Heat Stress in Poultry Birds

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Abstract

In many parts of the India summer is severe with maximum temperature reaching around 40^{0}C. During summer weight gain, FCR, egg production egg shell quality are all adversely affected and mortality is high. Any management technique that increases nutrient intake during heat stress will minimize the drop in production efficiency. The way to increase nutrient intake despite decrease in feed consumption is to increase the nutrient density of the ration, take advantage of natural increase in feed consumption at certain times of the day and adjust ventilation fans to provide more cooling during the evening. There are several constraints to the future development of the poultry industry. The most obvious constraint on poultry production is the climate with increasing temperature.

Introduction

In many parts of the India summer is severe with maximum temperature reaching around 40^{0}C.There is also shortage of water in summer since water table goes down, bacterial count is high. It is therefore a challenging task to manage and run the business of poultry. During summer weight gain, FCR, egg production egg shell quality are all adversely affected and mortality is high. Disease incidence is also more because wet litter, immunosupression, vaccination failures and contaminated drinking water which are common in summer months.

Current production methods often involve large number of birds being housed together making them susceptible to heat stress. Heat stress not only causes suffering and death in the birds, but results in reduced or lost production. There are several constraints to the future development of the poultry industry. The most obvious constraint on poultry production is the climate with increasing temperature.

Heat is produced by essential body processes which include maintenance, growth and egg production. Heat production is affected by body weight, Species, breed, feather cover, size of the combs, wattles, level of feed intake, level of production, feed quality and to a lesser extent by the amount of activity and exercise. Posture has Considerable influence on heat loss

Stress is the nonspecific response of the body to any demand and stressor can be defined as an agent that produces stress at any time (Seyle, 1976). Although temperature measured with an ordinary thermometer is the simplest single index of thermal strain on birds, there is much more to it than that. The heat stress is one of the most significant environmental stressors in challenging poultry production. In India during the past 20 years, an increase of 0.6^{0}C environmental temperature affecting all parameters of production performance in poultry and is often associated with sudden and massive deaths. It has also been associated with decrease in body weight gain, feet intake and feed efficiency common nutrient retention, lower body protein and total mineral retention.

Temperature regulatory mechanism in poultry

The internal body temperature of domesticated birds (chickens) at 41.2°C to 42.2°C is measurably higher than that of mammalian livestock and humans (36°C to 39°C). The upper temperature limit beyond which living cells and tissues progressively fail to operate is governed by the temperature at which enzymes (enzymic proteins) are denatured (destroyed) by loss of configuration (shape) and chemical activity. This starts to occur in the region of 46°C and thus poultry have considerably less scope than other animals when suffering from heat stress and quickly succumb to higher temperature. In comparison, actual body temperature of poultry may fall as much as 20°C below the normal range with birds still making full recovery if carefully re-warmed. Poultry are not well adapted and disposed to high ambient air temperatures. They lack sweat glands in the skin and are therefore unable to gain much from natural evaporative cooling, although there is some direct diffusion of water through the skin tissue. Only the head appendages (e.g. comb) are very rich in blood vessels and able to act as sites for direct loss of heat, so poultry appears to have few limited options for heat loss in warm conditions. Domestic poultry is clearly less tolerant of heat than cold and much more likely to die from heat stress (hyperthermia) than succumb to stress associated with low temperature (hypothermia).

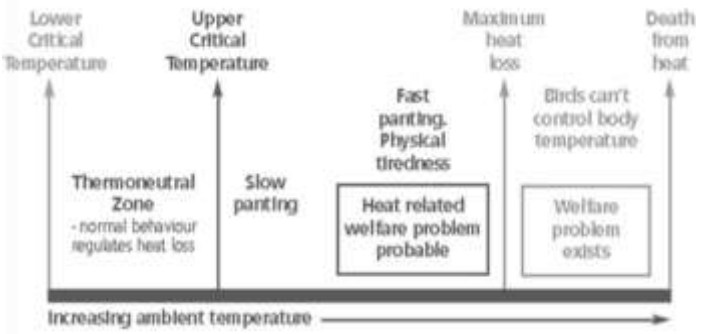

Fig. 1. Diagram of Thermoneutral Zone

Table 1 General guide to the reaction of adult poultry to various temperatures

55o to 75 ˚F Thermal neutral zone. The temperature range in which the bird does not need to alter its basic metabolic rate or behavior to maintain its body temperature.

