CHAPTER 2

Changing photoperiod and first and second cycles of egg laying: Influence of step-down photoschedule (LD 18:6 to LD 12:12) in pullets and adults of RIR breed.

Introduction

Though cross breeding and selection procedures have resulted in the generation of better genetic breed of poultry birds, the many qualitative and quantitative traits, like growth, sexual maturation, initiation of egg laying, the duration of egg laying and the number of eggs laid, are not realised to the full genetic potency. This is mainly due to the epigenetic effects of various environmental factors. Epigenetic effects of nutrition, management techniques, humidity, light and temperature have all been recognized to influence poultry productivity. Feed management and nutritional manipulation have been shown to influence poultry productivity (Dunn *et al.*,1990; Sandoval and Gernat, 1996). Photoperiod has also been recognized as an important environmental variable, in poultry breeding and rearing, from the many experimental evidences available.

Absolute photoperiod is of lesser importance in the domestic hen as ovarian development and sexual maturity have been shown to occur at the

same age, regardless of the duration of photoperiod, under widely different lighting regimens (Lewis *et al.*,1994). Earlier studies have shown that exposure of laying hens to shortened photoperiod results in reduced egg production (Sykes, 1956; Hutichson and Taylor, 1957; Morris *et al.,* 1964). Age at first egg (AFE) was shown to be advanced or delayed when growing pullets are exposed to an increased or decreased photoperiod respectively (Morris, 1968). These were later related to the size and timing of change in photoperiod (Morris, 1963; Lewis *et al.*, 1992). Sexual maturity has been shown to be delayed when pullets are reared under 6h or 18h of photoperiod from day one, compared to a rearing photoperiod of 10h (Morris, 1967). The sexual response of the domestic hen to changes in photoperiod has been related with age and, Morris (1968) demonstrated greater responsiveness closer to sexual maturity. Sexual maturity was delayed in pullets reared under normal or long days as against short days (8h light/day) (Payne, 1975; Proundfoot, 1980; Renden and Oates, 1989). It was also inferred that the sensitivity of hens to changes in photoperiod is variable in terms of photoperiod or age, as changes made between 8-16h proved to be more potent than changes outside this range, and effectiveness of photoperiod was better manifested at ages relatively ahead of sexual maturity (Morris, 1963; Lewis *et al.*,1992).

Studies on photoperiodic manipulations in the domestic hen have been carried out mostly on breeds in the temperate countries, but, none on breeds of tropical countries. The Indian RIR breed has been raised specifically for better temperature resistance by a cross between the original RIR breed and the Indian Kalinga brown breed (as per poultry records). A related study on exposure of pullets to an initial short photoperiod, recorded better reproductive potential and laying performance (Dandekar,1998). The objective of the present study, is to evaluate the

effect of, rearing pullets of RIR breed (dual purpose breed for egg and meat) on a long photoperiod of L:D 18:6, from day one till 90 days of age and, then shifting them to natural photoperiod, on growth and various parameters of laying performance, as compared to pullets reared throughout under natural photoperiod. The second objective was to evaluate the effect of a similar photic manipulation in adult hens, from 72 weeks to 76 weeks of age (starting from the last week of first lay), on the performance of second lay as, studies are sparse with regard to second lay barr, management practice of induced moulting by starvation (Clarke *et al.*, 1992).

Materials and methods :

As detailed in chapter 1

Results :

Set-up I :

Body weight and duration of egg laying :

The body weight of pullets reared under LP was only marginally higher compared to the control birds at all age, though there was more noticeable difference at 60 days (Table 1a). The control hens commenced egg laying by 178 days (approximately 6 months) while, the LP hens started egg laying by only 206 days (approximately 7 months). Cessation of egg laying occurred at 530 and 512 days in the two groups, with an effective duration of egg laying of 352 and 306 days respectively (Table 1b) (fig. 1 & 2a).

Number, weight of eggs and rate of lay :

The control hens laid a total of 168 eggs/hen as against 156 eggs/hen by the LP hens. The average number of small eggs (< 40 gms) laid by the control hens was 16/hen while it was only 8/hen in the LP hens. The effective lay as represented by average sized eggs (40 gms and above) obtained by subtracting the number of small eggs from the total number, was 152 and 148 eggs/hen respectively. The control hens laid at a rate of 0.47 eggs/hen/day with an average between egg duration of 50 hrs; in the LP hens the same were 0.51 eggs and 47 hrs respectively (Table 2a) (fig. 2b). The overall average weight of eggs was 46.6 in the control group and 47.80 in the LP group (Table 2b).

