DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Agriculture and Natural Resources

FSA1073

Sprinklers Cool Birds and Conserve Water

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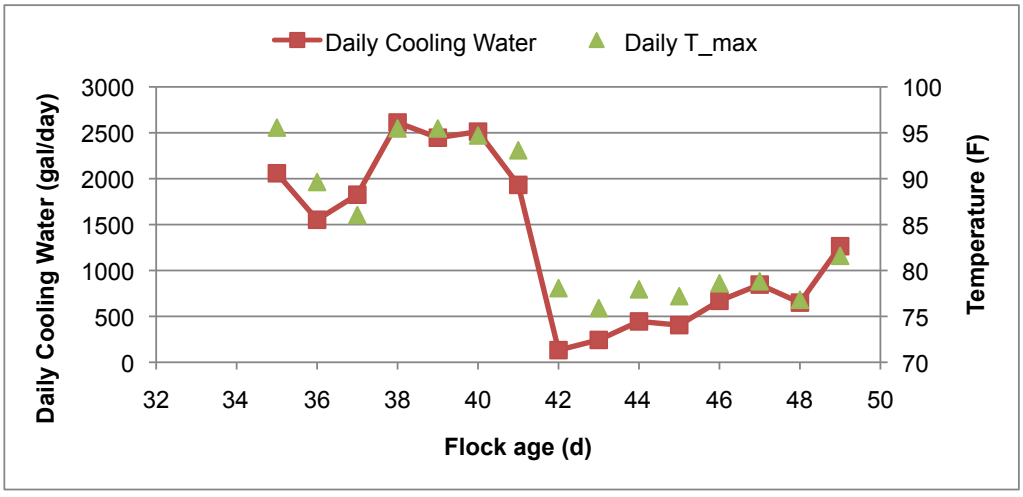
Introduction

Keeping birds comfortable during hot, humid weather is critical for optimizing weight gains, feed conversion and livability. Improved growth rates and the trend to heavier average market weights contribute to greater heat loads in modern broiler barns. While the poultry industry has made significant strides to minimize seasonal effects, even the best housing design can still result in birds settling with lighter weights when nature turns up the temperature. Current methods used by the industry to overcome heat stress include tunnel ventilation that uses exhaust fans to rapidly move air along the length of the barn. When wind speed alone no longer provides adequate bird cooling, water is circulated over the cooling pads to cool the air entering the house. The final stage of cooling involves the use of interior foggers that saturate the air with a fine mist to increase air cooling. In both cases, the air temperature is reduced by water evaporation, absorbing heat from the air. Unfortunately both systems tend to saturate the barn air with moisture (>70% RH), which is counterproductive to the bird's own natural ability to cool itself by evaporative heat loss through the air that it breaths out.

A second challenge with recirculating cool-cell systems is the significant water usage that is directly correlated to outside temperature and how rapidly the air moves through the house. Figure 1 shows that a single 40 by 400 foot barn with 120 feet of pads used as much as 2,500 gallons of

FIGURE 1. Daily cooling water usage by cool-cell systems and the corresponding daily maximum ambient temperature. (Data collected at the Applied Broiler Research Farm of the University of Arkansas in August 2011.)



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water per day with 38-day-old birds present (does not include bird water consumption). Cooling water consumption could be even higher under 100°F days with the same age of flock. Drought conditions during the 2012 summer were a wake-up call for many producers regarding the need to better conserve water yet maintain good bird performance.

Sprinklers Versus Foggers

An alternative to the traditional cool cells and foggers is the sprinkler system which works by cooling the birds instead of the air. Cattle and hogs are often cooled in hot weather by sprinkling with water. Only a few years ago poultry producers avoided catastrophic losses by hosing birds with water during extremely hot weather (if fans were present). Low-pressure water sprinkling does not cool the barn air but rather works by wetting the birds' feathers. Heat is then absorbed directly from the birds as these water droplets evaporate and are carried away by the tunnel fans. The natural response of any producer or live production manager is the thought that sprinklers will soak the litter causing terrible conditions. This is proving to simply not be the case; sprinkler houses are actually drier than cool-cell and fogger houses. The computerized sprinkler control systems take into account bird age and barn air temperature to determine how much water will be "sprinkled" and at what intervals – less water is used via sprinklers when birds are young than when birds are older, covering more floor space and generating more heat (Figure 2). As more cooling is required, there is less opportunity for the water to fall on the floor. Sprinkler systems use intermittent spraying of controlled water volumes followed by sufficient time for the water to evaporate and be removed by 500+ feet per minute wind speeds. As a result, litter conditions in the sprinkler houses, as measured on the day of sell, were similar to those in the cool-cell houses (Figure 3).

