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Poultry Housing Tips

Temperature, Relative Humidity and Evaporative Cooling

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Probably one of the most commonly asked questions about summertime ventilation is whether evaporative cooling systems should be used on hot and very humid afternoons. For instance, should growers turn off their foggers or pads when it is 95ºF outside and 90% relative humidity? This is a tough question to answer, not because there isn't an answer, but because it is a virtually impossible situation. It is like asking if you should use a tunnel ventilation system in north Georgia on a 95ºF day in December. Yes you should, but the situation is VERY unlikely to occur.

The reason for the near impossibility of a 95ºF day with 90% humidity lies in the laws of psychrometrics. Psychrometrics explains how air temperature, moisture, and energy interrelate. One of the most basic psychrometric principles is that warm air can hold more water than cold air. For instance, for every 20ºF increase in air temperature, the moisture holding ability of air doubles. So, if I have 70ºF air and 100% relative humidity (holding all the water that it can) and I warm that air to 90ºF, the air can now hold twice the amount of water so the relative humidity would be cut in half to 50%. The relationship between temperature and relative humidity can be seen in the graph below of hourly outdoor temperature and humidity measurements for Alma, Georgia during July of 1994 (Alma is in Southeast Georgia about 65 miles from the coast). As is apparent from the figure, relative humidity is

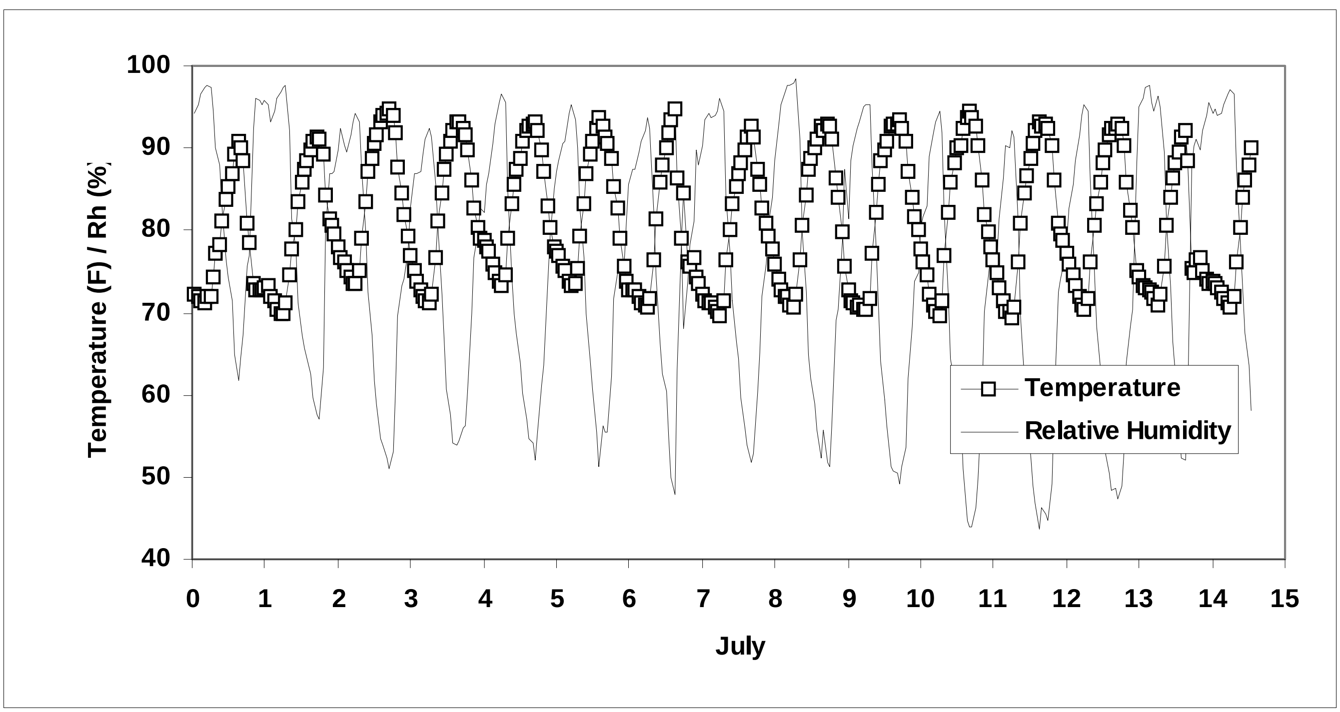

Figure 1. Hourly Temperature and Relative Humidity Measurements for Alma, Georgia (July, 1994)

