# Effect of Heat Stress on Laying Hens Acclimated to Cyclic *Versus* Constant Temperatures

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*ABSTRACT* Two trials were conducted to determine the effect of heat stress on commercial layers acclimated to a 24-hr cyclic temperature of 15.6 to 35 to 15.6 C *versus* those acclimated at a constant 25 C temperature, which was the mean temperature of the 24-hr cyclic temperature. Producing eggs for an 8-week period in a 24-hr cyclic temperature regimen (15.6 to 35 to 15.6 C) *versus* a constant temperature regimen (25 C) did not significantly affect percent egg production, feed consumption, egg weight, body weight change, feed efficiency, egg shell breaking strength, or egg shell thickness. Heat stress (39 C) resulted in a significantly greater reduction in egg production and egg shell breaking strength for the layers acclimated to the constant *versus* the cyclic temperature regimen.

*(Key words:* laying hens, heat stress, egg production, egg shell breaking strength)

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## INTRODUCTION

Broiler chickens at market age can acclimate in 3 days to resist extremely high mortality from heat prostration (Reece *et al.*, 1972). The acclimation treatment used by Reece *et al.* (1972) consisted of equal weight broilers taken from a 21 C temperature environment and exposed for 3 days to 24-hr temperature cycles of 21 to 32 to 21 C and 24 to 35 to 24 C before the temperature stress treatment was applied. In reviewing acclimation to high environmental temperatures, Smith and Oliver (1971) noted that acclimation may be mainly associated with low basal metabolic rate at high ambient temperatures.

The objective of the study was to determine the effect of heat stress on egg production and egg shell quality of commercial layers acclimated to constant and cyclic temperature regimens.

## EXPERIMENTAL PROCEDURE

Two trials were conducted. For 8 weeks for each trial DeKalb 231 layers were acclimated to 24-hr linear temperature cycle of either 15.6 to 35 to 15.6 C or a constant temperature of 25 C, which was the mean of the cyclic temperature used. The dewpoint was a constant 15.6 C in both treatments. The heat stress temperature of 39 C with a relative humidity of 26% was maintained for 16 hr. A battery containing 16 compartments 36 × 67 cm (37 cm high) was placed in each of two controlled environment chambers. The chambers were based on a design described by Reece and Deaton (1969). Three layers were placed in each battery compartment for a total of 48 layers for each trial and each temperature treatment.

The 35 C temperature was attained each day at 1600 hr and the low temperature was attained each day at 0400 hr. During the heat stress period the 39 C temperature was attained at 1600 hr and maintained until 0800 hr the next day, at which time the normally assigned temperature regimen was restored.

Light from incandescent bulbs at an average intensity of 32 lx was supplied from 0500 to 2100 hr. Feed and water were supplied *ad libitum*. All eggs laid during the 5th day of each week during the 8-week period were weighed and their breaking strength and shell thickness recorded. After the high temperature stress period, all eggs laid the 2nd, 3rd, 6th, and 7th day poststress were weighed and their breaking strength recorded. Egg shell breaking strength was determined with a universal testing instrument by the technique described by Reece and Lott (1975). Shell thickness was measured with a micrometer. The basal layer diet contained 17% protein and a metabolizable energy value of 2,889 kcal/kg. The calcium and available phosphorus levels were 3.25 and .60%, respectively. The hens used in trial 1 were 7 months old when the trial started, and those used in trial 2 were 9 months old when the trial started.

A split-plot analysis according to Cochran and Cox (1962) was used to statistically evaluate the effect of heat stress on egg production, shell breaking strength, and egg weight. The statistical evaluation for mortality was by chi-square. The randomized block and split-plot analysis were used to determine if differences existed for cyclic *versus* constant temperature effects.

## RESULTS AND DISCUSSION

The effect of cyclic *versus* constant temperatures on laying hen performance is given in Table 1. There was no significant difference for the two trials in hen/day egg production, feed consumption, egg weight, body weight change, feed efficiency, egg shell breaking strength, or egg shell thickness for the layers acclimated at a 24-hr cyclic temperature of 15.6 to 35 to 15.6 C or 25 C, which was the mean temperature of the cyclic regimen (Table 1). Previous work comparing cyclic *versus* constant temperature regimens on the performance of commercial egg layers was conducted by de Andrade *et al.* (1977) and Miller and Sunde (1975). The previous workers noted a difference in some performance characteristics in cyclic *versus* constant temperature exposed laying hens, but these workers were also using higher cyclic or constant temperature regimens than we used in this study.

For a 5-day period after the heat stress was applied, the reduction in percent egg production was significantly greater for the layers exposed to the constant 25 C temperature than for layers exposed to the 15.6 to 35 to 15.6 C temperature cycle (Table 2). The 5-day poststress period was chosen because all temperature-exposed groups for each trial had attained or exceeded in one day of the 5-day period the average 14-day prestress hen/day egg production (Table 2).