One significant difference with sprinklers as compared to cool cells is the air temperature inside a chicken house with sprinkler cooling is either the same as or only slightly lower than the outside air. As a result, the humidity of the air in a sprinkler house is similar to the outside air, but consistently lower than that of the air in a cool-cell house as shown with the dotted lines in Figure 4. It is important to note that when barn temperatures are at or below the set point, birds readily give up the extra heat they generate to the "dry" air that moves over them. As barn temperature rises above the desired set point, birds no longer cool themselves by the air carrying or "convecting" the heat away (also called sensible heat loss) and additional evaporative heat removal is needed. With sprinkler systems, the controller utilizes bird age and temperature information to increase the amount of water as needed for bird cooling. Increasing the sprinkler run time or decreasing the time between sprinklings will compensate for the higher temperature so birds stay comfortable. While sprinkler houses may have higher air temperatures than cooling pads or fogger houses, adequate cooling is still achieved by direct evaporative heat loss from the feathers and increased respiration losses from the birds' lungs due to lower air relative humidity (Figure 4).

Sprinklers Save Water

Due to the focus of water evaporation at each individual bird's surface, the cooling water used by sprinkler houses averaged 70% less than the cooling water used by the cool-pad-only houses. In tests conducted at the Applied Broiler Research Farm of the University of Arkansas over five summer flocks, the sprinkler houses (pad cooling turned off) used in the range of 4,000 to 10,000 gallons of cooling water per flock per house (40 by 400 feet), compared to the pad-cooling houses (range of 20,000 to 40,000 gallons per flock) (Figure 5). Results from three summer flocks when sprinklers and cooling pads were used in combination (cool pad set points were set at 17°F higher than house environmental controller set points) show that the combination-cooling house saved 40% of cooling water compared to its paired pad-cooling house. Supplementing the sprinklers with the cool cells under extremely hot conditions may be necessary to gain the best flock performance and water savings.

FIGURE 2. More sprinkled water is used when the house is warmer during the day or with older age of birds (same study).

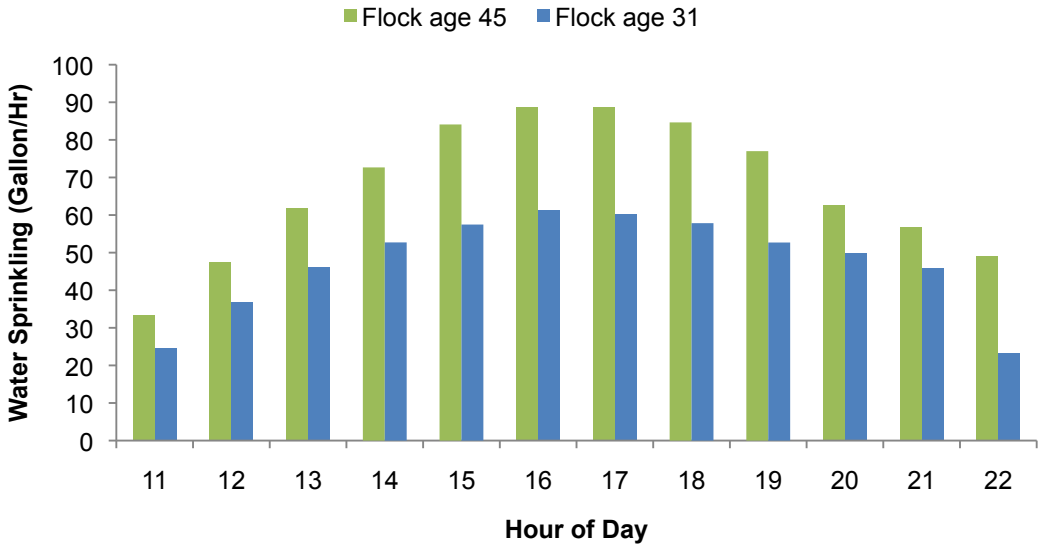


FIGURE 3. Litter moisture conditions in sprinkler houses and in cool-pad houses on the market day of flocks (same study).

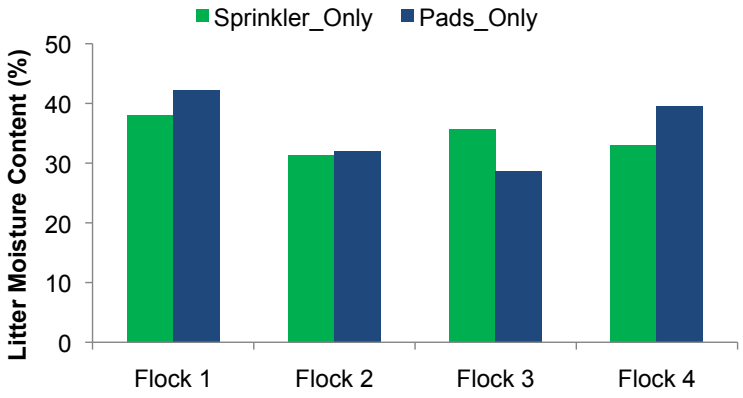


FIGURE 4. Inside temperature and relative humidity on a typical summer day using either sprinklers or cooling pads.

