Egyptian J. Anim. Prod.(1994) 31 (1):27-41.

PUBERTY OF FRIESIAN HEIFERS IN SUBTROPICAL ZONE, EGYPT

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SUMMARY

Twenty three Friesian heifers aged nine months were divided into two groups (Gh and Gc) according to their birth date to study the effect of season of birth on age and body weight at puberty. Gh and Gc included the hot (May through October) and cold (November through April) seasons born heifers, respectively. The same heifers were thereafter divided into two classes according to the season at which they reached puberty to study the effect of season at onset of puberty on pubertal related phenomena.

Animals were checked for heat three times daily by a vasectomized bull. Ovulation was considered to have occurred when progesterone level reached ≥ 1.0 ng/ml and continued at that level for three consecutive samples at least (minimum of 10 days). In the quiet ovulation cases, ovulation date was determined by subtracting three days from the day at which the progesterone reached ≥ 1 ng/ml. Ovulation was considered to coincide with heat when the oestrous day was followed by an increase in progesterone concentration to more than 1.0 ng/ml within five consecutive days.

Overall means of age at puberty and it's corresponding body weight were 16.9 ± 0.7 months and 223.4 ± 5.2 kg, respectively. Ovulation cycles length showed gradual increase with ovulation cycles progress post-puberty. Puberty onset was accompanied with high occurrence of

Issued by Egyptian Society of Animal Production.

quiet ovulation and weak expression of heat. Poor oestrous behaviour signs decreased gradually with oestrous progress.

Season of birth had insignificant effect on age and body weight at puberty. Heifers which reached puberty in the cold season had higher percentage of quiet ovulation in their pubertal ovulation than those which reached puberty in the hot season. Moreover, heifers of the latter group exhibited more pronounced behaviour signs than that of the first group.

Keywords: Friesian, season, puberty, reproductive performance

INTRODUCTION

Friesian cattle are distributed in many countries with diverse climatic conditions. In temperate zone several research works were conducted to study the pubertal age of Friesian heifers and it's related phenomena (Swanson et al., 1972; Marrow et al., 1976; Schillo et al., 1982 and 1983 a).

In sub-tropical and tropical areas, particularly in Egypt, no data are available about such phenomena (i.e. regularity of ovulation cycles post- puberty, hormonal levels, oestrous behaviour and effect of season on pubertal aspects). Moreover, long span was observed between the reported age at puberty (about 13 months, El-Keraby, 1970 and El-Gaafrawy, 1979) and age at first calving (31 months, Barrada et al., 1969). The difference between the pubertal age and age at first calving (18 months) means that there are either inaccurate estimates of pubertal age in the previous works or faults in the herd management resulting in delay of the age at first calving.

This study was planned to determine pubertal age of female Friesian calves as affected by season of birth using plasma progesterone levels to avoid inaccuracy in puberty determination.

MATERIALS AND METHODS

1- Experimental animals and management

A total of 23 purebred Friesian heifers aged nine

months was divided into two groups according to their season of birth. The year was divided into two climatic seasons; cold season (November through April) characterised by low ambient temperature (ranged from 7.0 to 25.0 °C with an average of 14.8 °C) and short daylight length (averaged 11.2 hrs) and hot season (May through October) with high ambient temperature (ranged between 21.0 and 34.0 °C) and longer daylight length (averaged 12.8 hrs). The first group (Gh, n=6) included the hot season born heifers, while the second group (Gc, n= 17) included the cold season born ones. These two groups were used to study the effect of season of birth on age and body weight at puberty.

Regardless of the birth date, the animals were divided into two classes according to the season at which they reached puberty to study the effect of pubertal season on oestrous behaviour development and the regularity of ovarian cycles post puberty, Ch (n=12) and Cc (n=11) included the heifers which showed their first ovulation during the hot and cold seasons, respectively.

Animals were housed loose in a semi-shaded paddock. Animals were fed according to their live body weight on concentrate mixture plus rice straw (Hot season) and /or berseem (Cold season). Routine weighing was conducted once monthly to determine the growth rate and pubertal body weight.

2- Detection of oestrous activity

The heifers were checked for heat symptoms three times daily at 08:00, 16:00 and 22:00 hours by a vasectomized bull. The bull was left with the heifers for a period of 30 minutes at each check time to recognize the heifers on heat. The recorded sexual symptoms, each comprised of two signs, were as follows:1) changes of external genitalia (hyperaemia of vulva and vaginal mucus discharge); 2) female self behavioral pattern (homosexual behaviour and sniffing of the genitalia of other females) and 3) mutual behaviour with the male (attraction of male towards female and standing response during mating).

Heat was considered strong when the standing behaviour was accompanied with at least any three sexual signs; moderate when the standing behaviour was accompanied with any two signs and weak either when the female

showed standing behaviour without showing any of other signs or when other signs occurred without the receptivity to the male providing that it was followed by ovulation.

