Initiation of egg production by turkey breeder hens: Sexual maturation and age at lighting

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ABSTRACT

Experiments were completed addressing photoresponsiveness in juvenile Large White turkey breeder hens, the age at sexual maturity, and the earliest age at photostimulation for egg production using conventional lighting management. In the first experiment, hens were photostimulated at 8 or 16 wk of age with a daily photoperiod of 16L:8D after receiving 8L:16D from hatch. Controls received 16L:8D continuously from hatch. In experiment 2, hens were given naturally declining long day lengths from hatch to 14 wk of age, a daily photoperiod of 8L:16D for the next 10 wk, and were then photostimulated at 24 wk of age with a daily photoperiod of 16L:8D. Data were collected by pen for the onset and rate of egg production, BW, and egg weight. The hens reached sexual maturity and laid eggs as early as 21 to 22 wk of age and the weight for the first 7 eggs was 56.1 g ± 1.5. The hens were not photoresponsive to photoinduced egg production at 16 wk of age but were fully responsive by 24 wk of age as compared with controls. Photostimulation at 24 wk of age resulted in a slight delay in onset of lay (4 to 5 d) but otherwise typical egg production. These hens produced 113.3 eggs per hen to 54 wk of age as compared with 95.2 eggs for controls photostimulated at the more conventional 30 wk of age. Egg weight was 73.0 versus 80.0 g for the first 7 eggs laid for hens photostimulated at 24 wk of age versus 30 wk of age. At 36 wk of age, egg weights were similar (84.0 vs. 83.7 g). We may conclude that Large White turkey breeder hens can become sexually mature and lay eggs as early as about 22 wk of age. Appropriate prelay short day exposure is required to fully photosensitize juvenile hens for photoinduced egg production and this requires a development time beyond 16 wk of age. Photostimulation of fully photosensitive hens for a typical production period can occur as early as 24 wk of age. We demonstrated that the conventional age at lighting of 29 to 30 wk of age can be significantly advanced.

INTRODUCTION

Turkey breeder hens are typically light-restricted during the immediate prelay period to terminate photorefractoriness (PR) and ensure that they are maximally photosensitive. They are then conventionally photostimulated with long day lengths (LDPP) at 29 to 30 wk of age to induce egg production 2 to 3 wk later. There is evidence that turkey hens are capable of laying eggs at a much earlier age, but the quantity and quality of the eggs remains equivocal. Considerable economic benefits accrue if breeder hens can be advanced in the age at which they start egg production.

As early as 1962, Shoffner et al. reported that egg production by Large White (LW) turkeys responded satisfactorily to stimulatory light levels at 24 wk of age (Shoffner et al., 1962) and Woodard et al. (1974) reported a similar response for Medium White hens. Additionally, Hocking (1992) noted that medium-sized turkey hens laid more eggs to 54 wk of age when photostimulated at 18 or 24 wk of age as compared with hens photostimulated at 30 wk of age. Siopes (1992) photostimulated LW turkey breeder hens at 24 to 30 wk of age in 2 different seasons of the year and concluded that the results did not support advancing the age at photostimulation to 28 wk or earlier. Clear seasonal responses occurred to lighting at all ages. Subsequent studies of advancing the age at lighting for LW turkeys by Siopes and Neely (1999) and Siopes (1999) demonstrated that the age at lighting could be acceptably advanced to 26 wk of age by use of modified light regimens such as intermittent lighting and ahemeral lighting. These lighting regimens were designed to enhance initial egg size without adverse effects on egg production.
Yang et al. (1999) noted that about 12% of LW turkey hens laid eggs by 23 wk of age when raised continuously on LDPP and most of the hens initiated lay between 24 and 30 wk of age. Essentially all LW turkeys laid eggs when exposed continuously to LDPP from hatch (Siopes, 2000). The age at onset varied by season of the year and was 22 and 25 wk of age for November and June hatched poults, respectively. Subsequent egg production by hens in these 2 reports was inferior to that of hens that received typical light management. In the likelihood that this reduced performance was a consequence of reduced photoresponsiveness (relative PR), then exposure to short day lengths (SDPP) for at least 8 wk before 25 wk of age should terminate any PR and enhance responsiveness to LDPP.

