

TECHNICAL BULLETIN



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Heat Stress in Commercial Layers and Breeders

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It is not uncommon during the summer months to have periods of high environmental temperatures often accompanied with high relative humidity. Acute heat stress can profoundly affect the productivity of a flock. At environmental temperatures above 32°C (90°F), high mortality and large production losses are readily evident, but at lesser extremes, heat stress is often overlooked as a cause for subtle losses in egg production or poor growth.

Thermoregulation of the Hen

Chickens, unlike most other animals, do not possess sweat glands to aid in heat loss. The chicken removes excess body heat in four ways. Body heat can be lost by *radiation* from the skin surface through the air to another object (i.e., another bird). Heat can be directly transferred by *conduction* to cooler objects with which the bird is in contact, such as the cage, litter, or slats. Body heat is also lost to the surrounding air by *convection*. When the environmental temperatures are between 28°C and 35°C (82°F and 95°F), radiation, conduction, and convection heat losses are usually adequate to maintain the bird's body temperature. The bird dilates the blood vessels of the skin, wattles, and comb to bring the internal body heat to the skin surface to facilitate conductive, convective, and radiation heat loss. Floor birds will search for cool places in the house and dig into the litter to increase the conductive and convective heat loss. Drooping of the wings promotes convective heat loss by increasing the surface area of the body. Caged birds are more susceptible to heat stress because they are unable to seek a cooler place and there is less conductive heat loss in cages. As the environmental temperature approaches the body temperature of

the bird, 41°C (106°F), the efficiency of these heat loss mechanisms diminish. At this point the *evaporation of water* from the respiratory tract becomes the major heat loss mechanism of the bird. The evaporation of one gram of water dissipates 540 calories of maintenance energy. Birds pant (open mouth breathing), or hyperventilate to increase evaporative cooling. When panting fails to prevent the rise in body temperature the bird becomes listless, then comatose, and soon dies. Birds raised from a young age at high environmental temperatures will acclimate to higher environmental temperatures and can maintain good productivity. The non-acclimated flock exposed to rapid increases in environmental temperature (acute heat stress) typically has the greatest loss in production and mortality.

Effects of Heat Stress

One of the primary effects of high environmental temperature on a flock is reduced feed intake. A reduction in appetite is the birds' effort to reduce energy intake in response to the increase in the energy in the environment, thereby reducing the energy needed from the feed. Birds may use body fat for a source of energy that produces less heat than digestion/metabolism of proteins or carbohydrates in the feed. The reduced feed intake and subsequent loss of needed nutrients quickly affect the productivity of the flock. Growth retardation occurs in growing birds. Laying flocks typically have a reduction in egg size, followed by lowered egg production, and reduced eggshell quality.

In breeders, high environmental temperatures decrease the hatchability of embryos and the fertility of roosters. Factors influencing the

extent of losses from heat stress are:

1. the maximum temperature to which the flock was exposed,
2. duration of the high temperatures,
3. the rate of temperature change, and
4. relative humidity of the air.

The nasal passages function to filter dust and bacteria from air entering the respiratory tract, and this system is by-passed when birds open-mouth breathe. This can lead to an increased incidence of secondary bacterial respiratory infections.

Brooding chicks at too high temperatures is another time when heat stress losses may occur. The ability of young chicks to regulate their body temperature is not fully developed and they may quickly become overheated.

Effect of Heat Stress on Egg Shell Quality

The heat stressed laying flock often lays eggs with thinner shells because of acid/base disturbances in the blood as a result of panting (hyperventilation). As birds pant there is excessive loss of CO₂ gas from their lungs. The lowered amount of CO₂ in the blood causes the blood pH to elevate or become more alkaline. The higher blood pH reduces the amount of ionized calcium in the blood. Ionized calcium is the form of calcium utilized by the shell gland when producing the eggshell. Increasing the amount of calcium in the diet does not correct this problem. Contributing to thin eggshells are reduced intake of calcium as feed intake drops, and an increased loss of phosphorus as a result of the acid/base imbalance.

