INTRODUCTION

A hot environment is an important stressor affecting poultry production in tropical and sub-tropical regions. Thus, the effect of high ambient temperature and resultant heat stress on the performance of commercial egg-laying stocks needs to be studied. In tropical and sub-tropical hot climates, the production performance of chickens is adversely affected by high ambient temperature and this leads to reduction in feed intake, feed efficiency, growth rate and meat yield as well as meat composition or it causes high mortality in heat-tolerant and egg-type chickens (Cahaner and Leenstra, 1992; Yunis and Cahaner, 1999). Management practices (cooling and ventilation system) can be used to decrease the effect of heat stress, but they involve high costs and in many cases, are neither economical nor available to farmers in developing countries of the tropical climates. Hence, previous research findings have established that alternative and more sustainable methods is through genetic approaches for poultry production in hot climates (Horst, 1983). The results of this study will offer suggestion on the ways to develop a heat stress index in commercial layers in humid tropics and provide an additional strategy on the inclusion of heat tolerance genetic merit in the development of layer stocks for the region.

MATERIALS AND METHODS

LOCATION, DURATION AND ANIMALS

Data on four thousand (4,000) pullets each of Isa Brown (IB) and Bovan Nera (BN) strain were assessed for egg laying performance traits. The research, carried out at Funtuna Farms, Oregere, Ogun State, Nigeria (Figure 1) covered the entire production cycle of 52 weeks. Performance traits include egg-laying performance, age of birds at peak performance and age at point of lay. Climatic variables include temperature and relative humidity from which temperature-humidity index (THI) was calculated. To reduce the complexity of the analyses, the effect of heat stress was studied only as the function of temperature, relative humidity and temperature-humidity index (THI). THI was grouped into 3 classes: Less than 26 (<26.00), between 26 and 29 (26-29.00) and greater than 29 (>29.00) showing the degree of heat stress the laying birds were exposed to.

TEMPERATURE-HUMIDITY INDEX (THI) MODEL

Heat stress was measured using THI to analyze its effect on egg-laying performance traits (NOAA, 1976). The index was calculated using temperature and relative humidity in the pen houses. The model is as follows:

\[ THI = \frac{\left( \frac{T}{23.7} + 0.555 + 0.0088 \times R_h \right)}{1 + 0.0166 \times R_h} \]

where:

- \( T \): Environmental temperature (°C)
- \( R_h \): Relative humidity (%)

A regression analysis of THI and egg-laying records was done to establish a relationship between THI and egg-laying performance.

STATISTICAL MODEL FOR HEAT STRESS FUNCTION

The statistical model for heat stress function to estimate the thresholds of heat stress and associated decline in production performance is:

\[ Y = \beta_0 + \beta_1 T + \beta_2 T^2 + \epsilon \]

where:

- \( Y \): Observation of the production traits,
- \( T \): Dummy regression for the associated decline in production due to heat stress, was set to zero if THI was below an assumed threshold (no heat stress) and equal to (THI)-threshold otherwise.
- \( \epsilon \): Standard thresholds were tested and the one that provided the highest coefficient of determination (R²) was selected.

RESULTS AND DISCUSSION

TEMPERATURE AND RELATIVE HUMIDITY PATTERNS

Figure 2 showed the weather patterns of Funtuna farms, Oregere-Rimo, where the research was conducted. The fluctuations in temperature and relative humidity were as a result of seasonal changes in weather patterns showing a direct relationship between environmental temperature, relative humidity and heat production in laying chickens. From Figure 2, the temperature and relative humidity readings showed that the highest humidity occurred when the temperature was lowest and this occurred in the 8th month revealing a tropical seasonal variation while the temperature was highest in the 5th month (May).

Figure 2 also showed the temperature-humidity patterns of the weather around the farm during the month-of-lay of study period. The temperature range within the study period was between 24.5ºC and 30.9ºC at 5th and 8th month while the humidity ranged between 47% and 89% at 1st and 8th month respectively. The derived temperature-humidity index (THI) in figure 3 was grouped into 3 classes as <26, 26-29, and >29 showing the level of heat stress to which chickens were exposed and the depression in performance caused by heat stress as a function of the rate of decline of production per unit increase in THI. With increasing THI levels, there was a consistent production until a certain threshold (THI=27.5), when a decline occurred with increasing THI. Hence, a combination of increasing temperature and varying relative humidity hampered productivity of chickens in the study location.

Figure 3: Comfort limits of heat tolerance and heat stress indices for layers

APPLICATIONS

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