65o to 75 ˚F Ideal temperature range.

75o to 85 ˚F A slight reduction in feed consumption can be expected, but if nutrient intake is adequate, production efficiency is good. Egg size may be reduced and shell quality may suffer as temperatures reach the top of this range.

85o to 90 ˚F Feed consumption falls further. Weight gains are lower. Egg size and shell quality deteriorate. Egg production usually suffers. Cooling procedures should be started before this temperature range is reached.

90o to 95 ˚F Feed consumption continues to drop. There is some danger of heat prostration among layers, especially the heavier birds and those in full production. At these temperatures, cooling procedures must be carried out.

95o to 100 ˚F Heat prostration is probable. Emergency measures may be needed. Egg production and feed consumption are severely reduced. Water consumption is very high.

Over 100 ˚F Emergency measures are needed to cool birds. Survival is the concern at these temperatures.

Methods of heat loss in poultry

Radiation- loses are proportional to the temperature difference between the body surface and the surrounding surfaces. Thus, hot poorly insulated roofs increase house temperature and make heat stress worse in hot weather.

Convection- heat loss will occur from the natural upward movement of warm air from around a hot body. It can be assisted by providing moving air but only if the air moves fast enough to breakdown the boundary layer of still layer which surrounds the body.

Conduction- conduction is relatively unimportant but heat will flow by direct surface to surface transfer if the birds are seated on litter which is cooler than their bodies. However the litter immediately under the birds under the birds soon assumes a temperature close to that of the body.

Evaporation- such losses are very important at high temperatures. Poultry do not sweat, but they depend on panting and this is only effective if the humidity is not too high. Hot humid conditions are therefore much more stressful than hot dry conditions.

Physiological effects of panting-

Panting removes heat by the evaporation of water, from the moist lining of the respiratory tract. However panting itself generates body heat and it causes poultry to eliminate water from the body. It can induce respiratory alkalosis, which occurs because the bird blows off Excessive carbon dioxide when it pants. As a result, Body fluids become more alkaline, causing the kidneys to excrete excessive amounts of several electrolytes.

Heat loss mechanisms- Poultry do not sweat and therefore must dissipate heat in other ways to keep their body temperature at approximately 105°F. Body heat is dissipated to the surrounding environment by way of radiation, conduction, convection these are called as sensible heat loss mechanisms these methods are effective only when the environmental temperature is below or within the thermal neutral zone of the bird (55° to 75°F). Sensible heat loss proportion varies according to temperature difference between bird and its nearby environment. Poultry loses heat from comb wattle and unfathered portion of the body. Bird maintains body temperature through sensible heat loss without much deviation in normal physiology and metabolism. When the environmental temperature crosses 77°F, these methods of heat loss begin shifting from sensible to evaporative heat loss.

Signs of heat stress in poultry

Exposure of poultry to high environmental temperature generates behavioral, physiological and immunological responses which impose detrimental consequences to their productivity. In general, following signs are exhibited by birds during heat stress-

- Gasping and panting
- Decrease appetite
- Increased water consumption
- Spreading wings
- Reduced social activity
- Increased cannibalism
- Extremely pale combs and wattles
- Reduction of egg production
- Poor egg shell quality
- Less body weight gain in broilers
- Reduced feed efficiency

Effect of heat stress in Broilers and layers

1. Growth and production efficiency

Broilers subjected to chronic heat stress had significantly reduced feed intake, lowered body weight and higher feed conversion ratio. Feed intake is reduced by 5% for every 1 ^{0}C rise in temperature between 32-38^{0} F (Sohail

et al., 2012). Stocking density has a major role as a potential compounding factor, both from the standpoint of productivity as well as welfare.