Management of the Heat Stressed Flock

Steps to consider in flocks suffering from heat stress:

- During periods of high temperature, the flock has a high demand for drinking water. The water to feed ratio is normally 2:1 at 21°C (70°F), but increases to 8:1 at 38°C (100°F). It is critical that drinking water be available to heat-stressed flocks in the amount they require. For floor raised flocks or breeders, providing additional drinkers can help to accommodate the increased need.
- Cooling the drinking water by flushing waterlines with fresh cooler water has been shown to increase feed consumption and egg

production in heat-stressed birds.

Unfortunately, the plastic water pipes rapidly equilibrate with the environmental (air) temperature, making it difficult to keep the water temperature below the air temperature, particularly at the end of long water lines.

- Do not disturb the birds during the hottest time of the day (afternoon and early evening). Adjust work schedules and lighting programs so that routine work is done early in the morning or at night.
- Postpone routine management practices which require bird handling, such as debeaking, eyedrop or wingweb vaccinations, or transferring until the weather is cooler - or do them at night.
- Do not spray vaccinate flocks during times of high environmental temperatures. The birds cannot tolerate the fans being turned off, and Newcastle and bronchitis vaccines can place an additional stress on the respiratory tract.
- Adjust the amounts of medications and volumes of water used for water vaccinations to reflect the increased water consumption of the flock during hot weather.
- Do not withhold drinking water from the flocks when water vaccinating. Flock thirst is already high and denying drinking water is not advised. Postpone these vaccinations whenever possible. Heat stressed birds have decreased immune function and may not respond as well to vaccination.
- Use vitamin and electrolyte supplements in the drinking water. Shifts in the acid/base balance in the blood of heat stressed birds cause the loss of sodium, chloride, potassium, and bicarbonate in the urine. The use of electrolyte solutions in the drinking water may help to replenish these minerals and correct the acid/base balance. These drinking water solutions are best used in anticipation of a rapid rise in environmental temperature.
- Using roof sprinklers or spraying the roof with cool water during times of extremely high temperature may lower the inside house temperature. Be sure that the water system can accommodate the water demands for both this and increased bird water consumption. Be sure to never compromise the availability of drinking water to a heat stressed flock.

- Lower fan thermostats so all fans run continuously during the night and early morning hours. Night cooling of the house will prolong the period of moderate temperature the next morning.
- Increase the movement of air in a house by placing space fans in it.
- Transport birds at night, place fewer birds per coop and leave a few empty pallets to increase the ventilation around the birds.
- Avoid overstocking cages during the summer months.

Nutritional Management of the Heat Stressed Flock

Heat-stressed flocks usually experience a loss in appetite. This decreased feed intake can be compensated by formulating a more concentrated feed. The actual energy requirement of the bird is reduced at high environmental temperatures because the bird derives more of its required energy from the environment. All the other dietary nutrients (i.e., protein, minerals, and vitamins) remain the same, except possibly for phosphorus (which is increased).

The following feeding protocols during periods of increased temperatures are generally regarded as appropriate.

- *Monitor* impending changes in weather patterns. With existing weather forecasting technology, poultry producers should not be surprised by unusual weather changes. *Anticipate weather changes.*
- A by-product of the digestion/metabolism of feed is the production of body heat (heat increment). It is widely recognized that fat has the lowest heat increment of the energy nutrients - i.e., carbohydrate, protein, and fat. In comparison to proteins and carbohydrates, the digestion of fat results in less production of body heat per calorie of feed energy. The heat load of the bird can be reduced by replacing other dietary energy with dietary fat.
- Insure that the *non-energy* nutrients, such as protein, amino acids, vitamins, and minerals are *increased* in the formula in proportion to the *decrease* in feed intake.
- When the nutrient density of the formula is increased to compensate for the reduction of feed intake, the protein content of the feed may,

in some instances, be reduced by about 0.50% below the calculated value. If this is done, the intake of the needed amino acid can be optimized by providing increased quantities of synthetic amino acid such as methionine and lysine. Adjusting the intake of protein is important because the body heat produced by protein digestion/metabolism is, as noted earlier, the greatest among the energy nutrients - i.e., carbohydrate, fat, and protein.