The breaking strength of eggs responded in much the same manner as percent egg production with the breaking strength for eggs produced in a prestress temperature of 25 C constant dropping significantly more than the eggs produced in a prestress temperature cycle of 15.6 to 35 to 15.6 C when both are exposed to the same heat stress (Table 2). Average egg weight was not significantly affected by heat stress in relation to the prestress temperature

TABLE 1. *Effect of cyclic versus constant temperatures on laying hen performance (2 trials, 8 week period)*

| | Laying house temperature, C[1] | | | | | |
|---|---|---|---|---|---|---|
| | Trial 1 | | Trial 2 | | Avg, Trials 1 and 2 | |
| | 15.6 to 35 | 25 | 15.6 to 35 | 25 | 15.6 to 35 | 25 |
| Hen/day egg production (%) | 65 | 66 | 79 | 75 | 72[a] | 71[a] |
| Feed consumption (g/day) | 105 | 108 | 103 | 104 | 104[a] | 106[a] |
| Egg weight (g) | 58 | 57 | 56 | 57 | 57[a] | 57[a] |
| Body weight change (g) | +22 | +39 | −27 | −20 | −3[a] | +10[a] |
| Feed efficiency (g feed/g egg) | 2.8 | 2.9 | 2.3 | 2.4 | 2.6[a] | 2.7[a] |
| Egg shell breaking strength (kg) | 3.36 | 3.32 | 3.20 | 3.08 | 3.28[a] | 3.20[a] |
| Egg shell thickness (mm) | .318 | .321 | .322 | .314 | .320[a] | .318[a] |

[1] A 24-hr linear temperature cycle from 15.6 C to 35 then back to 15.6 C *versus* a constant 25 C temperature regimen.

[a] Within each row, like letters denote no difference ($P \leq .05$).

TABLE 2. *Effect of heat stress on laying hens acclimated to cyclic versus constant temperatures*

| | Laying house temperature, C[1] | | | | | |
|---|---|---|---|---|---|---|
| | Trial 1 | | Trial 2 | | Avg, Trials 1 and 2 | |
| | 15.6 to 35 | 25 | 15.6 to 35 | 25 | 15.6 to 35 | 25 |
| Hen/day production (%) | | | | | | |
| Avg 14-day prestress | 66 | 66 | 79 | 72 | 73 | 69 |
| 1-day poststress[b] | 58 | 36 | 67 | 48 | 63 | 42 |
| 2-day poststress | 53 | 41 | 75 | 39 | 64 | 40 |
| 3-day poststress | 57 | 50 | 71 | 65 | 64 | 58 |
| 4-day poststress | 55 | 69 | 81 | 74 | 68 | 72 |
| 5-day poststress | 68 | 62 | 83 | 76 | 76 | 69 |
| Avg 5-day poststress | 58 | 52 | 75 | 60 | 67[a] | 56[b] |
| Breaking strength (kg) | | | | | | |
| Avg 14-day prestress | 3.44 | 3.45 | 3.16 | 3.08 | 3.30 | 3.27 |
| 2-day poststress | 2.98 | 2.78 | 2.56 | 2.44 | 2.77 | 2.61 |
| 3-day poststress | 3.19 | 3.07 | 2.86 | 2.64 | 3.03 | 2.86 |
| 6-day poststress | 3.52 | 3.60 | 3.01 | 3.04 | 3.27 | 3.32 |
| Avg 2–3-day poststress | 3.09 | 2.93 | 2.71 | 2.54 | 2.90[a] | 2.74[b] |
| Egg weight (g) | | | | | | |
| Avg 14-day prestress | 56.7 | 58.0 | 57.6 | 57.1 | 57.2 | 57.6 |
| 2-day poststress | 54.4 | 55.2 | 57.5 | 56.1 | 56.0 | 55.7 |
| 3-day poststress | 54.9 | 56.5 | 58.1 | 56.6 | 56.5 | 56.6 |
| 6-day poststress | 55.2 | 55.7 | 58.9 | 57.9 | 57.1 | 56.8 |
| Avg 2–3-day poststress | 54.7 | 55.9 | 57.8 | 56.4 | 56.3[a] | 56.2[a] |

[1]A 24-hr linear temperature cycle from 15.6 to 35 then back to 15.6 C *versus* a constant 25 C temperature regimen.

[2]Consisted of a 16-hr stress period at 39 C.

[a,b]For each poststress trial average, differing letters denote significant difference ($P \leq .05$).

treatment (Table 2). Average egg weight dropped at the same rate for the 2- to 3-day poststress period for layers acclimated previously to the 15.6 to 35 to 15.6 C temperature cycle or the constant 25 C temperature. The intent was to stress rather than create mortality during the heat stress period; however, significantly more hens (7) died during the heat stress period from the groups acclimated to the 25 C constant temperature regimen (2 in trial 1, 5 in trial 2); in trial 2 during the heat stress period, 1 hen acclimated to the cyclic temperature regimen died.

These data demonstrate that "seasoning", an industry terminology to denote acclimation, will prevent loss of eggs, and the breaking strength of the eggs laid will be higher, should heat stress occur either through mechanical malfunction or with a natural heat wave. As noted previously, broiler chickens were acclimated in 3 days to resist extremely high mortality from heat prostration (Reece *et al.,* 1972). No attempt, however, was made to establish the minimum acclimation period required to prevent a minimum loss of eggs or breaking strength from the eggs that are laid. The acclimation period in this study was 8 weeks.

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