at or near 100% at night when the air temperatures are the lowest, in the low to mid seventies. As the sun rises and temperatures increase to highs in the mid nineties, about a 20°F increase, the relative humidity is approximately cut in half and drops to between 40 to 50%.

Some days, of course, are more humid than others due to weather fronts that may bring more or less moisture into an area. Likewise, some locations are more humid than others due to the availability of water. For instance, locations near the coast or a large swamp will be more humid than desert areas. But the fact remains, when temperature goes up...relative humidity goes down.

The relationship between temperature and relative humidity can be seen more clearly in Figure 2. In this graph, hourly temperature measurements for the entire month of July were graphed with their corresponding relative humidity. For instance, on July 30 at 9 a.m. the air temperature was 77°F and the relative humidity was 63%. A diamond was placed where the 77°F vertical temperature line intersects the horizontal 63% relative humidity line (see arrow in Figure 2).

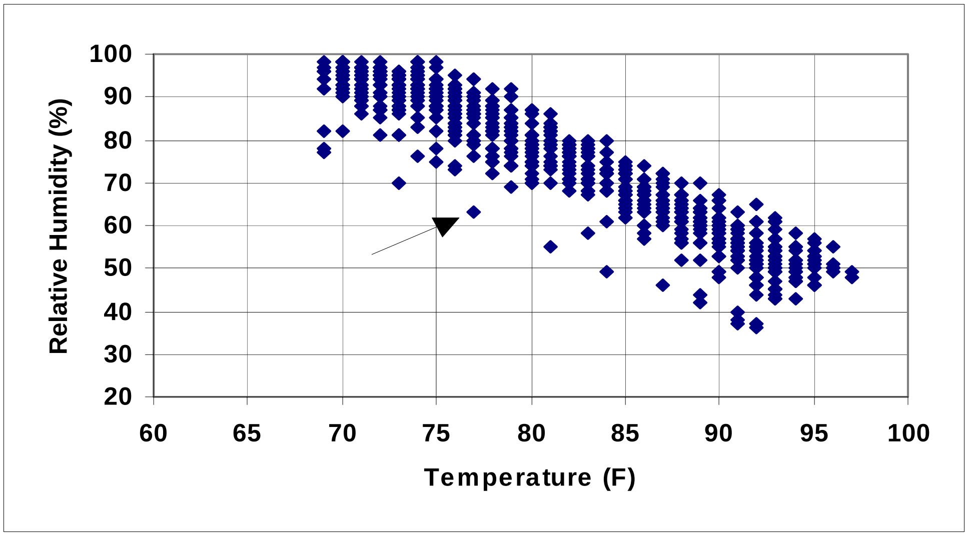

Figure 2. Temperature Vs. Humidity for July (Alma, Ga 1994)

After studying this graph it becomes clear that relative humidity tends to be lower at higher air temperatures. For instance, any time during the entire month of July when the temperature was 75°F, the relative humidity ranged between 75 and 100%. But, whenever air temperature was 90°F or above, humidity ranged from 40 to 65%. At no time during the entire month was the relative humidity above 75% when air temperature was above 85°F.

