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College of Agricultural and Environmental Sciences / Athens, Georgia 30602-4356

Temperature, Relative Humidity and Evaporative Cooling Systems

BY: MICHAEL CZARICK, EXTENSION ENGINEER
MICHAEL LACY, EXTENSION POULTRY SCIENTIST

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When you think about circulation or exhaust fans do you think in terms of a single thermostat setting? Probably not. Typically fans are brought on in stages. The hotter it gets, the more fans that are turned on. But, when thinking about evaporative cooling system (pads/foggers), which can potentially do nearly as much cooling as fans, most people do tend to think in terms of single thermostat setting, ie. 85°F.

Though much of the time a single thermostat setting for evaporative cooling systems works fine, it can lead to problems such as excess litter moisture and insufficient cooling ability. These two problems may seem opposite in nature, but they are both due to the evaporative cooling system not being in tune with outdoor conditions, namely air temperature and relative humidity.

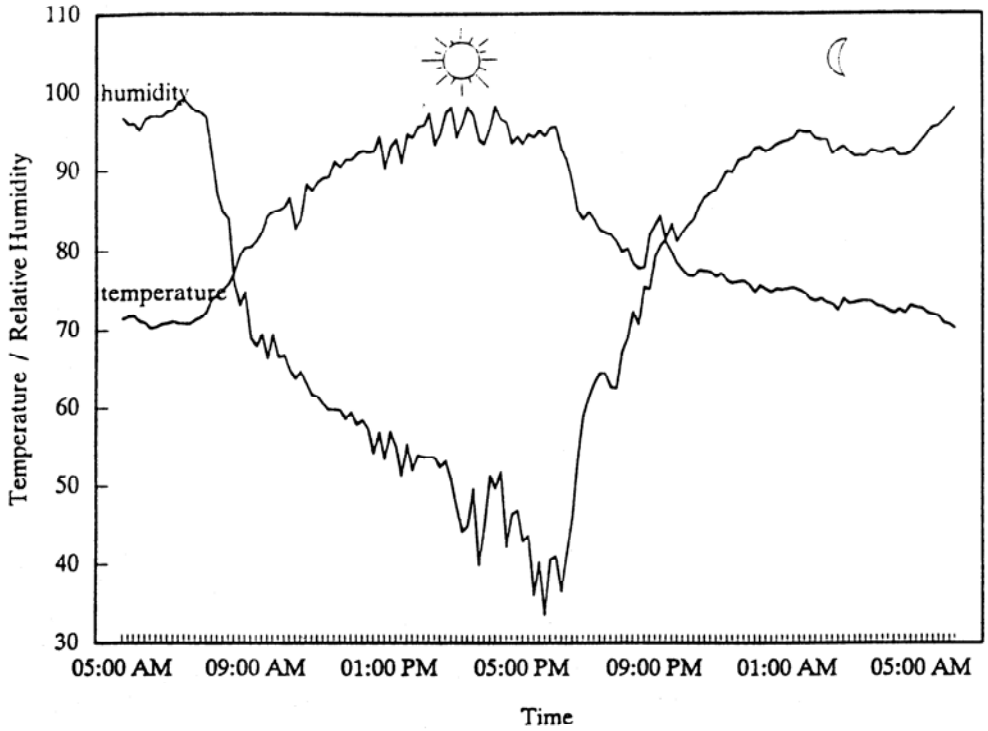

Figure 1. Air Temperature and Relative Humidity Interaction

We are all well aware of the fact that outside air temperature is not constant. On a typical summer day it will vary about 20°F from day to night. What is not so well known is that outdoor relative humidity (Rh) is also not constant. In fact, it changes two to three times as much as air temperature on any given day.

For the most part, outside temperature reaches a high during the mid-afternoon and a low just before daylight. Relative humidity on the other hand does the exact opposite. It reaches a low during the mid-afternoon and a high just before daylight (Figure 1). The two are inversely related: the higher the temperature the lower the relative humidity, the lower the temperature the higher the relative humidity.

