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Effect of changing lighting programs at various ages on laying performance in turkey hens (*Meleagris gallopavo*) housed in cages or in floor pens

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Abstract : Laying performances of turkey hens, raised in cages or on conventional litter floor and photostimulated abruptly or progressively at ages varying between 29 and 34 weeks, were measured up to 57 weeks of age. The results indicated that more eggs were laid by hens maintained on the litter floor, but no significant increase over the number laid by those housed in cages could be detected. Similarly, while more eggs were laid at a given age by the hens photostimulated precociously, no significant differences in egg production were observed with respect to the age at photostimulation or the rate of increase in the length of the photoperiod. Alternately, a significant decline in the time interval between the initiation of photostimulation and the mean date of the first egg was found when photostimulation was applied at older ages. When photostimulated after 33 weeks of age, some hens even started to lay spontaneously. Pausing and definite disruption of reproductive activity in caged hens were related to the expression of broody behaviour and molting respectively. The occurrence of these events was associated with a decrease in egg production.

I- Introduction

Early studies demonstrated the stimulatory effect of artificial illumination on reproductive performance in turkeys (Albright and Thompson, 1933 ; Marsden, 1936). Thus, a uniform onset of reproductive activity and a high rate of lay can be obtained by restricted light during the growing period, followed by stimulatory lighting later on (Mc Cartney *et al.*, 1961 ; Woodard *et al.*, 1974). Current turkey management practice with medium size strains consists of photostimulation at around 30 weeks of age. However, data on the lowest critical age at which turkey hens can beneficially be given stimulatory light following a period of light restriction are contradictory (Mc Cartney *et al.*, 1961 ; Mc Cartney, 1971 ; Woodard *et al.*, 1974 ; Krueger *et al.*, 1982 ; Herron and Whitehead, 1985 ; Hocking, 1989 ; Noll, 1989). Similarly, the data on the reproductive performance of hens raised in cages or in floor pens respectively are contradictory (Woodard *et al.*, 1961; Logan, 1965 ; Thomason *et al.*, 1972).

We report here the reproductive performances of turkey hens, housed in floor pens or in cages, subjected to either abrupt or progressive photostimulation at ages varying from 29 to 34 weeks.

II- Material and Methods

An experimental flock of approximately 300 medium white turkey hens, of female breed, were provided by BETINA (France). They were housed in 5 rooms located in the same experimental unit. Sixty hens were housed in 5 litter floor pens (12 hens per pen). A pen measured 1.00m wide and 2.90m long and was equipped with four nests to which access was controlled automatically. The other hens were housed in individual cages located in the four other rooms. A cage measured 45cm wide, 60cm long and between 60 to 70cm high. Their floor, which had a slope of 17%, was composed of a wire structure coated with a plastic lattice 3,5cm wide and spaced 3,5cm apart.

Hens were exposed to a maximum light intensity of 10 lux. Light were on for 7 hours during a minimum of 14 weeks of the rearing period. They were transferred from the breeding barn at 29 and 30 weeks of age respectively. Thereafter, a lighting program of 14h light and 10h night (photoperiod : 3h00-17h00) was substituted abruptly at 29 (treatment 1 ; n=60 & treatment 2 ; n=23) or 30 weeks of age (treatment 3 ; n=24) (Table 1). Photostimulation was applied progressively between the 33rd and the 34th weeks of age (9h of light on day 1 ; 11h on day 4 ; 13h on day 6 & 14h on day 8) or abruptly at 34 weeks of age for the hens under treatments 4 (n=96) and 5 (n=88) respectively. The 14h photoperiod was maintained until hens were 48 or 49 weeks old and increased to 15 hours thereafter. The minimum light intensity was of 50 lux. Room temperatures were maintained at a minimum of 12° C. Food and water were provided *ad libitum* throughout.