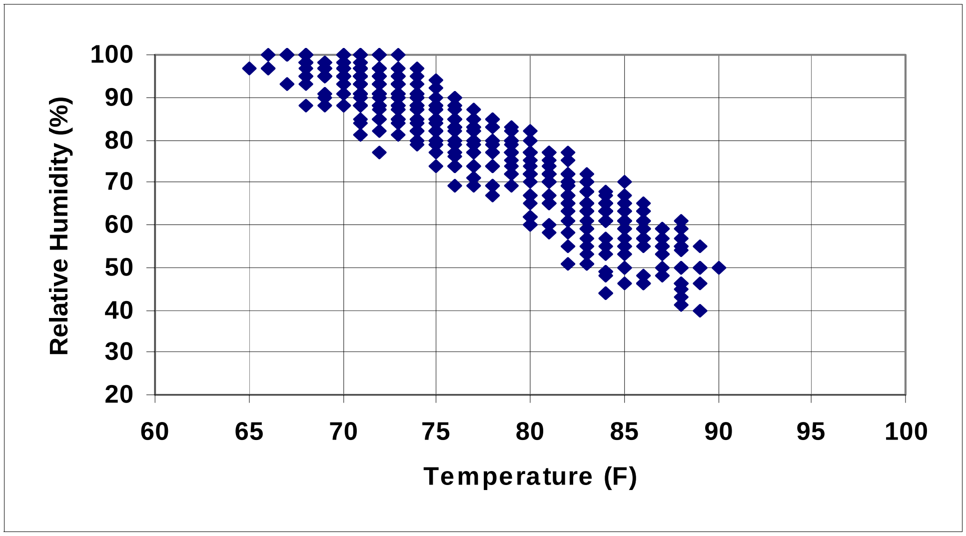

Figure 3. Temperature Vs. Humidity for July (Athens, Ga 1994)

Figure 3 illustrates temperature and humidity data for Athens, Georgia during the same period. From the graphs, you can see that Athens was about five to seven degrees cooler than Alma. The highest temperatures during the month of July were about 90°F, whereas Alma reached the mid to high nineties. Humidity was about 10% lower in Athens, as you might expect, being further from the coast. The important thing to note is that in both locations for the month of July, the hotter it got, the lower the humidity. Figure 4 illustrates the relationship between temperature and humidity for the entire summer in Athens for 1994.

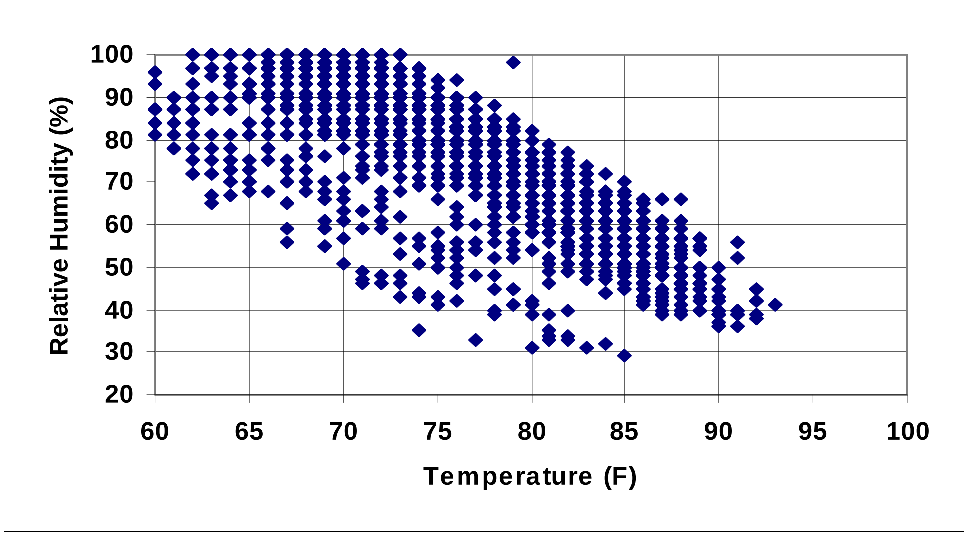

Figure 4. Temperature Vs. Humidity for Summer 1994 (Athens, Ga)

Just to prove that the summer of 1994 was not unique, let's go back and look at 1993. The summer of 1993 was a hot one much warmer than the summer of 1994 (see Figures 3 and 4). With the increased temperatures came lower relative humidities. For instance, during the summer of 1994 the warmest temperatures recorded in Athens were in the mid nineties. This corresponded with relative humidities in the mid forties. But during the summer of 1993 when air temperature climbed over 100°F, relative humidity was below 35%. Again, higher air temperatures resulted in lower relative humidity.