The foregoing ages represent the earliest reported ages for egg production by turkey hens and suggest a normal physiological age limit for inducing egg production (puberty-sexual maturation) of 22 to 25 wk of age. The question is, how close to the putative age limit can turkey hens be photoinduced and provide acceptable reproductive performance? Can we advance the conventional lighting age of 29 to 30 wk for turkey hens? The purpose of the present experiments was to further document the earliest age at onset of egg production and to evaluate the potential for advancing the age at lighting of LW Nicholas turkey breeder hens using conventional lighting management. The earliest age reported for onset of egg production is about 22 wk of age and this compares to egg production at 32 to 33 wk of age under commercial conditions, so there appears to be ample room for improvement.

**MATERIALS AND METHODS**

To examine a broader range of ages for early lighting of LW turkey breeder hens than currently exists, 2 experiments were done. Hens were photostimulated at 8 or 16 wk of age after receiving SDPP from hatch (experiment 1). In experiment 2, hens were given LDPP from hatch to 14 wk of age, SDPP for the next 10 wk, and were then photostimulated at 24 wk of age with LDPP.

Nicholas poults were brooded and reared in light-controlled buildings. The pens were not temperature-controlled except during the brooding period but were insulated and mechanically ventilated. Guidelines of the primary breeder were followed except as noted below. All birds were maintained in floor pens with wood shavings as litter and the treatment pens were identical within an experiment. There were 3 nest boxes, 1 hanging tube feeder, and 1 hanging bell waterer per pen. Lighting was by incandescent lamps at a mean light intensity of about 54 lx at turkey head height. Light was controlled by mechanical clocks and electronically recorded to validate control. Feed and water were available for ad libitum consumption at all times.

### Experiment 1

Turkey hens exposed continuously to LDPP from hatch can lay eggs as early as 22 wk of age but at reduced quantity or quality, or both. This experiment tested if the poor early egg production was a photoresponsiveness issue and if the egg production could be improved by prelay SDPP exposure starting from hatch. Such a SDPP exposure has never been reported before. Here and following, photoresponsive is used synonymously with photoinduced egg production.

Eggs from a commercial breeder were hatched on site in November and 3 light treatment groups were started on the day of hatch. Poults received 8 h of light per day (8L:16D) to either 8 wk (January) or 16 wk (March) of age and 16 h of light per day (16L:8D) thereafter. A control group was given 16L:8D continuously from hatch to the end of the experiment. Heat sources used during the brooding phase provided no extraneous light. Each treatment group consisted of 4 replicate pens of 5 hens each. Hens were given a pelleted layer ration at 18 wk of age calculated to contain 16% CP, 3.5% calcium, and 2,970 kcal of ME/kg of feed. Data were collected by pen for daily egg production, BW, and the weight of fully formed, intact eggs.

### Experiment 2

This experiment was designed to apply SDPP (light restriction) at a time closely related to age at onset of earliest lay. Thus, lighting management was associated with sufficient somatic development to support egg production. Hens were obtained as poults hatched in June from a commercial breeder and reared in a curtain-sided house on site. Primary breeder management guidelines were followed except as noted in the following. From hatch to 16 wk of age, the birds received natural day lengths only. Day lengths had declined from about 14.5 h in June to 11.6 h at 16 wk of age (October). At this time, the hens were moved into closed-confinement housing where the photoperiod was controlled at 8 h per day (8L:16D). At 24 wk of age (December), 8 pens of 4 to 5 hens each (n = 36) were photostimulated by changing the photoperiod from 8L:16D to 16L:8D. Feed was changed from a prelay ration calculated to contain 12% CP, 0.85% calcium, and 3,084 kcal of ME/kg of feed to a layer ration calculated to contain 16% CP, 3.5% calcium, and 2,970 kcal of ME/kg of feed. A control group of hens in 4 pens of 5 each (n = 20) was photostimulated at 30 wk of age (January) with 16L:8D and given a layer ration.