Individual egg production and the age at the first egg were recorded over a period of 25 to 27 weeks for the hens housed in cages. Data from the hens which died during the experiment were not taken in consideration. Conversely, egg production and broodiness occurrence data were collected daily, food consumption weekly and body weight at 31, 38, 42, 47 and 56 weeks of age under treatment 1 (floor pen housed hens). Under this treatment, identification of the out of lay hens was carried out by oviducal palpation and measurement of the pelvic bone gap. Broody hens were identified by twice daily inspections of the nest (9h00 & 16h00). The broody management program consisted of automatic ejections from the nest only, with a maximum frequency of 14 ejections per day, from the fourth week of lay onwards. This procedure was previously shown to be as effective in maintaining egg production as nest ejections combined with either rotation of the flocks or isolation of the broody hens (Guémené, 1990). Caged hens were not treated for broodiness because the accuracy of detecting broody females in cages is questionable. It has also been reported (Zadworny, 1985) that cages are not conducive to broodiness, although observations in the present study indicate that this behaviour does, in fact, occur in a such environment.

Data on reproductive performances, and the intervals between photostimulation and the onset of egg-laying were analysed by analyses of variance.

III- Results

Data on the reproductive performances for all treatments are summarized in table 1. The variations in egg production, food intake, body weight and percentage of hens identified broody for the hens maintained on the litter floors (treatment 1) are shown in figure 1. The onset of egg production occurred during the second week of exposure to a stimulatory photoperiod when the hens were 31 weeks old. The peak of lay (68,3%) was attained between 2 and 3 weeks later. The percentage of hens which were identified as broody each week ranged from 5 to 10% from the 5th week of lay until the end of the experiment. The percentage of hens which were broody one or more times during the experiment was 27%. An increase in feed intake from 150 to 250g per day occurred during the 10 first weeks of egg production paralleled by a reduction in body weight to a minimum (7,8kg) when hens were 38 weeks old. Thereafter, feed intake remained stable and body weight increased to an average value of 10kg.

Table 1 : Reproductive performances of turkey hens, lighted at ages varying between 29 and 34 weeks, raised in litter floor pens (treatment 1) or in cages (other treatments)

(1) The interval measured for hens which had started laying before or in the week following photostimulation were not taken in consideration

(2) Interval between first increase in photoperiod and first oviposition

	Floored pen	Cage				ANOVA
Treatment	1	2	3	4	5	
Number of hens (n=)	60	23	24	96	89	
Mortality (n=)	4	1	1	4	4	
Experimental Unit	pen	hen				
Age at transfert (weeks)	29	29	30	29	30	
Age at lighting (days)	206	206	213	235-242	242	
Photoperiod	14	14	14	9h at 235d	14	
Lighting - 48 w. age				11h at 238d		
				13h at 240d		
				14h at 241d		
48 w. age - end	15	15	15	15	15	
Age at 1st egg (days)		227,7±5,2	238,2±3,2	251,2±5,6	258,0±4,1	p<0,001
Interval (lighting-1st egg) (1)		21,7±5,2	19,8±3,2	16,2±5,6 (2)	16,0±4,1	p<0,001
No. of eggs						
at 57 weeks of age	88,5±7,0	82,7±24,8	81,6±24,2	74,5±21,3	79,0±17,7	p=0,20
24 weeks after lighting	80,0±6,3	75,0±19,2	74,7±19,9	74,5±21,3	80,6±18,6	p=0,30
after 25 weeks of lay	84,5±6,6	79,2±21,9	79,5±22,7	74,5±21,3	80,6±18,6	p=0,35
No. of out of lay hens at 57 weeks of age (%)	14,4	39,1	33,3	28,3	31,5	
No. of broody (treat. 1) or pausing hens (treat. 5) (%)	26,7				18,0	

The reproductive potential of turkeys was maximized on conventional litter floor in the present study. 88,5 eggs per hen were laid at 57 weeks of age. In addition, more eggs were laid at a given age by the hens which were photostimulated precociously (Table 1). Nevertheless, no significant effect of housing conditions nor of the age at photostimulation were found with respect to overall egg production, neither at 57 weeks of age nor after 25 weeks of egg production nor 24 weeks after photostimulation (Table 1, Figures 2 &3). In fact, maximum and equal number of eggs were laid 24 weeks after photostimulation under treatments 1 and 5. Increasing the daylength gradually prior to sexual maturity did not result in increased egg production (Table 1, Figures 2 &3).

