MODELLING HEAT STRESS CHARACTERISTICS ON THE LAYERS' PERFORMANCE TRAITS IN SOUTH-WESTERN NIGERIA.

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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, need 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 meat-type 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 method 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) strains were assessed for egg laying performance traits. The research, carried out at Funtuna Farms, Ogere, 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), between 26 and 29 (26-29) and greater than 29 (>29) (showing the degree of heat stress the laying birds were exposed to)

Figure 1: The map of South-Western Nigeria showing the location of the study by the pointer ($6^0 56^1$N and $3^0 41^1$E)

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 (t, h) = (9/5t + 32) – 11/2 (1-h)(9/5t- 26)(NOAA, 1976)

Where t = maximum temperature (°C)

h = minimum 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:

$$Y_{ij} = \beta_o + \beta_1 t + ?_{ij}$$

where: Y_{ij} =Observation of the production traits,

β_o = intercept,

β_1 = slope

t = dummy regression for the associated decline in production due to heat stress, t was set to zero if THI was below an assumed threshold (no heat stress) and equal to (THI-threshold) otherwise. Several thresholds were tested and the one that provided the highest coefficient of determination (R^2) was selected

DATA ANALYSIS

Data were subjected to different analyses: general linear model (GLM) procedure of SAS for egg-laying data; descriptive analysis for climatic data and linear regression, analysis that combine both climatic and egg-laying data. Duncan New Multiple Range Test (DMRT) was used to detect significant differences among means and slopes were compared by homogeneity of regression test to determine whether or not they could be considered as estimates of a common value.

RESULTS AND DISCUSSION

TEMPERATURE AND RELATIVE HUMIDITY PATTERNS

Figure 2 showed the weather patterns of Funtuna farms, Ogere-Remo, 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 heat variation while the temperature was highest at 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 2: Temperature-humidity patterns during the month of study