Monthly variation in first lay : Table (3 a,b,c) (fig. 3a,b)

The average monthly egg yield was significantly greater in the LP hens during the first 7 months, with maximally greater difference manifested during the first 4 months. The NLD hens yielded the largest average monthly clutch size of three, only during the second month while, the LP hens yielded average monthly clutch size of three or above during the first three months (fig. 4, 5a,b). In terms of the number of clutches of various sizes (Table 4), the NLD hens laid the largest clutch size of 5 eggs during the second month. Clutches of 4 and 3 eggs were laid till the sixth and the ninth month respectively while, clutches of 2 and 1 eggs were laid throughout. The LP hens also showed a similar trend, except for the largest clutch size of 6 eggs during the second month and, of 5 eggs during the first and the second months. A comparative account of the monthly rate of lay (table 5a), reveals a maximum rate of 0.66 and 0.61 eggs/hen/day at an egg interval of 36 hrs and 39 hrs in NLD hens during the second and fourth months respectively and, a maximum rate of 0.78,

Table **1 a.** Body weight gain upto 180 days (6 months) in NLD and LP pullets.

	30 d	**60 d**	**90 d**	**120 d**	**150 d**	**180 d**
NLD	117.2 ± 16.33	312.85 ±18.22	600.00 ±16.32	852.80 ±20.05	1020.8 ±23.65	1140.20 ±25.43
LP	120.0 ±14.14	386.6** ±4.71	610.10 ±21.21	916.0* ±13.8	1075.0 ±19.07	1170.1 ±15.39

Values : Mean ± SE * P<.05, ** P<.005, *** P<.0005

Table **1 b.** Age at initiation, termination and total days of egg laying in NLD and LP birds.

	Initiation (days)	**Termination (days)**	**Effective days of lay**
NLD	178.34 ±4.32	530.65 ±5.76	352.36 ±4.53
LP	206.68*** ±3.98	512.32* ±4.85	306.21*** ±4.11

Values : Mean ± SE * P<.05, ** P<.005, *** P<.0005

Table **2 a.** Laying performance during first lay in NLD and LP birds.

	Total no. of eggs/hen	**Total number of small eggs/hen**		**Total no. of effective eggs/hen**	**Rate of lay**	
		number	**%**		**eggs/day**	**mean oviposition interval in hrs**
NLD	168.47 ±3.76	16.25 ±2.43	9.5	152.22 ±2.86	0.47	50
LP	156.71* ±4.01	8.3** ±.87	5.1	148.41 ±3.89	0.5	47

Values : Mean ± SE * P<.05, ** P<.005, *** P<.0005

Table **2 b.** Mean monthly and average egg weight in NLD and LP birds.

months	NLD	LP
1	42.20 ± .33	43.61 ± .52*
2	44.46 ± .54	45.42 ± .28*
3	44.92 ± .34	46.56 ± .27**
4	44.08 ± .38	45.30 ± .29
5	44.16 ± .44	46.39 ± .80**
6	46.18 ± .76	45.17 ± .49
7	45.48 ± .39	46.96 ± .34*
8	45.90 ± .39	48.14 ± .31**
9	45.28 ± .52	49.04 ± .42***
10	45.90 ± .25	50.44 ± .88***
11	45.66 ± .25	-------
12	48.06 ± .26	-------
Overall egg weight.	51.71 ± .79	47.81 ± .94**

Values : Mean ± SE * P<.05, ** P<.005, *** P<.0005

Table **3 a.** Average monthly total number of eggs in NLD and LP birds.

	1	2	3	4	5	6	7	8	9	10	11	12
NLD	15.55 ±1.29	20.0 ±0.81	14.75 ±.35	18.25 ±1.70	16.00 ±.83	13.25 ±1.25	13.75 ±.95	15.20 ±2.06	14.00 ±1.40	12.5 ±.57	9.57 ±.50	3.25 ±.53
LP	21.33*** ±.57	21.82 ±.63	21.67*** ±.39	18.60 ±1.10	15.28 ±.48	16.70* ±.39	11.59* ±.47	12.01 ±.23	9.41*** ±.72	5.03*** ±.82	1.02*** ±.08	--

Table **3 b.** Average monthly total number of clutches in NLD and LP birds

	1	2	3	4	5	6	7	8	9	10	11	12
NLD	8.0 ±.60	6.5 ±.57	6.75 ±.50	7.0 ±.80	6.75 ±.50	7.25 ±.50	10.0 ±.81	11.0 ±.81	9.25 ±.95	8.00 ±.81	8.75 ±.95	3.25 ±.50
LP	7.01 ±.30	6.66 ±.577	6.66 ±.52	7.07 ±1.01	8.33 ±1.15	7.66 ±1.52	9.66 ±.57	9.33* ±.50	9.66 ±.577	7.66 ±.70	1.00*** ±.004	--

Table **3 c.** Average monthly clutch size of NLD and LP birds.