Figure 1: Variation in egg production, feed intake, index of broodiness and body weight during the productive period of hens housed in floor pens.

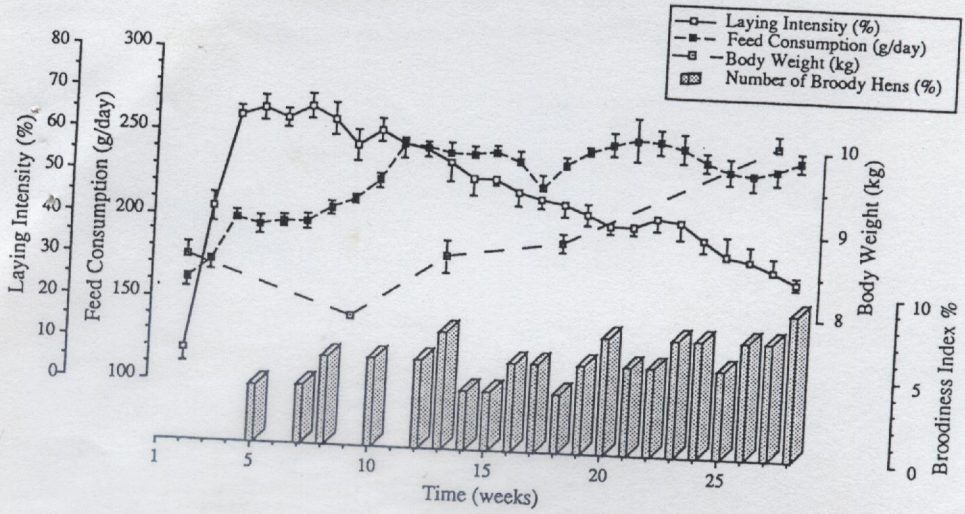


Figure 2 : Variation in laying intensity of turkey hens, photostimulated at ages varying between 29 and 34 weeks, housed in floor pens (treatment 1) or in cages (other treatments).

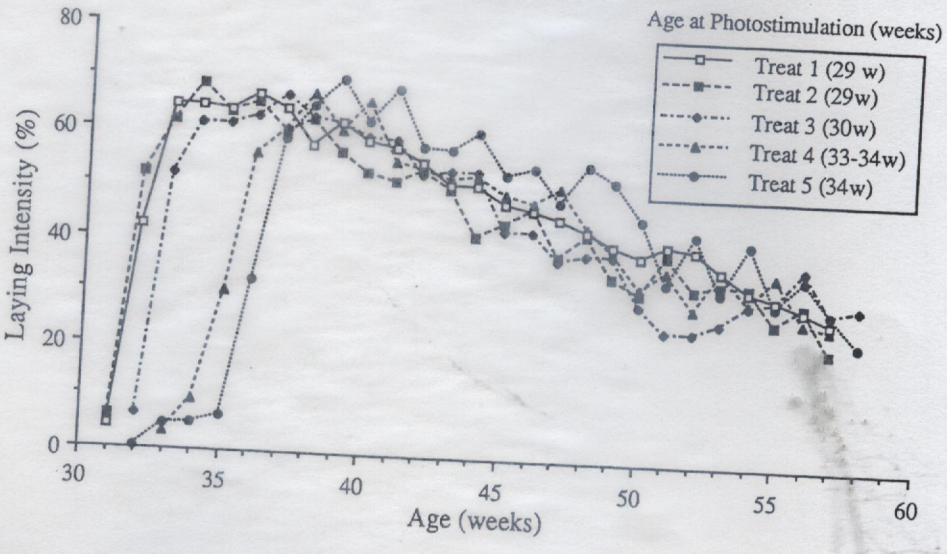


Figure 3 : Cumulative average number of eggs produced by turkey hens housed in floor pens (treatment 1) or in cages (other treatments) and photostimulated at ages varying between 29 and 34 weeks. Lengthening of the photoperiod occurred on week 0.

