EDUCATION AND PRODUCTION

Duration of Fertility in Ad Libitum and Feed-Restricted Caged Broiler Breeders

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ABSTRACT

It has been shown in previous studies that fertility can be reduced in overweight broiler breeder (BB) flocks. In an effort to determine the effect of ad libitum feeding on the duration of fertility in BB hens, 60 52-wk-old Shaver Starbro hens were randomly assigned to one of two treatments, ad libitum feeding (F) or restricted feeding (R) to maintain breeder target weights. All hens were reared to 52 wk under conditions of feed restriction. All birds were weighed individually on a weekly basis. At the beginning of each of two 4-wk study periods (56 to 60 wk and 60 wk to 64 wk), all birds were inseminated on 2 consecutive d with 0.05 mL pooled BB semen. All eggs were weighed and placed in a forced air incubator the same day that they were laid. After 7 to 10 d of incubation, the eggs were broken out and scored macroscopically as fertile with live embryo, fertile with dead embryo (early embryonic death), or clear (assumed infertile). The duration of fertility was defined as the number of days from the day after the second insemination to the last fertile egg before two consecutive interfile eggs.

Hen BW were significantly different between treatments within each of the two 4-wk studies. The mean BW of the F hens was 4,261 g in Study 1 and 4,448 g in Study 2. The BW of the R hens were 3,459 g in Study 1 and 3,565 g in Study 2. Egg production levels and average egg weight was not different between treatments in either study. In Study 1, the duration of fertility for the F hens (12.7 d) and the R hens (12.7 d) were not different. In Study 2, the durations of fertility were significantly higher (P < 0.05) in the R hens (12.7 d) than in the F hens (10.0 d). These results support the theory that overweight BB have a reduced duration of fertility that may contribute to a reduced fertility in artificially inseminated and naturally mated flocks.

(Key words: broiler breeder, feed restriction, fertility duration, artificial insemination)

INTRODUCTION

The factors that affect the length of time that spermatozoa can remain viable in the oviduct of the modern broiler breeder (BB) chicken following artificial insemination (AI) or natural mating have not been clearly defined. Following insemination, spermatozoa are subject to selection, storage, and transport to the infundibulum, the site of fertilization (Brillard, 1993). The duration of fertility is dependent, in part, on the numbers of sperm residing in the sperm storage tubules after AI or copulation (Brillard, 1993). Layer chickens with a higher rate of lay tend to have a longer duration of fertility than do layer chickens with a lower rate of lay (Beaumont et al., 1992). Beaumont et al. (1992) suggested that there is a strong correlation between laying rate and duration of fertility in both layer and broiler hens.

Fertility is negatively affected in BB hens that are excessively above target BW (Yu et al., 1992). While comparing artificially inseminated feed-restricted and full-fed BB, Yu et al. (1992) found that full-fed hens produced fewer total and settable eggs and had lower percentages of egg fertility, hatchability, and embryonic viability. It has been speculated that because differences in BW in BB are predominantly due to differences in fat, accumulations of fat in the uterovaginal junction may reduce the duration of fertility by reducing the storage capacity of the sperm storage glands (McDaniel et al., 1981). Bilgili and Renden (1985) showed that high BW in BB hens was negatively correlated with the percentage fertile eggs of total eggs laid over 21 d, the duration of fertility and fertile egg production. However, oviductal fat content and measures of fertility were not found to be significantly correlated. It was suggested that the adverse effects of percentage or total body fat on fertility involves mechanisms other than increased oviductal lipid accumulation as speculated by McDaniel et al. (1981). It can be difficult to identify factors that have an effect on the duration of fertility in frequently inseminated hens. This study was undertaken to investigate the effects of excess BW on the duration of fertility in laying BB hens.
MATERIALS AND METHODS

Sixty Shaver Starbro hens were randomly selected at 52 wk of age from a flock of 180 hens. The birds had been raised to 52 wk of age following accepted guidelines of beak trimming, wing-bandaging at 4 wk of age, feed restriction to maintain body weight at breeder target levels, individual bird weighing weekly and artificial insemination. The birds were reared in floor pens to 20 wk of age at which time they were individually caged. The cages were 51.0 cm x 45.7 cm with a sloped floor. The hens had ample room to stand fully erect. The flock was photostimulated at 20 wk by increasing the day length from 8 to 15 h in a single step. The flock was fed a standard BB starter and grower ration during the rearing period. At 20 wk of age, a breeder ration with 16.3% CP, 2,738 kcal ME/kg, and 3.46% Ca was provided.