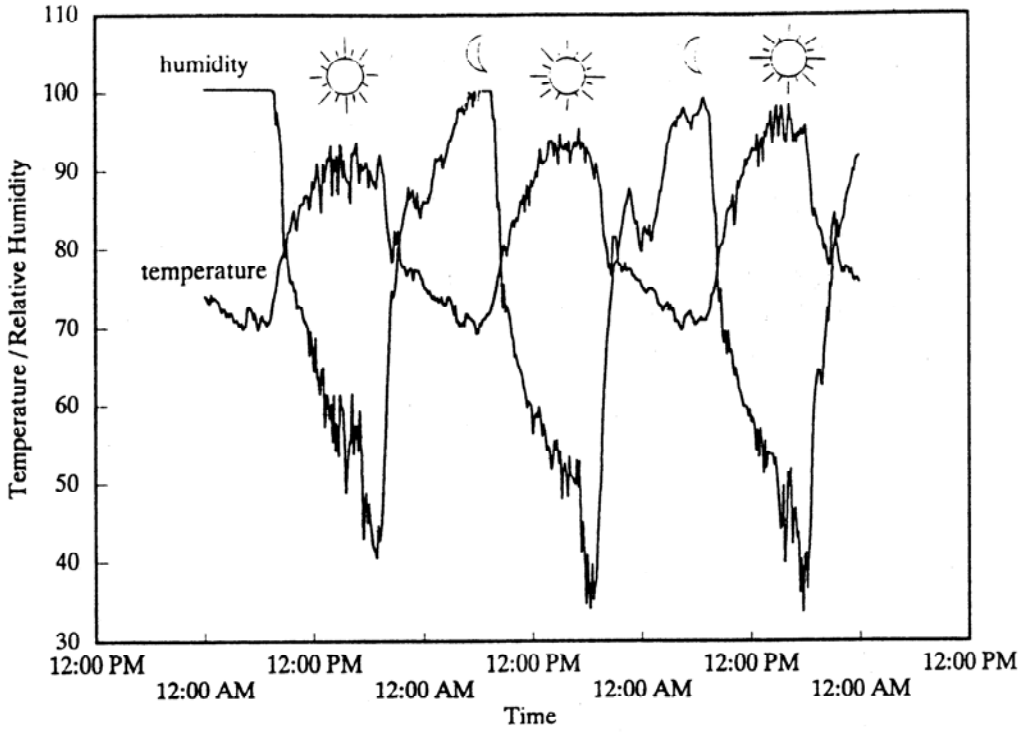

Figure 2. Relative Humidity Versus Temperature.

The extent to which relative humidity decreases through the day can be affected by weather systems and proximity to large bodies of water. If a weather system moves in that has a lot of water associated with it already, the drop in humidity will not be as great. If the house is located near an ocean, the decrease in relative humidity throughout the day will not be as dramatic because of the amount of moisture that will be evaporated into the air from the body of water. Nevertheless, the fact remains that relative humidity does drop as air temperature increases.

The reason for this inverse relationship between temperature and relative humidity is that as air temperature rises its ability to hold moisture is increased. In fact, for every 20 degree rise in temperature the moisture holding ability of air doubles. For instance, if the air temperature was 70°F and RH was 100% at 5 a.m. and the temperature increased to 90°F at noon, the moisture holding ability of the air would double. As a result, the air would now hold only half of the moisture it is capable of holding and the relative humidity of the air would theoretically drop to 50% (Figure 2).

The fact that relative humidity drops as air temperature increases allows producers to use fogging nozzles and evaporative cooling pads to help reduce heat stress. The hotter the day, the dryer the air becomes, and the more cooling that can take place through the evaporation of water.

A good rule of thumb to follow is that outside air temperature should be above 85°F and humidity below 75% before foggers or evaporative cooling pads are used. For the most part, you can use air temperature as a guide on how to use your evaporative cooling system. By the time the outside temperature reaches 85°F outside, humidity is almost always below 75%. The two go hand in hand.

