993 and 1994 showed a direct relationship between vine maturity and susceptibility to blackspot bruise (Figure 2). In both years, fields that had more than 50% dead vines were more susceptible to bruise than fields that remained green up to vine kill. In a separate study, we were able to show a decline in tuber dormancy with increasing vine maturity (Figure 3). The bottom line is that stressed potatoes that sit in the soil under dead vines for a long period prior to harvest are more likely to exhibit problems with processing quality, higher bruise incidence, and sprout quicker in storage. Therefore, you need to be ready to move these potatoes to market quicker to minimize the impact of these quality issues.

Figure 2. Influence of vine maturity prior to vine kill on susceptibility to blackspot bruising for commercial fields of Russet Burbank grown during 1993 and 1994.



Under "ideal" conditions all potatoes would be harvested at pulp temperatures between 50 to 55°F. Realistically, the recommendations are to harvest between 45 and 65°F. Monitoring pulp temperatures and adjusting harvest times during the day may be necessary to stay within that temperature range. This temperature range may need to be narrowed if harvesting in a rocky field, growing a susceptible variety, or growing conditions in the field increased crop susceptibility to bruising or disease such as stress, early-die, and over- or under-watering.

Figure 3. Relationship between vine maturity in mid-August and sprouting of Russet Burbank potato grown at Parma, ID during 1992.



There are several major consequences to harvesting under conditions when warm pulp temperatures are difficult to avoid. First, probability for pink rot and Pythium leak increases substantially. Pulp temperatures above 65 to 70°F dramatically increase the chance for potatoes to become infected with *Pythium* even without major wounding. Ideally, it is best to harvest potatoes with pulp temperatures below 65°F to minimize the potential for tuber decay due to Pythium leak. Although pink rot does not need a wound to infect and decay a tuber, the chance for infection increases dramatically as the tuber is wounded, especially at pulp temperatures above 60°F. Even if you are gently handling your potatoes, pulp temperatures of 70°F increase the chances of pink rot development tremendously if the inoculum is present. Consider post-harvest spray applications going into storage if there is a high risk of disease. Phosphite-based products are recommended to minimize late blight or pink rot development in storage, but will not cure already decayed tubers.

Each storage ventilation system is designed to provide the desired volume and rate of air to the bulk potatoes. Proper air distribution is essential to handle the temperature and disease concerns associated with stressed potatoes as described above. Any change in this sophisticated air distribution design will compromise condensation management and temperature equilibration of the pile. The aboveground duct pipe must be properly aligned, connected, and sealed to deliver the air as needed. Gaping holes and misaligned ducts will not provide the air to the pile as designed nor desired. Ensuring this system is properly aligned is a "must" to start the storage season.

If tuber pulp temperatures are already high that means the heat of respiration will be high. This combination highlights the need to focus on the number one storage management objective – remove that heat as quickly as possible. There may not be adequate outside cooling air available to get control of this heat load. Operate fan and humidity systems as soon as the first few ducts are covered. This early operation helps to remove pulp temperature differences between fields, truckloads and time of day. Refrigeration can be an option to cool potatoes at harvest, although the system must have the capacity to handle the high heat load and fresh air also must be provided to purge carbon dioxide out of the building. If using outside cooling air only, maximize run time by bringing fresh air in 1 to 2°F lower than the coolest potatoes and continue with this step down process until you reach the desired curing temperature. Some computerized control panels can be programmed to do this whereas others may have to manually reset at each step down in temperature. Do not simply set the set point to 55°F – this will not maximize run time. The longer potatoes are above 55°F in storage, the greater the risk for disease break down.

Maintain pulp temperatures at 50 to 55°F for 2 to 3 weeks for proper wound healing. Factor in the time and temperature potatoes were at warmer temperatures prior to reaching the recommended curing temperatures. Relative humidity of 95 percent is always recommended for the wound-healing period and for continued short or long term storage. Reduce pile temperatures slowly, approximately 2 to 3°F per week, to the desired holding temperature for the variety and market use. Continue to monitor the storage daily for operational continuity and for early detection of any potato problem that might develop.

One final word about varieties and susceptibility to stress. Some varieties are much more likely than others to lose yield and quality after exposure to stressful conditions. For example, Russet Burbank is consistently one of the most sensitive varieties in terms of developing stress-related disorders such as sugar ends (Figure 4). This has important implications because when you grow a variety like Russet Burbank there is a very low margin for error in the management decisions outlined above.

Figure 4. Incidence of sugar ends defect in three potato varieties grown in trials at Parma, ID during 2014 and 2015.