The 60 hens were individually weighed and randomly assigned to one of two treatments. Thirty hens were feed-restricted (R) to maintain breeder recommended BW targets. Feed was allocated daily on an individual basis. The second treatment consisted of feed allocation on a full-fed (F) basis. All birds were weighed individually on a weekly basis. Study 1 began after a 4-wk acclimation period (52 to 56 wk of age).

Two study periods were conducted (56 to 60 wk of age and 60 to 64 wk of age). When the hens were 56- or 60-wk-old they were inseminated once at 1300 h on each of 2 consecutive d with 0.05 mL of pooled BB chicken semen. No further inseminations were conducted for the following 26-d period. The study period began the day following the second insemination. This was the earliest time an egg fertilized with sperm from the 1st insemination d could be oviposited. Prior to the start of Study 1 all of the hens had been inseminated weekly with 0.05 mL pooled BB chicken semen. The hens had an average fertility of 92.3% from 25 wk of age. All settable eggs laid during the 26-d study period were identified by hen, individually weighed, and placed in an incubator the same day they were laid. For the purposes of this experiment, eggs capable of being set included eggs with shell deformities, abnormal shapes, or double-yolked eggs. After 7 to 10 d of incubation under standard conditions, the eggs were broken out and scored macroscopically as fertile with live embryo, fertile with dead embryo (early embryonic death), or clear (assumed infertile). The duration of fertility was defined as the number of days from the day after the second insemination to the last fertile egg before two consecutive infertile eggs. In order for a hen to be included in the data it must have laid at least one fertile egg. Hens excluded from the first study period remained eligible to participate in the second study. Hens producing no eggs were culled from the experiment. As a result of these criteria, four R and five F hens were removed from the data set in Study 1 and three R and six F hens were removed from the data set in Study 2.

One-way analyses of variance were computed within study using the General Linear Models procedure of SAS® (SAS Institute, 1992) to determine differences between treatments (F or R). Pearson Correlation coefficients were computed between mean hen BW, BW gain, settable egg production, average egg weight, and duration of fertility across treatments within each study (n₁ = 51, n₂ = 51). Settable egg production was expressed as a percentage of settable eggs over 26 d. Significance was assessed at P < 0.05.

RESULTS AND DISCUSSION

The mean BW of the R and F hens were significantly different within each study period (Table 1 and Figure 1). The high variance associated with the average gains over each study period was related to the fact that some hens lost BW during the study. An equal number of R and F hens in each study lost BW despite the fact that the F hens had ad libitum access to feed. A greater number of hen-days lost weight in Study 2 than in Study 1 (11 hens for Study 2 vs 6 hens for Study 1). As seen in Table 1, hen-day settable egg production was not different between treatments in either Study 1 (F = 52.6%, R = 60.2%; P = 0.095) or in Study 2 (F = 49.2%, R = 56.1%; P = 0.128). Average egg weight was also not significantly different between feed allocation treatments in either Study 1 (F = 71.0 g, R = 69.1 g; P = 0.063) or Study 2 (F = 71.2 g, R = 69.2 g; P = 0.057) (Table 1). There were no significant differences between treatments in the percentage of fertile eggs laid, the

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### Table 1. Means (± SD) of bird BW, BW gain, production level, settable egg weight, and duration of fertility measured by treatment for each study period