	1	2	3	4	5	6	7	8	9	10	11	12
NLD	1.93 ±.16	3.07 ±.34	2.18 ±.21	2.60 ±.24	2.37 ±.10	1.80 ±.24	1.36 ±.04	1.39 ±.27	1.52 ±.24	1.56 ±.12	1.11 ±.13	1.0 ±.006
LP	3.04*** ±.08	3.54 ±.21	3.26* ±.34	2.69 ±.55	1.81* ±.28	2.20* ±.34	1.20 ±.10	1.27 ±.11	0.96*** ±.05	0.65*** ±.05	0.25*** ±.001	--

Values : Mean ± SE * P<.05, ** P<.005, *** P<.0005

Table 4. Monthly variation in the average number of clutches of various sizes laid by in NLD and LP birds.

No of Months.		Clutches of various sizes.					
		1	2	3	4	5	6
1	NLD	3.5 ±1.29	1.75 ±0.5	2.0 ± 0.81	0.5 ±0.18	-----	----
	LP	---	3.3±1.15**	1.05± 0.69	1.66 ±0.52*	0.66 ±0.08	----
2	NLD	1.25 ±.95	1.0 ±.21	1.75 ±.75	2.25 ±.5	1.25 ±.22	----
	LP	----	0.33 ±0.08	3.00 ±0.92	2.66 ±0.57	0.37 ±0.14**	0.66± 0.12
3	NLD	1.75 ±.50	1.78 ±.50	1.83 ±.80	1.00 ±.09	----	----
	LP	.33 ± .09**	2.01 ±0.69	1.66 ±0.54	3.01 ±0.68*	----	----
4	NLD	0.25 ±.05	3.75 ±.5	2.25 ±.78	.50 ±.13	----	----
	LP	0.33 ±0.10	5.66 ±0.68	2.33 ±0.57	----	----	----
5	NLD	0.50 ±.01	3.5 ±1.29	2.16 ±1.5	.50 ±.08	----	----
	LP	1.66 ±0.58	4.33 ±1.52	1.33 ±0.57	0.33 ±0.07	----	----
6	NLD	3.0 ±1.82	2.25 ±1.2	1.25 ±.30	.50 ±.11	----	----
	LP	3.66± 1.31	4.66 ±1.63	0.66 ±0.17	0.66 ±0.20	----	----
7	NLD	6.5 ±1.29	2.75 ±.5	.50 ±.05	----	----	----
	LP	7.42 ±1.68	2.14 ±0.93	----	----	----	----
8	NLD	6.5 ±2.38	3.75 ±1.5	.25 ±.01	----	----	----
	LP	7.33 ±1.52	2.04 ±0.79	0.33 ±0.07	----	----	----
9	NLD	4.2 ± 2.21	4.75 ±1.2	.25 ±.01	----	----	----
	LP	6.33 ± 0.57	1.01 ±.43*	0.33 ±0.06	----	----	----
10	NLD	4.0 ±1.15	4.25 ±0.5	----	----	----	----
	LP	3.00± 0.28	1±.03***	----	---	----	----
11	NLD	8.25 ±1.5	.75 ±.15	----	----	----	----
	LP	1±.09***	----	----	----	----	----
12	NLD	3.0 ±.81	----	----	----	----	----
	LP	----	----	----	----	----	----

Values : Mean ± SE, n=12 ,* P<.05, **P<.005, ***P<.0005.

Table **5 a.** Average monthly rate of lay in NLD and LP birds.

Months.	Mean monthly oviposition interval in hrs.		Eggs /Day.	
	NLD	LP	NLD	LP
1	46	33.6	0.51	0.71
2	36	30.2	0.66	0.78
3	49	33.12	0.49	0.72
4	39	38.4	0.6	0.62
5	44	46.8	0.53	0.51
6	54	43.2	0.44	0.55
7	52	61.68	0.45	0.38
8	47	60	0.5	0.4
9	51	77.04	0.46	0.31
10	57	144	0.41	0.16
11	73	720	0.32	0.03
12	221	---	0.1	---

Values : Mean

Table **5 b.** Average egg yield at different hen ages in NLD and LP birds.

	Hen ages (from the day of hatch)	**Average number of eggs**	
		NLD	**LP**
1	208	15.5	--
2	237	35.5	21.33
3	267	50.25	44.99
4	297	68.5	66.65
5	327	84.5	85.31
6	351	97.75	100.64
7	387	111.5	117.3
8	417	126.7	128.96
9	447	140.7	140.96
10	477	155.2	150.29
11	507	164.95	155.29
12	537	168.20	156.29

Values : Mean

Table 6. Second cycle laying performance in NLD and LP hens.