Data were collected by pen for daily egg production, BW at the start of photostimulation, and egg weight (EW). Egg weights were obtained for the first 14 d of lay and for 7-d periods ending at 6, 12, and 18 wk of photostimulation. Eggs were collected a minimum of twice daily during the photophase for the entire study,
and the number of eggs laid on the floor or in the nest was recorded by pen. Abnormal eggs such as soft-shelled, cracked, and broken were also recorded daily. Time to onset of lay was defined as days to reach 50% hen-day production from the start of LDPP.

A 1-way ANOVA was used to evaluate the treatment effects using the GLM procedure of SAS software (SAS Institute, 2005). The least squares means option was used to estimate significant differences among treatment means. Statements of statistical significance are based on $P < 0.05$ unless specified otherwise.

RESULTS

Experiment 1

Body weights were reduced in the SDPP treatment groups as compared with control group hens (Table 1). The control hens initiated egg production earlier than both groups of SDPP-treated hens. Control hens initiated lay at 21.3 wk of age and all 4 replicate groups of these hens were laying eggs by 22.4 wk of age (Table 1).

Mean age at onset was 21.9 ± 0.2 wk of age and this compared with 24.4 ± 0.2 and 23.8 ± 0.9 wk for the 0 to 8 and 0 to 16 wk SDPP treatment groups, respectively. The first egg laid among hens in all treatment groups was at 20.9 wk of age by a hen in the 0 to 16 wk SDPP-treated group. Only this one hen laid eggs until 24 wk of age among the SDPP-treated hens. Subsequent eggs from both groups of SDPP-treated hens were initiated between 24 and 25 wk of age.

Egg production gradually increased to a peak of 36% by 35 wk of age in the control hens and was about the same at the end of the experiment (38 wk of age; Figure 1). Treatment with SDPP from the time of hatch and up to 16 wk of age did not improve egg production from the control hens. Egg production never exceeded 16% hen-day egg production in the SDPP treatment groups. By 33 wk of age, a typical age at onset of egg production in conventionally light-managed hens, the cumulative eggs per hen was 17.5, 3.7, and 6.1 for controls, 0 to 8 wk SDPP, and 0 to 16 wk SDPP treatment groups, respectively.

Table 1. Mean ± SEM for BW and egg weights associated with onset of egg production at an early age

<table>
<thead>
<tr>
<th>Treatment</th>
<th>BW (kg)</th>
<th>Age first egg</th>
<th>Egg weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22 wk</td>
<td>26 wk</td>
<td>30 wk</td>
</tr>
<tr>
<td>LDPP control</td>
<td>10.2 ± 0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.3 ± 0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.4 ± 0.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SDPP 0 to 8</td>
<td>9.6 ± 0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.7 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.3 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>SDPP 0 to 16</td>
<td>9.3 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.3 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.5 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
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</tbody>
</table>

<sup>a</sup>Means in a column with no common superscript differ significantly ($P < 0.05$).

<sup>1</sup>Hens received short days (SDPP, SL:16D) for the first 8 or 16 wk from hatching and long day lengths (LDPP, 16L:8D) thereafter.
the first 7 eggs laid ranged from 56.1 to 64.8 g. Egg weight gradually increased with age in all treatment groups and the earliest age at which an average EW of 75 g occurred was about 27.5 wk.

Experiment 2

Weekly egg production by age and by weeks of photostimulation is given in Figure 2. Hens photostimulated at 24 wk of age started egg production 5 wk earlier (27 wk of age) than those photostimulated at 30 wk of age. The mean time to reach 50% hen-day production occurred after 20.3 and 24.8 d in the hens photostimulated at 30 and 24 wk, respectively (Table 2). Egg production for either 24 or 30 wk of photostimulation was very similar between the 2 treatment groups and cumulative eggs/hen for 30 wk of photostimulation was 119 versus 113 in the hens photostimulated at 30 versus 24 wk of age, respectively (Table 2). Egg production to a given age was greater in the hens photostimulated at 24 than at 30 wk of age (113 vs. 95 eggs/hen to 54 wk of age, respectively; Table 2).

Initial EW was smaller in hens photostimulated at 24 than 30 wk of age (73.0 vs. 80.0 g, respectively, for the first 7 d of egg laying). Eggs remained smaller in the earlier photostimulated hens up to 12 wk of photostimulation (Table 3). However, when considered on an age basis as early as 36 wk of age, EW was similar between hens photostimulated at 24 and at 30 wk of age (Table 3). Thus, by the time the early lit hens reach an age equivalent to peak production in conventionally lit hens, the EW is the same.