<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment</th>
<th>Number of hens</th>
<th>Mean BW (g)</th>
<th>BW gain (g)</th>
<th>Egg production (%)</th>
<th>Average egg weight (g)</th>
<th>Duration of fertility (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Restricted</td>
<td>26</td>
<td>3,459 ± 188b</td>
<td>101 ± 81</td>
<td>60.2 ± 10.7</td>
<td>69.1 ± 3.1</td>
<td>12.7 ± 2.9</td>
</tr>
<tr>
<td></td>
<td>Full-fed</td>
<td>25</td>
<td>4,261 ± 347a</td>
<td>154 ± 217</td>
<td>52.6 ± 20.0</td>
<td>71.0 ± 4.1</td>
<td>12.7 ± 3.1</td>
</tr>
<tr>
<td>2</td>
<td>Restricted</td>
<td>27</td>
<td>3,565 ± 197a</td>
<td>76 ± 102</td>
<td>56.1 ± 12.9</td>
<td>69.2 ± 3.3</td>
<td>12.7 ± 3.3b</td>
</tr>
<tr>
<td></td>
<td>Full-fed</td>
<td>24</td>
<td>4,448 ± 403a</td>
<td>116 ± 193</td>
<td>49.2 ± 18.8</td>
<td>71.2 ± 4.1</td>
<td>10.0 ± 4.6a</td>
</tr>
</tbody>
</table>

*Means within a study with no common superscript differ significantly (P < 0.05).

**BW gain = BW at end of study – BW at start of study.**
percentage abnormal eggs (shell deformities or shape deformities), or the percentage of double yolked eggs in either of the 26-d study periods.

In Study 1, there was no difference in the duration of fertility between the R (12.7 d) and the F (12.7 d) treatments. In Study 2, there was a significant reduction in the duration of fertility of the F hens (10.0 d) compared to the R hens (12.7 d) by 2.7 d (Table 1). This result would seem to indicate that the additional weight gain of the F hens during Study 2 impaired their ability to maintain fertility. Fertility problems can occur at three levels; sperm storage capacity, sperm transportation, and oocyte health. It is unclear why the F hens in Study 2 had a reduced duration of fertility. It is important to note that as all fertility evaluations were conducted macroscopically, some very early dead embryos may have been mistakenly identified as infertile.

There were significant correlations between the following variables for both study periods: average hen weight and settable egg production ($r = -0.425$ for Study 1, $r = -0.421$ for Study 2) and duration of fertility and settable egg production ($r = 0.293$ for Study 1, $r = 0.369$ for Study 2). These findings support the observations of Beaumont et al. (1992), who suggest that there is a strong correlation between laying rate and duration of fertility in BB hens. The correlation of average hen BW and average egg weight ($r = 0.306$) was significant for Study 1 and the correlation of average hen weight with duration of fertility was significant in Study 2 ($r = -0.280$).

The longest period post insemination in which a hen laid a fertile egg was 22 d. This egg was preceded with four infertile eggs. It was not uncommon for a hen to lay one or more infertile eggs within a clutch of fertile eggs. Duration of fertility estimates would have been longer had the duration of fertility been defined as the number of days to the last fertile egg and not to the last fertile egg before two infertile eggs.

This experiment provides further support for the negative influence of increased BW on the duration of fertility in BB hens. It also suggests, however, that extreme differences in BW are required in order to affect the duration of fertility. Considering that only 1 to 2% of inseminated sperm actually remain in the oviduct (Bakst et al., 1994), and that the number of sperm residing in the sperm storage tubules is directly proportional to the duration of fertility (Brillard, 1993), efforts focused at increasing or maintaining the number of sperm remaining in the oviduct may improve the duration of fertility. Given that the duration of fertility of the F hens in Study 2 was 10.0 d, this experiment appears to indicate that BW has little practical effect on the duration of fertility when inseminations are conducted weekly. However, the effects of ad libitum feeding may require more than 8 wk to have an effect. If this is the case, BW may have a practical effect on the duration of fertility even with weekly inseminations. It is not known with certainty how often individual hens are mated in floor housed stocks. However, if the reduced duration of fertility in the F hens in Study 2 was due to a reduced number of sperm residing in the sperm storage tubules of the uterovaginal junction, this could affect the likelihood of fertilization regardless of insemination frequency.
REFERENCES