	Total no. of eggs/hen	rate of lay eggs/month	av. egg weight in gms.	total period of lay	effective lay
NLD	96.02 ± 3.57	8.9	48.79 ±3.87	11 m	9 m
LP	79.39* ±4.79	7.9	50.68 ±4.42	10 m	8 m

	monthly rate of lay (eggs/month)	trailing rate of lay		
		9 months	10 months	11 months
NLD	10.2 (upto 9 m)	-----	0.1	0.03
LP	9.3 (upto 8 m)	0.1	0.06	-----

Table 7. Comparative projection of total amount of feed consumed/bird till the end of lay and feed/dozen eggs.

	Govt. Poultry.	Present experimental regimen.	
		NLD	LP
Total no. of days.	530	530	511
Total feed/bird in Kg.	63.5	51.18	48.75
Difference			
Govt. Vs NLD	----	12.32 (19.4%)	
Govt. Vs LP	----	----	14.75
NLD Vs LP	----	----	2.43
Feed/dozen eggs.	4.23 Kg.	3.65 Kg.	3.75 Kg.

Months from IL	Total feed consumed in Kg.		Feed consumed (kg./dozon eggs)	
	NLD	LP	NLD	LP
7	24.247	24.23	2.603	2.470
8	27.540	27.650	2.608	2.570
9	30.84	30.95	2.630	2.63
10	34.14	34.25	2.639	2.73

