Reducing Plant Heat Stress – with Microbial Help

The impacts of heat stress can be reduced with attention to
irrigation, minor nutrients and **MetaGrow**™ microbes

To paraphrase an old saying, "We all complain about the weather, but most people don't do anything about it." While we cannot change the weather, we can mitigate the impacts of extreme heat on our crops. This technical bulletin will discuss the types of impacts of extreme temperatures on plants and the available management options to mitigate those impacts.

Types of Excessive Heat Impacts

- **Increased plant water demand**
  The hotter the temperature, the more water plants must transpire to keep themselves cool. Extreme temperatures can outstrip the plant's ability to uptake water, translocate it to the leaves, and respire in sufficient quantities. When water translocation is insufficient, leaf stomata close and photosynthesis stops. Plant species express this shutdown in different ways, but in general they droop or cup their leaves due to loss in cell turgor pressure. Transpiration shutdown typically occurs during the hottest afternoon hours. These hours are then lost to plant productivity, as the photosynthetic process is interrupted. This is like a plant holding its breath. Fruit is always the last to shut down transpiration. If the fruit gets hot in the late afternoon, actual crop damage is occurring in addition to the loss in plant productivity. When the fruit gets hot, bad things are happening: fruit is desiccating; sugars are caramelizing; vascular tissues are breaking down; tissue necrosis occurs from sun burning and ripening; acids are prematurely transforming or transforming to the wrong types; and senescence hormones are prematurely expressed. If you have a healthy plant with adequate available water, you will lose less of these plant productivity hours and avoid these direct impacts to crop quality and yield.

- **Rapidly changing effective plant moisture availability**
  Along with increased transpiration demand there is also increased irrigation losses to surface evaporation. Plants pull shallow moisture more easily than from deep roots. Trees and vines waterlogged from the winter and spring rains will be additionally disadvantaged, as deep roots feeder roots and root hairs, which do most of the water collection, suffered necrosis from anaerobic conditions and will not pull deep water as efficiently. For irrigation management purposes, figure the plant can only pull about half as much water from its deepest roots as from its shallowest roots, given the same moisture availability. Shallow root water mining efficiency can also be compromised by high temperatures. Shallow roots can also shut down and suffer necrosis from high temperatures. Be mindful of both these constraints when evaluating your effective soil water availability during peak heat stress periods.

35410 Jefferson Blvd, Clarksburg, CA 95612 916-284-9706 www.SGS-Ag.com

- **Reduced photosynthesis**
  Heat increases the formation of Reactive Oxidative Species (ROS) in the plant. These chemicals reduce the efficiency of several photosynthetic-related transactions. Transpiration shutdown also reduces photosynthesis, as explained above. Protein synthesis is also reduced or inhibited by these conditions. Photosynthesis that does occur during stomatal shutdown contributes to the accumulation of ammonium forms of nitrogen in the plant tissues which encourages infestations of mite and thrip pests.

- **Premature expression of ripening and senescence related plant hormones**
  In addition to ROS disrupting photosynthetic efficiency, they also can trigger formation of ripening and senescence-related hormones such as abscisic acid, ethylene and others. These premature ripening hormones can cause abortion of bloom and young fruit, shatter, premature hull split, and premature shift from fruit sizing into fruit maturation. Extreme heat and transpiration shutdown of the fruit can also change the forms of acid from vegetative to ripening forms, and cause vascular system collapse and necrosis. Once the fruit starts to grow again after the shutdown, it may not be able to shift sufficient nutrients to prevent other fruit quality impacts, such as calcium deficiency triggering blossom end rot.

Reducing Plant Heat Stress

- **Maintain adequate freely available soil moisture**
  Stay on the free release side of your soil moisture release curves. Make sure the water is where the roots are. Adjust your irrigation schedule to have more frequent irrigation with shorter durations. Factor in the increased water loss to surface evaporation. Increasing irrigation frequency will ensure that there is more "easy" water for the plant to mine and will help protect shallow roots from cooking. If you have different water sources, use your best quality water.

- **Avoid key minor nutrient deficiencies**
  Nutrient imbalances can negatively impact water translocation, stomatal efficiency, and cell wall turgor. Several nutrients are key for efficient translocation and transpiration. The most important for heat stress management include calcium, magnesium and silica. By avoiding these minor nutrient deficiencies, you optimize the transpiration capacity and build strong plant cell walls that are more resistant to desiccation, osmotic pressure and electrolyte leakage.
  For heat stress management -
  Calcium is important for translocation of water and nutrients, stomatal function, heat shock protein development and cell wall structure;
  Magnesium, which regulates enzymatic reactions, is required for translocation of sugars and starches, and stabilizes cell membranes;
  Silica reduces Reactive Oxidative Species (ROS) and reduces cell wall leakage.

35410 Jefferson Blvd, Clarksburg, CA 95612 916-284-9706 www.SGS-Ag.com

- **Avoid foliar sprays**
  Most foliar sprays increase leaf cell osmotic pressure stress. This is generally not a problem under normal conditions, but it can contribute to additional stress under extreme heat conditions even when the foliar is applied at the cool time of day. This is particularly true of pesticides which often stun the plant for a couple days even under favorable stress conditions. Avoid stacking additional sources of stress on top of the extreme heat stress as the combination of stressors is much worse than just additive.

- **Healthy soils reduce all abiotic stressors (heat, drought, salt pressure, cold, pest, disease)**
  Plants utilize microbial metabolites for stressor responses, and also to moderate the premature expression of fruit ripening and senescence hormones. It is the improved stress tolerance of the plant and the resulting reduction of the lost photosynthetic hours that partly explain MetaGrow performance. Our microbial programs result in higher fruit Brix and earlier ripening. Healthy soils produce plants that are less vulnerable to stress and therefore are less impacted by extreme heat.

Recommendation

Adjust your irrigation program, address nutrient imbalances that impact plant respiration, and build healthy soils that improve plant resiliency under extreme heat conditions.

We recommend a microbial program that starts with an application of 5 or 6 gallons per acre of **MetaGrow ST** (or 1 gallon per acre of **MetaGrow 5X+)** with 0.6 lb **MetaGrow MFOOD,** followed by monthly applications of 2 gallons of **MetaGrow ST** (or 50 oz per acre of **MetaGrow 5X+)** and 0.2 lb/acre **MFOOD** for the rest of the irrigation season. This program would cost $55 to $80 per acre depending on volumes and irrigation season duration. Even if started mid-season, this program will go a long way to reducing the impacts of the next extreme heat event and build soil health and plant vigor for improved performance next year.

35410 Jefferson Blvd, Clarksburg, CA 95612 916-284-9706 www.SGS-Ag.com