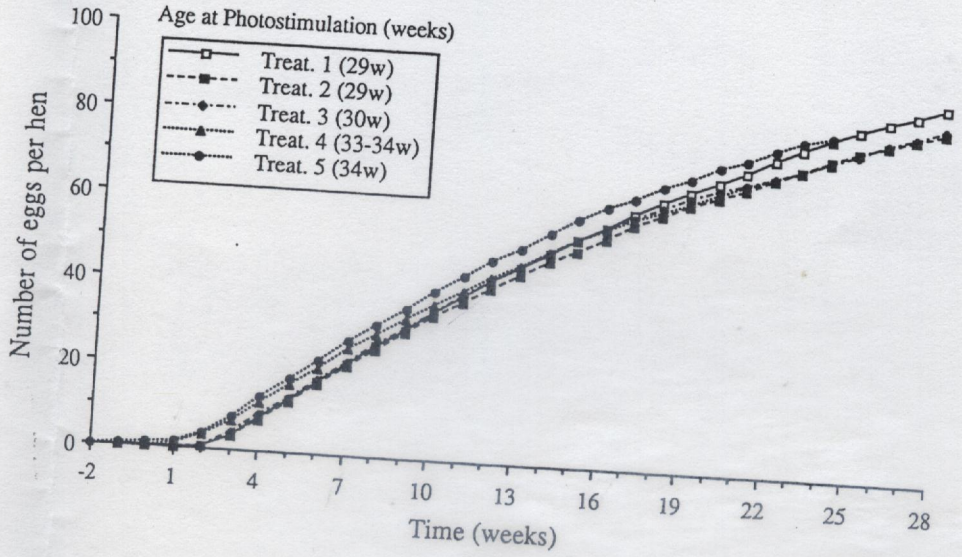
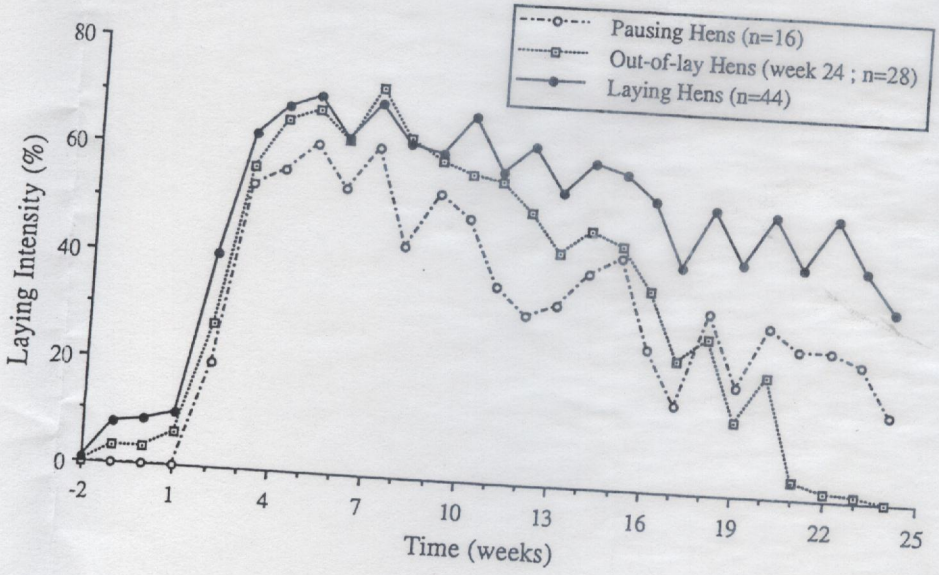


Figure 4 : Variation in the laying intensity of turkey hens which laid throughout the experimental period, paused or definitively stopped egg production.



A number of hens started to lay before or during the week of photostimulation under treatment 5 (n=12) and, to a lesser extent, under treatment 4 (n=9). In the turkey hen, the recrudescence of the yolk-filled hierarchy of follicles requires about 12 days for completion (Haller and Cherms, 1961 ; Nestor *et al.*, 1970). Data from the hens which started laying before or during the 7 days following photostimulation were therefore not taken in consideration for the calculation of the lag between the age at photostimulation and the laying of the first egg. However, delaying photostimulation resulted in a significant shortening ($p<0,001$) of lag to the laying of the first egg (Table 1). Hens photostimulated at 34 weeks of age started to lay some 5.7 days earlier than hens photostimulated at 29 weeks of age (16,0 vs 21,7 days after photostimulation).