DISCUSSION

Large White turkey hens can initiate egg production between 21 to 22 wk of age when given LDPP continuously from hatch and this represents their earliest age at sexual maturity. Subsequent egg production by such hens is atypical with regard to quantity and quality and is consistent with the hens being hatched in a relative PR state and thus requiring prelay exposure to SDPP to obtain typical egg production. Long day photostimulation of hens at 16 wk of age did not induce subsequent egg production in experiment 1. This represents the earliest age of record for attempting to photoinduce egg production from turkey hens. Lewis and Morris (1998) provided a review of such data for turkeys. Our hens received SDPP from hatch to 16 wk of age, a time period well established to be sufficient for SDPP to remove PR and photosensitize turkey hens for subsequent photoinduced egg production. Giving SDPP from hatch has no precedence for turkeys and diminishes the possibility that juvenile PR is a consequence of very early age exposure to LDPP.

Table 2. Mean ± SEM for BW, onset of lay, and egg production for hens photostimulated early at 24 wk of age

<table>
<thead>
<tr>
<th>Age at photostimulation</th>
<th>n</th>
<th>BW at photostimulation (kg)</th>
<th>Mean days to 50% production</th>
<th>Cumulative eggs/hen from 24 to 60 wk</th>
<th>Weeks of photostimulation</th>
<th>Age (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>24 wk</td>
<td>36</td>
<td>10.8 ± 0.16</td>
<td>24.8 ± 1.0</td>
<td>91.9 ± 3.6</td>
<td>113.3 ± 4.4</td>
<td>113.3 ± 4.4</td>
</tr>
<tr>
<td>30 wk</td>
<td>20</td>
<td>12.8 ± 0.06</td>
<td>20.3 ± 1.3</td>
<td>95.2 ± 4.2</td>
<td>119.3 ± 3.4</td>
<td>95.2 ± 4.2</td>
</tr>
<tr>
<td>P ≥ F</td>
<td>0.0001</td>
<td>0.02</td>
<td></td>
<td>0.59</td>
<td>0.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>

1From day of photostimulation.
The hens did not lay eggs in response to photostimulation up to 16 wk of age, but because continuous LDPP-induced egg laying by control hens at about 22 wk of age and egg laying typically starts 2 to 3 wk after photostimulation, they can respond to LDPP, albeit partially, by about 19 wk of age. This is in agreement with Yang et al. (1999). Further, hens were fully photosensitive by 24 wk of age (experiment 2). Thus, photostimulating LW turkey breeder hens with LDPP at 24 wk of age resulted in egg production similar to that of hens conventionally photostimulated at 30 wk of age. Egg production started at 27 wk of age and this is considerably earlier than the onset of eggs at about 32 to 33 wk of age in conventionally light-managed hens. Notably, this occurred when photostimulation was initiated under conditions that optimized egg production such as season of the year (December), appropriate day length (16L:8D), and no feed restriction.

This is the earliest reported age at lighting for LW turkeys that has resulted in what would be considered a normal rate of egg production. Egg production by LW turkeys was also reported to be similar when photostimulation occurred at 26 and 30 wk of age (Siopes and Neely, 1997; Siopes, 1999). Woodard et al. (1974) and Hocking et al. (1988) photostimulated Medium White turkeys at 24 wk of age and recorded rates of egg production as good as that in conventionally lighted hens. Siopes (1992) reported that egg production periods of 20 wk were statistically similar between LW turkeys photostimulated at 24 and 30 wk of age. In all 3 of these reports, the rate of egg production was numerically lower for hens photostimulated at 24 versus 30 wk of age. This trend was noted in the review paper by Lewis and Morris (1998). In the present study, a similar response was noted for egg production based on weeks of photostimulation and likely this was a consequence of the delay in onset of lay of 4 to 5 d (Table 2). A delay in onset of lay is a consistent response among reports of early age at lighting of turkey hens (Lewis and Morris, 1998).