- Restrict the intake of feed about three hours before temperatures are expected to exceed 36°C (95°F) for more than three hours. Adjust the lighting schedule to encourage the consumption of feed in the night and early morning. A midnight feeding or an intermittent lighting program can encourage feed consumption at night.
- Vitamin C in the ration (50-300 gms/ton of feed) can protect birds from the effects of heat stress and enhance the survival of birds exposed to acute heat stress.
- Do not use nicarbazin (anticoccidial drug) during warm weather, as it can aggravate heat stress induced mortality.

Treatment of the Heat Stressed Flock

- In emergency situations the flock can be sprayed with cool water to save the birds' lives. Comatose birds are rarely saved.
- Check and insure that the ventilation system is operating at its maximum.
- Potassium chloride or ammonium chloride (4-6 Lbs/ton of feed) has been beneficial in reducing the mortality in acutely heat stressed flocks. These compounds replace electrolytes, which can correct the acid/base imbalances occurring during heat stress, and encourage consumption of water.

Prevention of Heat Stress

The ventilation system should be checked to insure efficient operation.

- The fans and intake louvers should be cleaned. The fan belts should be tightened or changed to avoid slipping or breaking during the periods of high temperature. The inlets must be adequate to supply the airflow needed to ventilate the house during warm weather. Inadequate inlet space will throttle down the fans and decrease

airflow. The inlets should be kept clean and free of anything that might restrict the flow of incoming air. Use baffle boards to direct the incoming air onto the birds.

- The thermostats should be checked for accuracy. An auxiliary power system must be in place in the case of a power outage during hot weather.
- In houses equipped with evaporative cooling systems, the pads should be cleaned or replaced when they become clogged. Water flow over the pads should be checked to see that it is evenly distributed across the pads. Air will flow preferentially through dry areas since there is less resistance in these areas.
- Check the water filters and change if necessary. Clogged water filters can restrict the flow of fresh drinking water into the house.
- Remove manure from the house often during the summer. The heat produced as manure decomposes adds to the heat load of the house. The presence of large amounts of manure can restrict the movement of air beneath slats and cages.
- Do not overcrowd houses during the warm weather months.

Housing Design for Reducing Heat Stress

- Houses built in areas subject to high environmental temperatures should have evaporative coolers and/or evaporative fogging systems.
- Insulated roofs reduce the conduction of heat from outside.
- The water system must have the capacity to provide the volume of water required for high flock water consumption and the operation of evaporative cooling and fogging systems.
- Remove any unneeded large metal objects from around the houses (machinery, vehicles, nest boxes, junk), which could radiate heat into open houses.
- The minimum total fan capacity should provide the following ventilation rates at 95°F.

Increased air movement over the birds produces a wind chill effect, which will cool birds even with no drop in the house

<u>Weeks of age</u>	<u>Ft³ of air/minute/bird</u>
1	1.0
2-3	1.5
4-6	2.0
7-12	3.0
13-18	4.0
>18	6.0-7.0

temperature.

- Orient the house in an east-west axis to minimize solar heating.
- Roof overhangs should be sufficient to prevent the sunlight from shining into the house (open houses).
- Grow grass around the house to cool incoming air and reduce the reflection of heat into open houses. Bare ground can reflect a large amount of heat into the house.
- Use roofs made of reflective material such as shiny metal or white wash. Open ridged roofs allow the bird heat to escape. In dry climates, apply staking material such as straw or grass (at least 8 cm thick) on the roof for insulation from solar heat.
- Place water sprinklers on the roof ridge to remove heat from the roof.
- Drinking water stored in overhead water tanks can get very hot. These tanks should be a reflective color, insulated, and covered to avoid direct sunlight.

The keys to minimizing the effects of heat stress are *anticipating* periods of high environmental temperatures and implementing appropriate *management* and *nutritional* measures prior to the rise in temperatures.



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