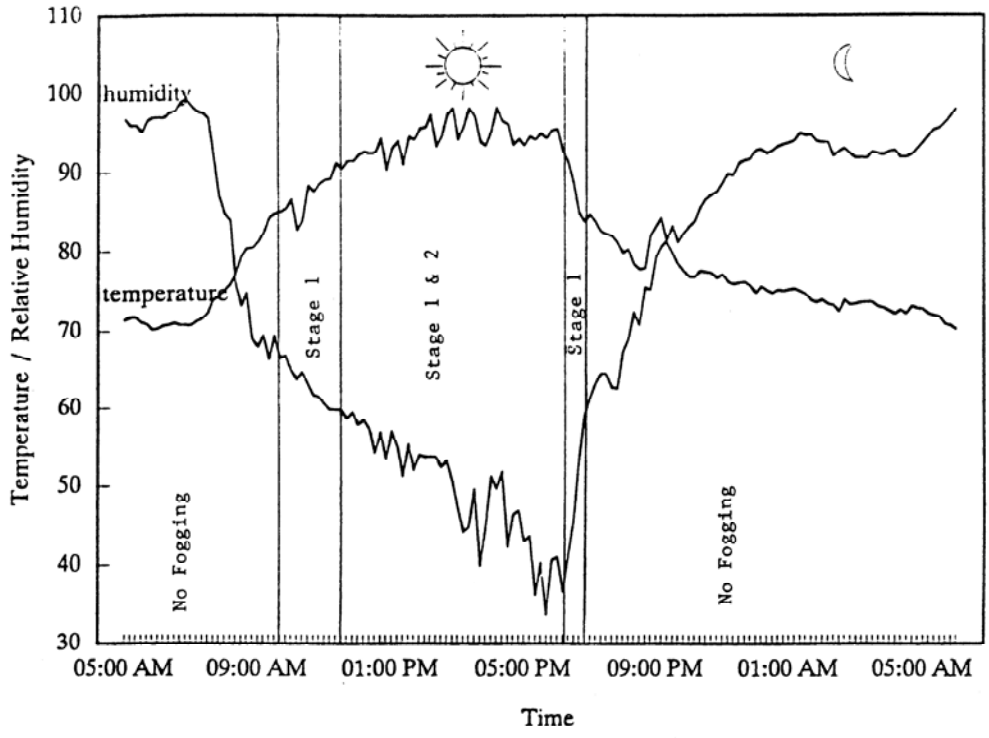

Figure 3. Staging Fogging Systems.

It is important to realize that 85°F is only a "starting" point for evaporative cooling. As air temperature continues to rise, relative humidity continues to fall. In order to maximize the efficiency of an evaporative cooling system, it must be able to take advantage of this further drop in relative humidity. For instance, in a house with fogging nozzles, 30 could be used at 85°F and another 30 at 90°F (Figure 3). If all 60 nozzles were used when air temperature first reached 85°F, the humidity would not be low enough to allow all the water to evaporate, leading to wet litter. Conversely, if only 30 nozzles were used at 90°F there would not be enough moisture added to get the house temperature down to a desirable level.

A similar situation exists in houses with evaporative cooling pads. Interval timers are used on circulation pumps to minimize pad run-off. The timers are typically set so that the pads just about dry out by the time the pump turns back on. If the timer was adjusted when it was 85°F and air temperature were to increase to 90°F, the pads will dry out long before the pump comes back on, limiting the amount of cooling produced. This potential problem can be avoided if the interval timer is by-passed as air temperature rises above 90°F.

One point to keep in mind, on what most people would consider a very humid day, relative humidity still drops as temperature increases. It may feel like the humidity is 90 percent, but in reality it is most likely between 50 to 60 percent. On these days you will probably be unable to run your evaporative cooling system wide open without causing excess moisture problems.

Michael Czarick
Extension Engineer
(404) 542-2154

Michael P. Lacy
Extension Poultry Scientist

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