When egg production was evaluated on a hen-age basis, the benefits of early age at photostimulation were apparent. To 54 and 60 wk of age, hens in the present study lighted at 24 wk of age produced significantly more eggs than those lighted at 30 wk of age (18 eggs to 54 wk of age, Table 2). Clearly, an advantage of photostimulating hens early is more time in lay and, thus, more total eggs per hen to a given age. This occurs even though there is a delay in onset of lay associated with early photostimulation.

In the absence of prelay, exposure to SDPP partial photoresponsiveness (relative PR) occurs as indicated by the fact that some eggs can still be produced starting as early as 21 to 22 wk of age (experiment 1 controls on continuous LDPP from hatch) but always at much less than typical rates. Juvenile turkey hens clearly do not possess absolute PR and this has been noted in prior reports by Yang et al. (1999) and Siopes (2000). Therefore, some photoresponsiveness is present by about 19 wk of age; it is just not fully developed with continuous exposure to LDPP. This emphasizes the requirement for prelay SDPP exposure to terminate PR and fully photosensitize hens and to obtain normal subsequent LDPP-induced egg production. But the earliest age at which SDPP exposure accomplishes this has not been known. The present experiments support SDPP-induced photosensitization to be completed as early as 24 wk of age.

What is the earliest age to photostimulate hens with LDPP that results in typical egg production? Results of the present experiments suggest a physiological limit for managing egg production and somewhere between 16 and 24 wk of age seems to be the minimum age at which turkey hens can be photostimulated into a typical egg production period. Hocking (1992) reported lighting medium size turkeys as early as 18 wk of age. Even though the initial rate of lay was reduced, the total eggs to 54 wk of age was greater (by 14 eggs/hen), but settable eggs were reduced by about 5 eggs/hen, for hens lit at 18 versus 30 wk of age. From experiment 1 herein, it was clear that 8 and 16 wk of age was too early an age to induce egg production in LW hens with LDPP, even though the hens were previously exposed from hatch to periods of SDPP (8 and 16 wk) that are well established to be long enough to induce photosensitivity. This is not to suggest that the poor egg production response when photostimulation occurred at these early ages was not due to poor PR alone. Rather, it was likely that more development time (age) was needed for SDPP to induce photosensitivity (terminate PR).

From the foregoing information, it appears that some physiological development time beyond 16 wk of age is

### Table 3. Initial egg weights (mean ± SEM) and subsequent egg weight comparisons by week of photostimulation and by age for hens photostimulated early at 24 wk of age

<table>
<thead>
<tr>
<th>Age at photostimulation</th>
<th>Initial egg weight (g)</th>
<th>Photostimulation (wk)</th>
<th>Age (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 7 d&lt;sup&gt;1&lt;/sup&gt;</td>
<td>8 to 14 d</td>
<td>14 to 18</td>
</tr>
<tr>
<td>24 wk</td>
<td>73.0 ± 1.1</td>
<td>77.3 ± 0.8</td>
<td>75.6 ± 0.8</td>
</tr>
<tr>
<td>(n = 108)</td>
<td>(n = 138)</td>
<td>(n = 246)</td>
<td></td>
</tr>
<tr>
<td>30 wk</td>
<td>80.0 ± 1.4</td>
<td>82.7 ± 1.5</td>
<td>81.6 ± 1.4</td>
</tr>
<tr>
<td>(n = 54)</td>
<td>(n = 84)</td>
<td>(n = 138)</td>
<td></td>
</tr>
<tr>
<td>P ≥ F</td>
<td>0.004</td>
<td>0.006</td>
<td>0.002</td>
</tr>
</tbody>
</table>

<sup>1</sup>First 7 d of lay.
required for LW hens to have normal egg production in response to LDPP. This likely involves development time of SDPP-induced effects on neuroendocrine processes for maximizing photoresponsiveness. Therefore, the earliest age at which a hen may be able to be photostimulated into lay with LDPP may be dictated by the age at which SDPP mechanisms mature and become effective in fully photosensitizing her. We know from the present experiments that this has occurred by 24 wk of age and is associated with the onset of lay.