Values : Mean

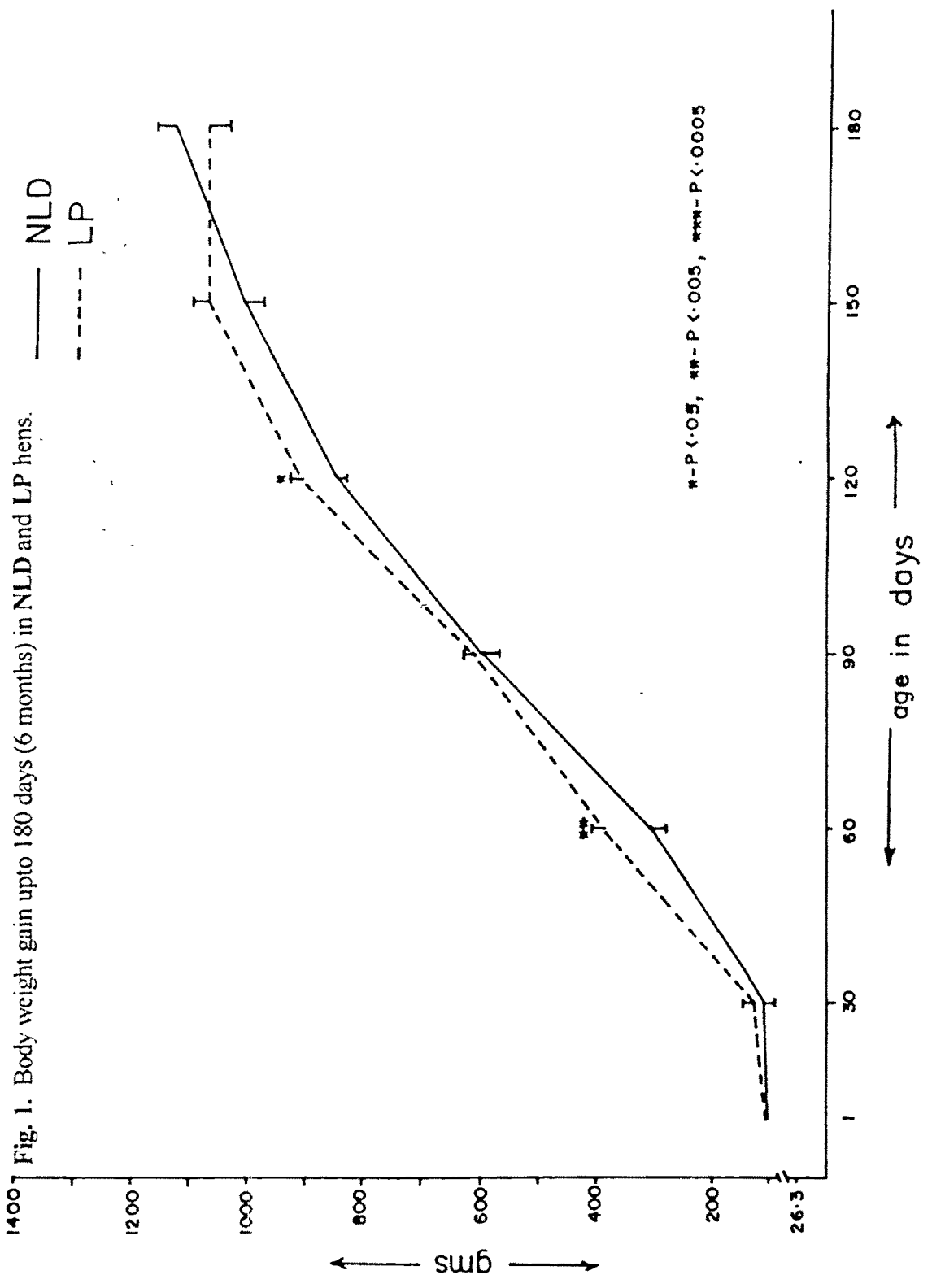


Fig. 1. Body weight gain upto 180 days (6 months) in NLD and LP hens.

Fig. 2. Figure showing initiation, termination and effective days of egg laying (A) and egg laying performance (B), of NLD and LP hens.