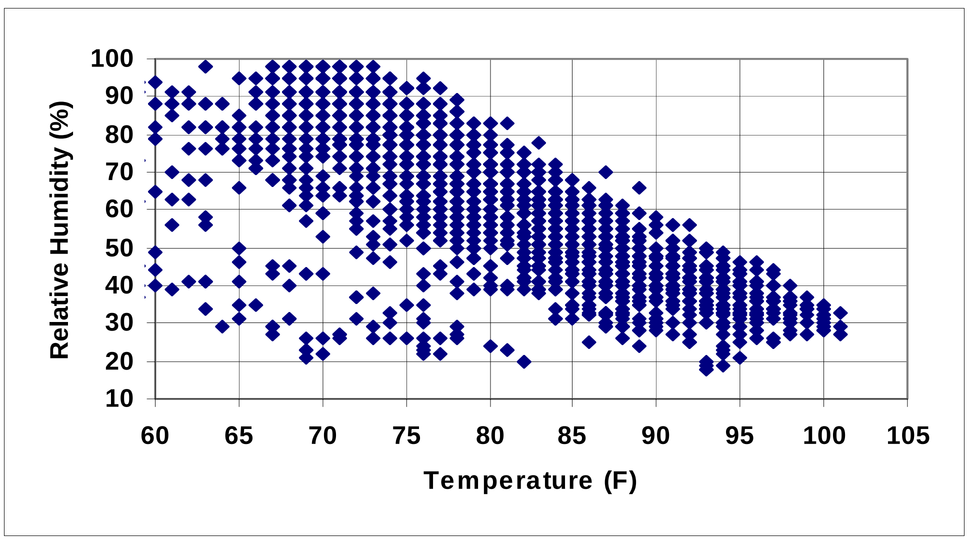

Figure 5. Temperature Vs. Humidity for Summer 1993 (Athens, Ga)

Though relative humidity decreases with temperature, there are days of course that are more humid than others. For instance, in Athens during the summer of 1993 when air temperatures were in the nineties, relative humidity varied between 30 and 60%. In other words, on some days when the air temperature reached 90°F the relative humidity was 30% and on other days when it was 90°F the relative humidity was 60%. Although this large difference in relative humidity would be reflected in the amount of cooling a fogging or pad system would produce, 60% relative humidity on a 90°F day is still dry enough to allow an evaporative cooling system to be effective.

Table 1 illustrates the amount of cooling the typical 2" paper fogging pad will produce at different temperatures and relative humidities. At 90°F and 30% relative humidity, a 2" fogging pad can reduce the incoming air temperature approximately 14°F. But when the relative humidity is 60%, the same system will only reduce the incoming air temperature 7°F. Yes, there is a large difference in cooling, but the fact remains that you can still get 7°F cooling even on the most humid day and thus a grower should not hesitate to use an evaporative cooling system during the hottest parts of the day.

Temperature	**Relative Humidity**					
	30%	**40%**	**50%**	**60%**	**70%**	**80%**
80 F	***12***	***9.9***	***8***	***6.2***	***4.5***	***3.0***
85 F	***12.8***	***10.6***	***8.6***	***6.6***	***4.9***	***3.1***
90 F	***13.7***	***11.3***	***9.1***	***7.0***	***5.1***	***3.3***
95 F	***14.6***	***12***	***9.6***	***7.4***	***5.3***	***3.4***
100 F	***15.4***	***12.6***	***10.1***	***7.7***	***5.6***	***3.6***
105 F	***16.3***	***13.3***	***10.6***	***8.1***	***5.9***	***3.8***

Table 1. Temperature Reduction from a 2" Paper Fogging Pad Under Different Weather Conditions.
(broiler house with eight 48" fans, 60 ft^2 of pad per fan, three rows of nozzles, 18" on center, 100 psi)

If you still believe that the relationship between relative humidity and temperature is different where you live, buy a temperature/relative humidity meter. They are available at stores such as Radio Shack for about $30. Place it in the shade near your poultry houses and check it periodically throughout the day. You will find that though some days are more humid than others, when it is really hot, the relative humidity will be much lower than you think.

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