Dawson and McNaughton (1992) and McNaughton and Dawson (1992) reported that SDPP effects on terminating juvenile PR and photosensitizing starlings required a development time in the prepubertal period and was effective at and just after puberty. In experiment 2 of the present study, the hens were given SDPP at a time period entering and just after puberty. That is, the earliest eggs from turkey hens were about 22 wk of age (experiment 1) and SDPP were given in experiment 2 from 14 to 24 wk of age. It is well established that at least 8 wk of SDPP is required to fully photosensitize a turkey hen. Lighting with LDPP at 24 wk resulted in subsequent egg production that was similar to controls photostimulated at 30 wk of age.

Therefore, LDPP normal egg production in turkey hens requires a prior exposure to SDPP that a) is given for an appropriate time period and b) is given at, or after, an appropriate development time has occurred in juveniles. Short day length effectiveness in photosensitizing hens only occurs after some development time beyond 16 wk of age and this appears to be at, or near, the age at which she is first capable of laying an egg, that is, at puberty (21 to 23 wk of age).

In addition to quantity of eggs, a major reason turkey hens are not conventionally photostimulated at an earlier age than 29 wk has been the absence of data for obtaining normal quality eggs. This is particularly true with respect to the occurrence of small and abnormal eggs (Woodard et al., 1974; Hocking, 1992; Siopes, 1992; Siopes and Neely, 1997). Other issues include health concerns such as damage to the oviduct (prolapse) and mortality. Hocking et al. (1988) and Hocking (1992) noted that medium size turkey hens photostimulated at 18 or 24 wk of age had increased soft-shelled eggs at the start of lay and a similar response occurred for LW hens lighted at 24 wk of age (Siopes, 1992). There were no significant differences noted in abnormal eggs (conformity, soft-shelled, and cracked) between controls and hens photostimulated early in the present study. Likewise, there was no difference in livability or presence of oviduct prolapse.

For hens photostimulated early in experiment 2, eggs commenced by 27 wk and peaked at about 32 wk of age as compared with about 32 and 36 wk of age, respectively, for hens photostimulated at 30 wk of age. This age difference is very important for EW considerations. It is a well-established fact that EW of turkeys increases with age during the first egg laying cycle. Also, younger hens are smaller than older hens and the hens lighted at 24 wk of age in the present study were significantly smaller than those lit at 30 wk of age. Body weight can affect EW, but it has been shown by Woodard et al. (1974) and Siopes (1992) that reduced EW of hens photostimulated at an early age can occur in the absence of different BW. Multiple factors influence EW and the maturational status of the oviduct seems a likely factor in our results, particularly because it can dissociate from BW.

The most important consideration for egg quality in early lighting of hens is that EW be sufficient to be considered a settable (hatchable) egg. Although in the present study initial EW (73.0 g) was smaller for hens photostimulated early than controls (80.0 g), the weights were within a commercially acceptable range, particularly by the second week of egg laying (Table 3). By 36 wk of age, peak production for the controls, EW was similar between hens photostimulated at 24 and 30 wk of age (Table 3). Hocking (1992) reported that hens photostimulated at 18, 24, or 30 wk of age had similar EW when compared at the same age. Therefore, initial EW is smaller and marginally acceptable for hens photostimulated at 24 versus 30 wk of age because of the age factor. However, EW normalizes very fast and by the time (age) conventionally lit hens reach peak production, EW of hens photostimulated as early as 24 wk of age will be similar. Considering the advantage that early age lighting has on the number of eggs produced, one would likely have the option of culling some initial eggs, if necessary, and still have a net benefit. At the present time, we do not consider BW or age to be limiting factors to photostimulating turkeys at 24 wk of age.

It was concluded that LW turkey breeder hens can become sexually mature as early as 21 wk of age. Appropriate prelay SDPP exposure is required to fully photosensitize juvenile hens for photoinduced egg production and this requires a development time beyond 16 wk of age. Further, photostimulation of fully photo-sensitive hens for a typical egg production period can occur as early as 24 wk of age.

ACKNOWLEDGMENTS

This work is part of the USDA Multi-State Research Project S-1020, Enhancing Reproductive Efficiency of Poultry. The author acknowledges the excellent technical assistance of Vickie Hedgpeth (Department of Poultry Science, North Carolina State University).

REFERENCES