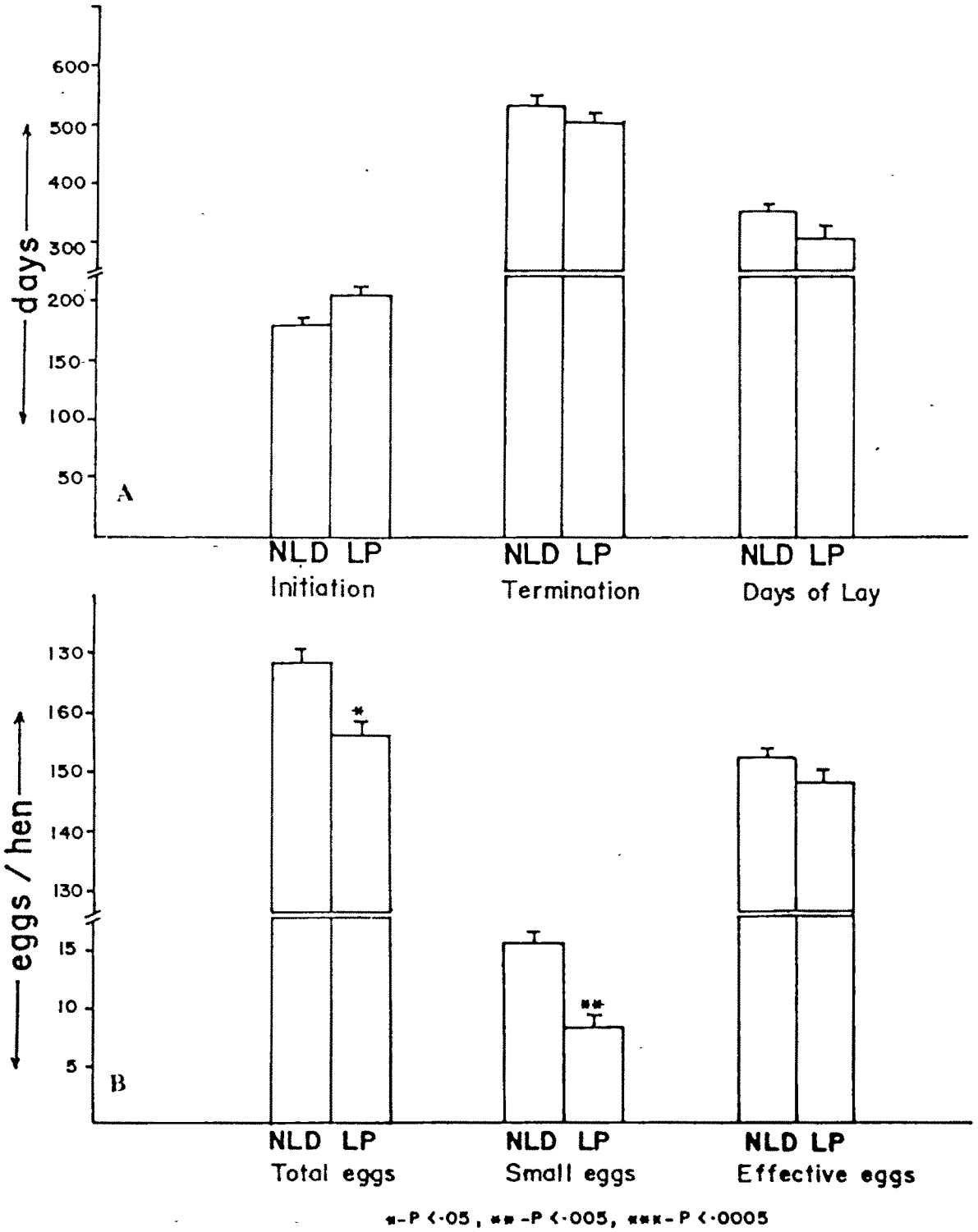
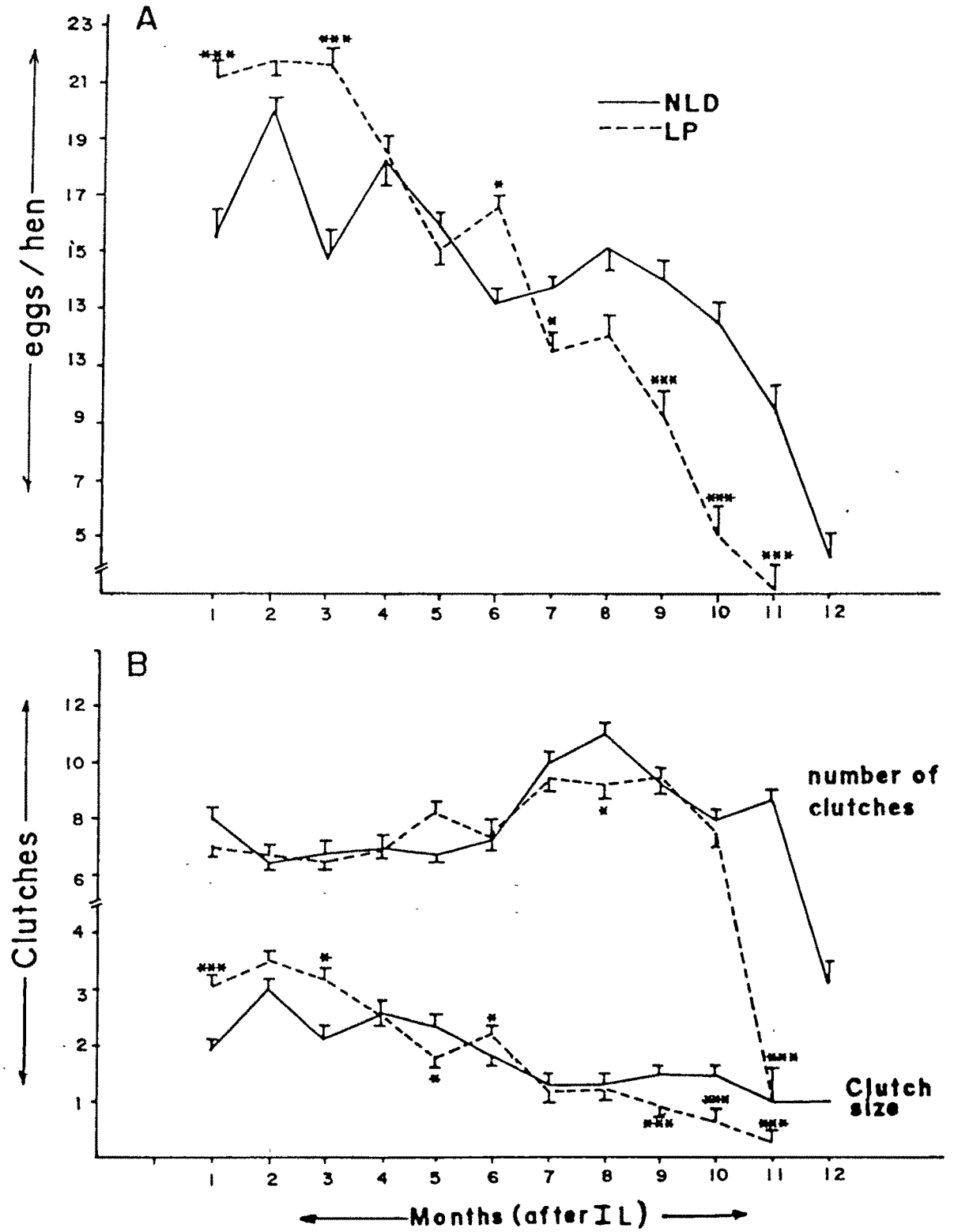


Fig. 3. Number of eggs laid/hen/month (A), number of clutches and clutch size (B) laid by NLD and LP hens.



0.72 and 0.71 eggs/hen/day with an egg interval of 30.2, 33.2 and 33.6 hrs in the LP hens during the second, third and first months respectively. The minimal rate of lay was 0.32 eggs/hen/day at an egg interval of 73h in NLD, and 0.31 eggs/hen/day at an egg interval of 77 h in LP hens.