Economic losses in broiler farming due to heat stress also arise as a result of lowered growth rate and decrease feed deficiency. Therefore, any technique which promotes feed consumption or increased activity during peak hot periods maybe counterproductive and the extra feed consumed will increase the bird's heat load and results in additional mortality.

2. Meat quality

Chronic heat exposure negatively affects fat deposition and meat quality in broilers. There is also a depression of meat chemical composition and quality. It has been documented that chronic heat stress decrease the proportion of breast muscle, while increasing the proportion of thigh muscles in broilers. Moreover, the protein content was lower and fat deposition higher in birds subject to heat stress (Zhang et al., 2012).

3. Egg quality

In laying hens, heat stress resulted in lowered egg production and quality. As the temperature rises above 32-35^{0}C egg production level may also decline, as total nutrient intake is insufficient to support normal rate of lay. Under high environmental temperature, the respiratory rate may increase from 29 cycles/ minute to more than 100 cycles / minute resulting in hyper ventilation which causes decrease carbon dioxide levels and may decrease the egg shell thickness. Therefore, heat stress causes losses in egg weight, egg shell thickness, egg shell weight and egg specific gravity (Macari et al., 1994)

4 Reproductive performances

Heat stress causes decreased egg production with reduced egg shell quality in laying hens. The diminished reproductive performance in heat stressed poultry might be caused directly by depressing the ovarian functions. In breeder males heat stress causes decreased semen quality and quantity. Semen characteristics such as consistency, spermatozoa concentration and seminal volume were depressed by environmental temperatures outside the zone of thermal comfort (McDaniel et al., 1996).

5. Immunity

Heat and relative humidity stress of layers caused poor production performance and also increase the percentage of mortality. This increase in mortality could be due to inhibition of immune responses. The broilers when they are subjected to heat stress had lower levels of total circulating antibodies as well as lower specific IgM and IgG levels. It is reported that birds exposed to chronic heat stress (4 weeks) had a lower white blood cell count and a higher heterophil/ lymphocytes (H/L) ratio. These results indicate that birds were under increased stress and also decrease in antibody titer.

6. Disease Incidence

High temperature has remarkable effect on the prevalence of diseases and can increase the insect vectors, prolong transmission cycle or increase the importation of vectors. The changes in climate may also have an adverse effect on biodiversity, distribution and migratory pattern of birds which may lead to emergence of disease Outbreaks.

Importance of management in alleviation of heat stress

As the shift in body fluid pH occurs, Feed intake is increasingly depressed, adversely affecting growth, production and overall performance of the birds. During the hot summer months, evaporative heat loss typically becomes the primary method by which birds regulate their body temperature unless proper ventilation is provided and other steps are taken to reduce heat stress.

(A) Feed and feeder management

Following practices may be adopted to minimize the losses from heat stress-

1. Any management technique that increases nutrient intake during heat stress will minimize the drop in production efficiency. The way to increase nutrient intake despite decrease in feed consumption is to increase the nutrient density of the ration. Recent research indicates that no phosphorus consumption can contribute to increased heat prostration losses.

2. Antioxidant vitamins such as vitamin A, E and C are to be supplemented in poultry diets because of their anti-stress effects and also their synthesis is impaired or reduced during heat stress.

3. Use of electrolytes during heat stress conditions may recoup from the respiratory alkalosis and balances the dietary cation- anion balances.

4. Anti stress compounds from spices and herbs such as turmeric, garlic, tulsi, aloe vera, phyllanthus sp., can be supplemented in the feed or water.