As birds aged, more of the caged hens went out of lay, but the incidence did not appear to bear any relationship to the age at photostimulation (Table 1). The individual egg production figures of hens under treatment 5 were analysed further to determine partial or definite cessation of lay (Figure 4). A partial cessation or pause in egg production is defined as a cessation of lay for a period of 7 or more consecutive days (Woodard *et al.*, 1974). The percentage of hens pausing during the experimental period, the mean duration and the mean occurrence of this event were 18% (n=16), 15,6 days and 1,7 times respectively. Hens displaying pauses laid approximately 31 fewer eggs than comparable hens which showed no pause in laying (60,1±19,9 vs 91,1±10,8). On the other hand, twenty eight hens which disrupted laying activity before the end of the experiment, were identified as "out of lay" hens. These definite disruptions were generally associated with moulting. These hens laid (64,4±18,5) eggs per bird, that is to say 26,7 fewer than those which remained in lay.

IV- Discussion

The results observed for the hens raised in the litter floor pens were quite coherent for the breed used in this study and the changes in the various criteria were comparable with previous reports (for review, Whitehead, 1989). The finding in this work, concerning egg production in cages versus floor pens contrast with those of Woodard *et al.* (1961) and Logan (1965) who showed that turkey hens kept in cages laid more eggs than did birds kept in floor pens, but that they also laid many more soft-shelled eggs (Woodard *et al.*, 1961). Conversely, Thomason *et al.* (1972) found no differences in egg production, egg weight, feed consumed per bird and per egg. Selection for increased growth in turkeys resulted in a greater incidence of follicles developing as pairs (Nestor *et al.*, 1970, 1980 ; Bacon *et al.*, 1972) and consequently resulted in a high incidence of double ovipositions. The second egg, which generally has a defective shell is often eaten if not promptly collected (Hocking, 1989). Therefore, the difference in egg production of the birds raised in cages and on the floor may be partially due to the accidental loss of a number of soft eggs.

Although, more eggs were laid at 57 weeks of age when the hens were photostimulated earlier, no significant effects were found. This lack of a significant effect of the age at photostimulation on reproductive activity differs from the reports of Herron and Whitehead (1985) and Hocking (1989) who recently reported beneficial effects of early photostimulation on egg production. On the other hand, Mc Cartney *et al.* (1961), Mc Cartney (1971), Woodard *et al.* (1974) and Krueger *et al.* (1982) did not find any beneficial effects. In

addition, exposing turkey hens at an early age to long days results in a hight percentage of non-layers (Wilson *et al.*, 1962) and in an increase in the occurrence of "twin follicles" (Hocking *et al.*, 1988), whereas a larger egg size can be obtained by delaying the onset of sexual maturity (Sexten and Mc Cartney, 1972 ; Woodard *et al.*, 1974). Also a quicker onset of lay was obtained with turkey hens given stimulatory light at an older age and some hens even started to lay spontaneously. Thus, stimulation of reproductive activity cannot be fully accounted for by the lengthening of the photoperiod. This phenomenon may cause management problems in connection with artificial insemination procedure. Therefore, any definition of the lowest age at which turkeys can beneficially be given stimulatory light must take various criteria into account such as number of settable eggs, fertility, hatchability and feed efficiency.

We did not observe any significant difference in gradually increasing the photoperiod from 7 to 14 hours, over an abrupt change at the desired time with respect to egg production. Similar observations were reported by Asmundson and Kratzer, (1951), Mc Cartney *et al.* (1961), Mc Cartney *et al.* (1971) and Bacon and Nestor (1977) whereas in contrast, Marsden *et al.* (1962) found that better performance was obtained with gradual increases. These differences in response may be related to the range of ages at which the hens are stimulated. Another factor, which is more likely to have an influence is the difference in the strains of turkey hens used in the various studies.