Set-up II :

The laying performance of adult hens of 72 weeks of age maintained under L:D 12:12 or L:D 18:6 for one month (till 76 weeks) and then shifted to normal ambient photoperiodic condition is given in table 6. The NLD hens laid an average of 96 eggs/hen with an average egg weight of 48.79 gms during 11 months at an average rate of 8.9 eggs/month while, the LP hens laid an average of 79 eggs with an average egg weight of 50.68 gms during 10 months at an average rate of 7.9 eggs/month. The effective period of lay was however only 9 months in the NLD hens with an average rate of lay of 10.2 eggs/month and a trailing lay rate of 0.1 and 0.03 eggs during tenth and eleventh months and, only 8 months in the LP hens with an average rate of lay of 9.3 eggs/month and a trailing lay rate of 0.1 and 0.06 eggs during the ninth and tenth months (Table 6).

Discussion :

The general poultry practice in India is to rear the chicks from the day of hatch till eight weeks on continuous lighting and then strictly under natural light during the growing period. This is followed by shifting the birds to laying house and maintaining them under 16 h of light from 20 weeks onwards with a further increase of one hour after 6 months of lay. No studies involving photoperiodic manipulations have ever been carried out to assesses the egg laying performance under Indian conditions.

First lay :

The present results show that IL (age at first egg) was significantly delayed (by 28 days) in pullets maintained under LP compared to those maintained under NLD. Whereas the NLD pullets started IL by the end of sixth month, the LP birds started IL by the end of seventh month. Termination of egg laying however occurred earlier in LP birds than in NLD birds (512 Vs 530 days), with a significant reduction in the effective number of days of lay (by 46 days). The delay in IL by 28 days seen in the present study in Indian RIR breed compares similar to the delay seen in ISA Brown and Shaver 288 breeds by 22 or 16 days when the photoperiod was reduced by 5 hrs from 13 to 8 hrs, at 84 days or, 119 days respectively (Lewis *et al.*, 1996 b). Though laying performance has also been related to feeding schedules (Charles and Tucker, 1993; Lewis *et al.,* 1996 a,b,c), the presently observed delay in IL is clearly due to photoperiod alone as, quantum of feed allotted was the same in both groups of birds. The total egg output by the LP birds was 8% less ($P< 0.005$) than the NLD birds. However, due to the shortened period of lay, the per day per hen yield and, the between egg interval, were both better by 7%. A further aspect of qualitative improvement was the fewer number of small eggs (<40 gms) laid by the LP birds compared to the NLD birds (5 Vs 10%). In terms of rate of lay and, the effective lay (based on the number of eggs of 40 gms and above), the Indian RIR breed seems to show a positive response to an approximate 5 h reduction in photoperiod, from 18 h, which is in quite contrast to the negative response shown by ISA Brown and Shaver 288 breeds (Lewis *et al.,* 1996 b).

Whereas Lewis et al. (1996 c) recorded significant increase in body weight in both ISA Brown and Shaver 288 breeds when the photoperiod was changed from 13 h to 8 h at 119 days, but not at 84 days, and an increase only in ISA Brown when the photoperiod was reduced from 18 h to 13 h at 84 days, in the present study, the LP birds on shifting to a reduced photoperiod did not show any difference in body weight compared to NLD controls either at the time of shifting or even at IL, though there was a tendency for non-significant marginal increment in weight. During the three months of rear under LP, the per day growth rate was significantly higher during the second month but, significantly lower during the third month compared to the NLD birds. Apparently, the most critical period at which photic effects manifest on body weight is between 30 and 90 days of age. Similar conclusion was drawn in the previous study on the effects of rearing RIR pullets under a short photoperiod (Dandekar, 1998). Both, the above study on short photoperiod as well as the present study on long photoperiod tend to corroborate the idea that there is no possible correlation between body weight and reproductive maturity though photoperiod has a definite influence on the physiology of the reproductive system, as, temporally regulated optimised photoperiodic changes can influence the laying performance of domestic hens. Similar conclusions have been drawn by studies on other breeds of domestic fowl under temperate conditions (Lewis *et al.,* 1996 a,b,c). The weight of first egg at IL, showed no significant difference between that of LP and NLD birds (37 gms in LP Vs 36 gms in NLD). This is quite different from the significant increase in first egg weight recorded by Lewis *et al.* (1996 c) in ISA brown and Shaver 288 breeds. However, the overall average egg weight and the average monthly egg weights were both consistently and significantly higher in the LP birds (Table 2b). Lewis *et al.* (1996 b) based on the studies on changes in photoperiod and feeding opportunity, had concluded

that, the changes in egg weights are usually in an opposite direction to those for rate of lay. But in the present study, the egg weight did not show a negative correlation with rate of lay as both have shown a favourable disposition.