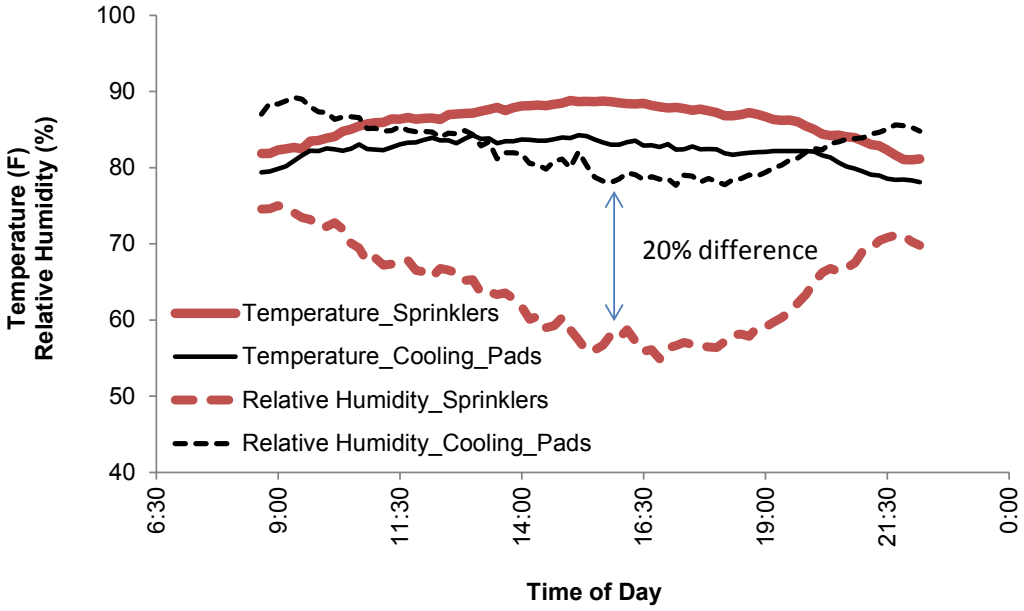
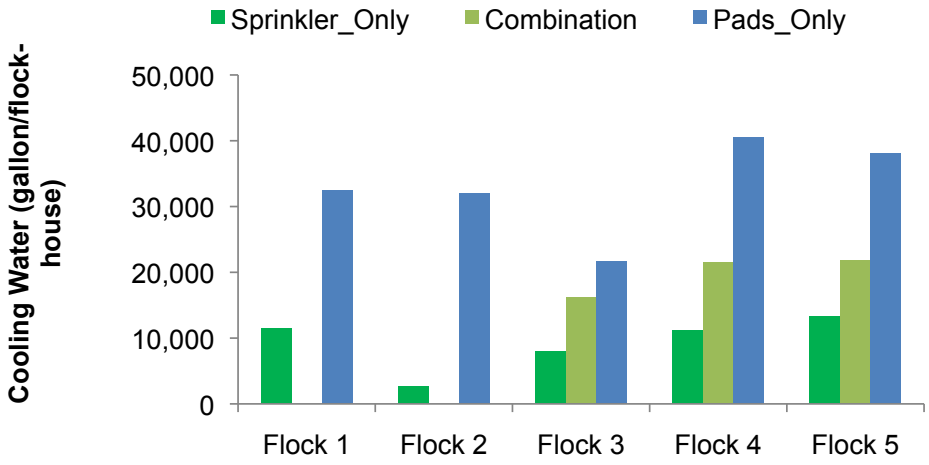


FIGURE 5. Cooling water used by sprinkler-only, cooling pads-only and the combined use of the two systems from 40 by 400 foot houses of five summer flocks (same study).



General Layout and Operation for Sprinkler Systems

The sprinkler system in a typical broiler house includes two or three lateral PVC lines with low-pressure (30 to 40 psi) sprinklers, depending on the width of the house. No booster pump is needed. Sprinklers should be evenly placed 20 feet apart and staggered on adjacent lines to ensure uniform floor coverage. The sprinklers should be grouped into zones with up to 20 nozzles in each zone. This allows the water to be activated by zone to avoid overwhelming the water supply on the farm. All existing temperature sensors inside the house should be shielded from water drops to avoid erroneous readings due to the chilled effect of water evaporation. Aluminum foil or pie plates are used as easy and inexpensive shields. Sprinklers are typically recommended for use after flock age of 21 days (for flocks raised to medium market weights) to minimize the possibility of most of the water ending up on the litter due to low floor coverage by the birds.

Summary

Overhead sprinklers together with tunnel ventilation can successfully cool broiler chickens with substantially less water. Cooling is achieved by intermittently spraying large water droplets uniformly into the house, typically beginning flock age of 21 days under normal stocking density. The amount of water spray varies according to the total live weight of the birds and the thermal condition inside the house. The relatively dry and fast-moving air inside the house helps to remove heat from birds' respiratory pathways to keep them comfortable and gives a chance for moisture to escape from the litter. Cooling water is significantly reduced since the birds are the cooling target instead of the air.

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FSA1073-PD-11-12N