We observed pauses in lay of long duration as well as the definite disruption of lay under our experimental conditions. Definite disruption of lay was generally associated with moulting whereas partial pauses may be linked to the occurrence of broodiness. The changes in the laying curve for these pausing hens are typical of flocks which have not been fully treated for broodiness (Nixey, 1978). Moreover, the expression of some typical broody symptoms (Guémené and Etches, 1989) were observed in some of the hens kept in cages. The difference of 31 eggs between hens showing pauses and those showing no pause is comparable to the number reported by Woodard *et al.* (1974) (27.5) but somewhat greater than the 20 egg difference between non-broody and broody hens by Nixey (1973). It is interesting to note that the number of pausing hens is lower than the overall number of hens which were identified broody at least once in floor pens. However, hens can lay eggs while expressing broody behaviour (Guémené and Etches, 1989) and we cannot exclude that such a juxtaposition occurred in caged hens. It is thus difficult to conclude as to the relative importance of broodiness expression in cages. This study shows however that expression of this behaviour is not uncommon in cages, which contradicts Nixey (1973) and Zadworny (1985) who reported that confinement of hens in cages greatly inhibits its expression.

In conclusion, under the conditions of this study, there were no significant effects of the housing conditions and of the age at photostimulation with regard to egg production. Nevertheless, further investigations are needed in order to ascertain, in particular, the effect of the age at photostimulation and the occurrence of broody behaviour in cages.

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EFFET DE L'AGE A LA PHOTOSTIMULATION SUR LES PERFORMANCES DE PONTE DE DINDES *(Meleagris gallopavo)* ELEVEES AU SOL OU EN CAGE-BATTERIE

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Résumé : Les performances de ponte de dindes, élevées en cage-batterie ou sur litière et photostimulées à des âges compris entre 29 et 34 semaines, ont été mesurées jusqu'à 57 semaines d'âge. Un plus grand nombre d'œufs a été pondu par les dindes élevées au sol, toutefois aucune différence significative avec les perfomances de celles élevées en cages n'a été mise en évidence. En outre, aucune différence significative en fonction de l'âge à la photostimulation et de son mode d'application n'a été mesurée dans nos conditions expérimentales. Par contre, une décroissance significative du délai entre la stimulation et la ponte du premier œuf est observée lorsque la photostimulation est appliquée plus tardivement. Certaines dindes ont d'ailleurs pondu spontanément lorsque la photostimulation a été appliquée au-delà de 33 semaines d'âge. Les arrêts de ponte temporaires et définitifs, observés chez certaines des dindes élevées en cages, sont généralement associés à l'expression du comportement de couvaison et à la mue. Leurs manifestations sont à l'origine d'une décroissance des performances globales du troupeau.

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Effects of individual body weight and of feed intake on the performance of dwarf broiler breeders and of their progeny

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Abstract

Four hundred and eight dwarf broiler breeder hens were divided into four groups of heavy, medium, light and ultralight body weight and each group was subjected to liberal, intermediate or severe feed restriction during the breeding period. The body weight was little affected by the level of restriction but egg production decreased when hens were severely restricted. Fertility and hatchability were impaired when hens ate a larger amount of food. Shell quality was unaffected by food intake. Egg weight and one-day old chick weight were higher in the heavier hens fed an enhanced amount of food. This positive effect was also observed at 6 weeks of age. Tibial ossification at 1 day and 6 weeks of age increased in broilers in proportion to the weight of the breeder hens and to the amount of food fed to these hens.

Introduction

Feed supply is restricted in broiler breeders during rearing to reduce body weight and fatness, and to improve subsequent breeding performance (Lee *et al.*, 1971). Feed restriction is maintained during the breeding period to enhance fertility (Mc Daniel *et al.*, 1981) but has to be applied carefully as over-restriction can decrease egg production (Leclercq, 1986). Quantitative feed restriction during rearing may reduce the uniformity of the flock due to competition for feed. The consequences of variation in the body weight of mature breeder hens on the performance of broiler breeders and of their progeny have scarcely been studied. Moreover, the question arises of how best to adjust the feed intake during the laying period to the individual body weight at sexual maturity. The purpose of the present study was to investigate the consequences of individual body weight fluctuations in a flock at sexual maturity and of the degree of feed restriction during the laying period on the subsequent performance of broiler breeders and their progeny.

Material and Methods

Four hundred and eight dwarf broiler breeder hens were caged individually from 23