The superior rate of lay in LP birds is clearly denoted by the significantly earlier attainment of 50% egg production which occurred at 3.7 months as compared to 4.9 months in NLD. The laying performance over the year analysed on a monthly basis (table 3 a)(fig. 3), reveals that the maximal lay (20 eggs or more per month) occurred only during the second month in the NLD birds while, it occurred during the first three months in the LP birds. Under both photic schedules, an age dependent monthly decline in egg production was evident. Similarly, a greater clutch size (3 eggs and above) was also recorded during the first three months in the LP birds against, only during the second month in the NLD birds. Both the groups of birds showed a reciprocal relationship between average clutch size and number of clutches, throughout. The data on the monthly distribution of clutches of various sizes, shows a maximum clutch size of five in NLD birds during the second month and, of six in LP birds also during the second month (table 4a). Both the groups showed a temporal decline in the yield of larger clutches. The LP birds have shown a better overall per day egg production with lesser mean oviposition interval. This aspect was well manifested for the first six months of egg laying. Considering an yield of < 12 eggs/ month as residual laying, the effective period of egg laying in LP birds was only 8 months as against 10 months in NLD birds. At the end of 10 months of egg laying in NLD birds, which corresponds to hen age 477 days, the egg yield is 155 eggs, while the LP birds at same age laid 150 eggs. At the end of 8 months of egg laying in LP birds which corresponds to hen age 447 days, the total egg yield is 140

which is exactly identical to NLD at same age (Table 5b). The table clearly shows, that the rate of lay in LP birds is superior to that of NLD birds as, the negative difference in egg output for LP birds in the initial stages (due to early IL in NLD), gradually got nullified and ultimately became significantly positive at 387 days of hen age.

Even in terms of feed consumption per 12 eggs, there was no significant difference between NLD and LP birds (3.65 Kg. Vs 3.75 Kg.) taken upto 537 days hen age (table 7). From the table it becomes evident that at the end of 7 and 8 months of egg laying (hen age 388 and 408 days for NLD or 416 and 446 days for LP), the feed consumption/dozen eggs is lesser in LP while, it is the same at the end of 9 months and, marginally more in LP birds at the end of 10 months. The rationed or allocated diet provided in the present study which is at an average 2.8% less than the feed consumption at the Government Poultry farm at a*d libitum* provision (as per the data obtained from the Government Poultry, Baroda), also did not have any adverse effect on egg production. Apparently, feed restriction as per the present schedule, has no bearing on laying performance in Indian RIR breeds and, the manifested differences between LP and NLD birds are solely due to photoperiodic manipulation (as feed provision was the same for both groups). Studies on different schedules of feed restriction have yielded different results as, Tucker and Charles (1993) obtained higher egg production by rationed diet during rearing and, Sandoval and Gernat (1996) observed no difference in laying performance but only a slight delay in attainment of sexual maturity.

In normal poultry practice, it is only the layer breeds of hens which are maintained for a second cycle of lay and, meat type and dual purpose breeds are usually disposed off at the end of the first cycle of lay as, their

second cycle productivity is very low. Any photoperiodic manipulation which could raise the second year productivity in such breeds, would be a positive endeavour of practical significance in poultry economy. A step-down photoperiodic manipulation (one month exposure to LP followed by ambient photoperiod), given at the fag end of the first cycle of lay, proved to be underproductive (table 6) as, these birds laid 17.7% lesser number of eggs. The effective period of lay in LP hens was 10 months as against 11 months in NLD birds. The overall rate of lay or even the rate of lay for effective period was also lower in LP birds. The poor second cycle performance of Indian RIR breed is evident from the herein obtained meagre yield of 96 eggs/hen, though the average egg weight was greater than the first cycle. The only favourable influence of LP was egg weight, as, the egg weight of LP hens was significantly greater than that of NLD hens. The average monthly egg yield was 37% less while, the overall egg yield was 43% less during the second cycle in NLD birds compared to the first cycle. In the LP birds, the same were 49.5% and 49% respectively. The maximum clutch size during the second cycle in both NLD and LP birds never exceeded two and, moreover, the oviposition interval was protracted and irregular. The present observation indicate the ineffectiveness of photoperiodic manipulations in adult RIR birds at the end of their first lay in improving the second cycle performance. It would be interesting to see the effects of such photic manipulation on birds subjected to similar manipulation during the first lay or, when given for a longer period prior to second lay.

It can be concluded form the present study that, a step down photoperiod at the interphase between brooding and growing periods (58-60 days), has no significant effect on the overall laying performance but, has a significant favourable influence on rate of lay. These observations

on Indian RIR breed, are at variance from those for ISA Brown and Shaver 288 breeds (temperate breeds), underscoring the genetic difference as well as the probable difference in tropical Vs temperate environmental components.