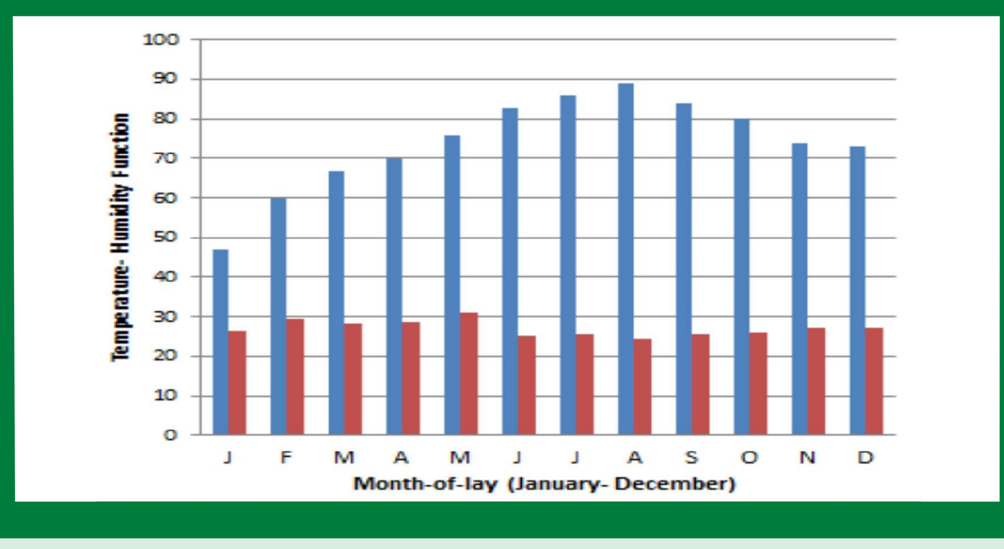

Figure 2a

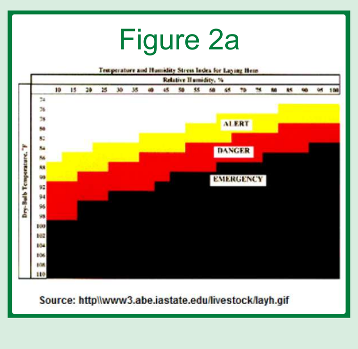

Figure 3

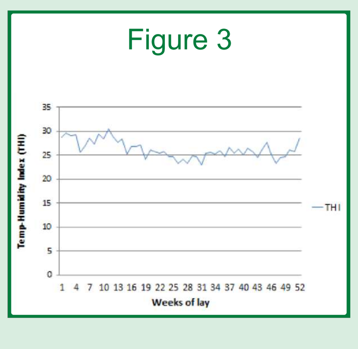

Figure 3a

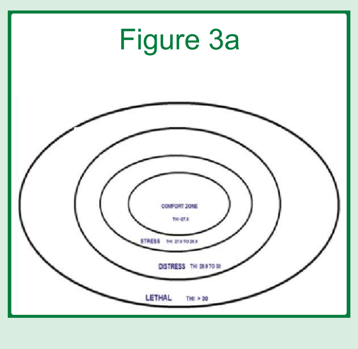

Figure 4

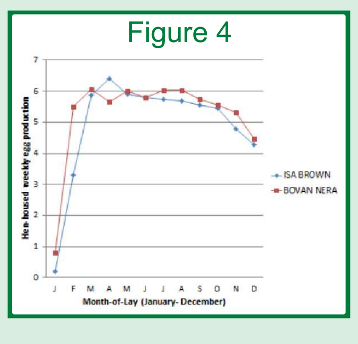

Figure 5

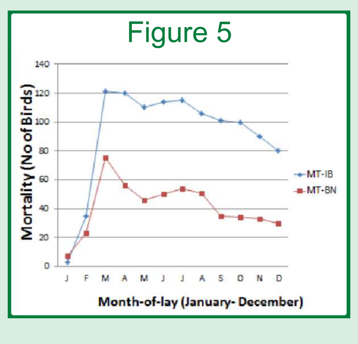

Figure 6

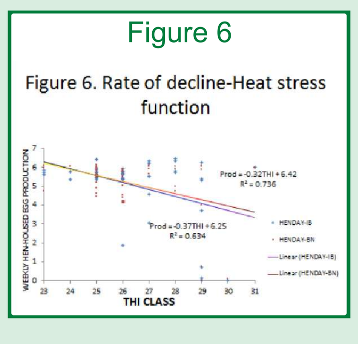

Figure 2a: A reference chat showing temperature-humidity index for commercial layers.
Figure 3a: Comfort limits of heat tolerance and heat stress indices for layers
Figure 4: Egg-laying performance of IB & BN during the month-of-lay
Figure 5: Mortality patterns of Isa Brown & Bovan nera during the month of the lay
Figure 6: Rate of decline-Heat stress function
Figure 3: Temperature-Humidity Index (THI during the study period)

TEMPERATURE-HUMIDITY INDEX (THI)

The temperature-humidity index (THI) classes observed were: less than 26 (< 26.00), between 26 and 29 (26-29.00) and greater than 29 (> 29.00). This showed the level of heat stress the laying birds were exposed and degree of heat stress as; comfort limit, heat stress, and severe heat stress respectively. With increasing THI level, there was a consistent egg-laying performance until a certain threshold (THI=27.5), when a decline occurred with increasing THI (Figure 6). Thus, increase in the temperature-humidity index markedly affected egg production performance of commercial layers in the study location. In dairy cattle, West et al. (2003) reported a negative effect of THI on milk yield among Holstein cattle.

This agrees with research findings of Ravagnolo et al (2000) who described decline in milk production from Holstein cattle as a result of heat stress by a broken-stick function. Also, Igono et al (1992) reported a linear and curvilinear relationship between THI and milk production from Holstein dairy cattle. Currently, commercial layers may be more susceptible to heat stress than in the past. The intense selection on production is carried out in the temperate climates. Since it was established that productivity and heat tolerance were antagonistic (Johnson et al, 1962), this selection leads to reduced heat tolerance and, consequently, lower egg production in hot climates.

EGG PRODUCTION AND MORTALITY

The mean weekly egg production was 4.98 ±0.21 and 5.20 ±0.21 for Isa Brown and Bovan Nera layers respectively (Figure 4). The difference in means was significant ($P < 0.05$). Figure 5 showed mortality pattern between the two strains of layer chicken ($P < 0.001$). Isa Brown recorded higher mortality (24.19±1.25) per month of lay than Bovan Nera (14.46±1.25). This result is in agreement with some previous reports such as Charles and Tucker (1993) who reported significant difference between modern hybrid stocks of chicken (ISA Brown, Hisex Brown, Ross G-Link Brown and Shaver Brown) in egg production in the temperate ($P < 0.001$). The result of this study also agree with the findings of Juarez and Fraga (1999) who reported significant effect between naked and normal plumage genotypes on egg production of Criollo laying hens. In addition, Hossain (1992) reported significant differences ($P< 0.05$) in egg production among Rhode Island Red, Barred Plymouth Rock and Indigenous (Desi) breeds of poultry under intensive and rural conditions in Bangladesh.

This result of this study was similar to the findings of Yalcin et al (2001) who reported that high ambient temperature during production are associated with an increase in the stress status of commercial chickens. According to Oluyemi and Roberts (2000), a temperature above 32^0C reduces egg production by causing heat stress which result to lowered feed intake and poor feed conversion and thus, lower egg production. In addition, Kekeoba (1985) reported that higher temperature (above 26^0C) caused a reduction in egg numbers. This result therefore, conformed to previous studies on the effect of heat stress on egg production. According to Kekeoba (1985) temperature above 40^0C caused high mortality in chickens due to heat stress. The high temperature causes panting, heat prostration, weakening of immune response to infections or death, resulting in economic loss to the farmers. Mckay *et al*. (2000) reported that continuous genetic selection for performance has led to tremendous improvements in growth rate achieved under optimal conditions, but this might lead to increased sensitivity of chicken stocks to high ambient temperature (Cahaner and Leenstra, 1992).

CONCLUSION

1. The result of this study revealed that temperature-humidity index is an important source of variation in determining heat tolerance merit of laying birds in hot-humid conditions.
2. The temperature-humidity index (THI) can be used to account for the effects of heat stress on production performance of commercial layers, hence, suitable for genetic studies of adaptation and heat tolerance.
3. The threshold of heat tolerance between the two commercial strains and the associated rate of decline were comparable. Bovan Nera recorded lower rate (0.32eggs/THI) as against Isa Brown (0.37eggs/THI)

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