5. Feed withdrawal during the hottest part of the day is very effective in reducing the heat stress mortality. Birds should not be fed during the afternoon. Since this will increase the amount of body heat that they must dissipate and thus increase the potential for heat prostration.

6. Cool water and adequate watering space may be provided to lesson heat stress.

7. Overcrowding of birds should be avoided.

8. Feed the birds at the time of day when feed consumption is highest. The light to dark cycle results in a U

shaped feed consumption curve. Shortly after lights come on, feet consumption is high. It gradually declines during midday and then increases about one hour before lights are turned off. If birds are fed during the cool part of the day feed consumption will be higher.

9. Efforts should be made to cool the birds as much as possible during the evening hours. Layer and broiler meat birds tend to build up body heat during extended periods of hot weather. If their body temperature can be reduced during the evening the birds will be able to consume more feed in the early morning. The house can be cooled in the evening by setting the fan thermostats so that the fans will continue to run until the internal house temperature reaches 75^0F or by using foggers.

(B) Building construction

Following points must be kept in mind while restricting losses from heat stress-

1. The building site, orientation, roof over and equipment design all affect the temperature inside the poultry house.

2. A grass cover on the grounds surrounding the poultry house will reduce the reflection of sunlight into the houses. Vegetation should be kept trimmed to avoid blocking air movement and to help reduce rodent problems. Shade trees should be located where they do not restrict air movement.

3. Air movement is particularly important in houses that are ventilated by natural air currents. All poultry houses, but particularly curtain-sided houses, should be positioned so that the roof line runs from east to west. This orientation will keep direct summer light from coming through the sidewall and causing heat to build up within the houses. Adequate insulation in the ceiling and sidewalls will pay dividends by reducing the amount of the sun's radiant heat energy that reaches the interior. Installing insulation to the end of a 24-inch roof overhang will prevent solar radiation from penetration on the side walls. The trend for the layer industry is toward light houses with mechanical ventilation. The new houses are of tighter construction and allow for greater bird density, requiring closure attention to building details. If the building has an attic band must be provided to reduce heat and moisture buildup above the insulation.

4. Condition of roof also affects the heating of poultry shed. A shining surface can reflect twice as much solar radiation as rusty or dark metal roofs. Roof should be kept free of dust and rust. Roof reflectivity can be increased by cleaning and painting the surface with metallic zinc paint or by installing an aluminum roof. These practices are particularly effective for buildings that are under insulated.

5. Fans should be routinely maintained. Maintenance should include cleaning the fan and keeping polish and belts in good condition and properly adjusted. Poultry netting on sidewalks or air inlets often will pick up enough dust to restrict air movement and should be cleaned regularly.

6. Keeping a readily available, clean, cool source of water available to poultry is essential to help the birds cope with high temperatures. Since the birds excrete electrolytes periods of heat stress, electrolytes can be added to the drinking water to replace the lost electrolytes and to stimulate water consumption. Avoid placing water pipes in contact with roof of poultry shed because the water will gain extra heat. Lines in which the water has become warm can be drained to allow cooler water to reach the waterers. A spare well or access to an alternate source of water should be available in case the primary water source fails.

Conclusion

Current production methods often involve large number of birds being housed together making them susceptible to heat stress. Heat stress not only causes suffering and death in the birds, but results in reduced or lost production. In India during the past 20 years, an increase of 0.6^0C environmental temperature affecting all parameters of production performance in poultry and is often associated with sudden and massive deaths. Understanding and controlling environmental conditions mainly increase in temperature is significant to successful poultry production and welfare. The impact of heat stress in poultry production causes great economic losses and these can be overcome by implementing the strategies including environmental management, nutritional manipulation, feeding practices management and supplementation of anti-stress compounds to alleviate the heat stress and water supplementation with electrolytes. Apart from these strategies, recently two innovative approaches have been explored including early life conditioning (i.e., prenatal heat acclimation) and genetic selection of breeds with increased capacity of coping with heat stress conditions (Lucas et al.,2013).

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