3- Detection of ovarian activity

Ovarian activity was determined by the concentration of plasma progesterone. Regular blood samples from the jugular vein (5 ml) were collected, staring from the 9th month of age, twice weekly at three to four days interval in heparinized tubes. Plasma was separated immediately and stored at -20 °C till progesterone assay was conducted. Direct radioimmunoassay technique (RIA) was performed using ready antibody coated tubes kit according to the procedure outlined by the manufacturer (DPC, Los Angeles, USA).

The cross reaction of the antibody (at 40-60 binding percentage) was < 2.4 % with each of 11- deoxy corticosterone, 11-deoxy cortisol, 20- dihydro progesterone and 5ß prognon -3,20 dioen and < 1.0% with any of the other steroids. The standard curve ranged between 0.0 and 40.0 ng/ml. Sensitivity value when assaying 100 µl of plasma was 0.05 ng/ml, approximately. The intra and inter assay coefficients of variation were 6.4 and 6.7%, respectively.

Pubertal age was accounted when the first ovulation was presumed. Ovulation was considered to have occurred when progesterone level reached ≥ 1.0 ng/ml and continued at least for three consecutive samples. In the quiet ovulation cases, ovulation date was determined by subtracting three days from the date at which the progesterone reaches ≥ 1 ng/ml. Ovulation was considered to coincide with heat when the oestrous day was followed, by an increase in progesterone concentration within the five consecutive days. According to their length, the ovulation cycles were categorized into long (>24 days), normal (18-14 days) and short (<18 days).

4- Statistical analysis

Data were analyzed by least squares analysis of variance using the General Linear Model procedure (SAS, 1985).

RESULTS

1- Age and body weight at puberty

Overall means of age and body weight at puberty obtained for the Friesian heifers in this work are presented in Table 1. Sixty percent of heifers reached puberty between 14.5 and 19.0 months of age with corresponding body weight between 190 and 234 kg. The correlation between age and body weight at puberty was 0.61.

Heifers born in hot season (Gh) tended to have insignificant older age at puberty than cold season born ones (Gc). Body weight at puberty was almost the same in both groups (Table 1). The range of both body weight and age at puberty was more narrow in Gh than in Gc.

2- Regularity of ovulation cycle length post-puberty

Post-puberty ovulation cycles length showed a gradual increase from the first to the third one. Occurrence of short ovulation cycles was more frequent in the first cycles than the subsequent ones (Table 2).

In the first ovulation cycles, heifers of Cc showed significantly ($P<0.05$) shorter cycles than those of Ch (Table 2). The decrease in the incidence of short cycles from the 1st to the 3rd cycle coincided with increase of normal length of cycle.

3- Progesterone concentration around puberty

Throughout the three weeks prior to the first ovulation progesterone concentration averaged 0.3 ng/ml with a range of 0.1 to 1.5 ng/ml. Some progesterone spikes were observed during the period of 21 to 19 days and to 7 to 5 days pre-puberty with a value of 1.1 ng/ml and 1.5 ng/ml for the two periods, respectively (Figure 1).

Average of progesterone concentration in short (n=15) and normal (n=7) cycles is illustrated in Figure 2. In short cycles, corpus luteum had short life span with a relative higher progesterone concentration. On the contrary, it was more than 3 weeks as appeared in the only case of long ovulation cycle (Animal no.9, Figure 1).

Table 1. Least squares means of age and body weight at puberty of Friesian heifers

Group	No.	Age (months) Range	Age (months) Means± S.E	Body Weight (kg) Range	Body Weight (kg) Means± S.E
Gh	6	14.5 - 18.7	17.9 ± 0.9	190 - 255	225.8 ± 10.2
Gc	17	12.1 - 20.1	16.4 ± 0.5	175 - 275	222.6 ± 6.3
Overall	23	12.1 - 20.1	16.9 ± 0.7	175 - 275	223.4 ± 5.2

Table 2. Effect of season at puberty on the regularity of ovarian cycle length (days) post-puberty of hot (Ch) and cold (Cc) season pubertal heifers

Ovarian cycles		Season Ch	Season Cc	Overall
First	no.	12	11	23
	Range	14-37	13-21	13-37
	Mean ± S.E	20.7 ± 2.1	14.9 ± 0.8*	18.0 ± 1.4
Second	no.	11	9	20
	Range	12-25	8-25	8-25
	Mean ± S.E	18.8 ± 1.4	18.2 ± 1.8	18.6 ± 1.1
Third	no.	7	4	11
	Range	15-24	12-25	15-25
	Mean ± S.E	20.4 ± 1.7	19.5 ± 0.1	20.1 ± 1.1

* Significant at ($P<0.05$).

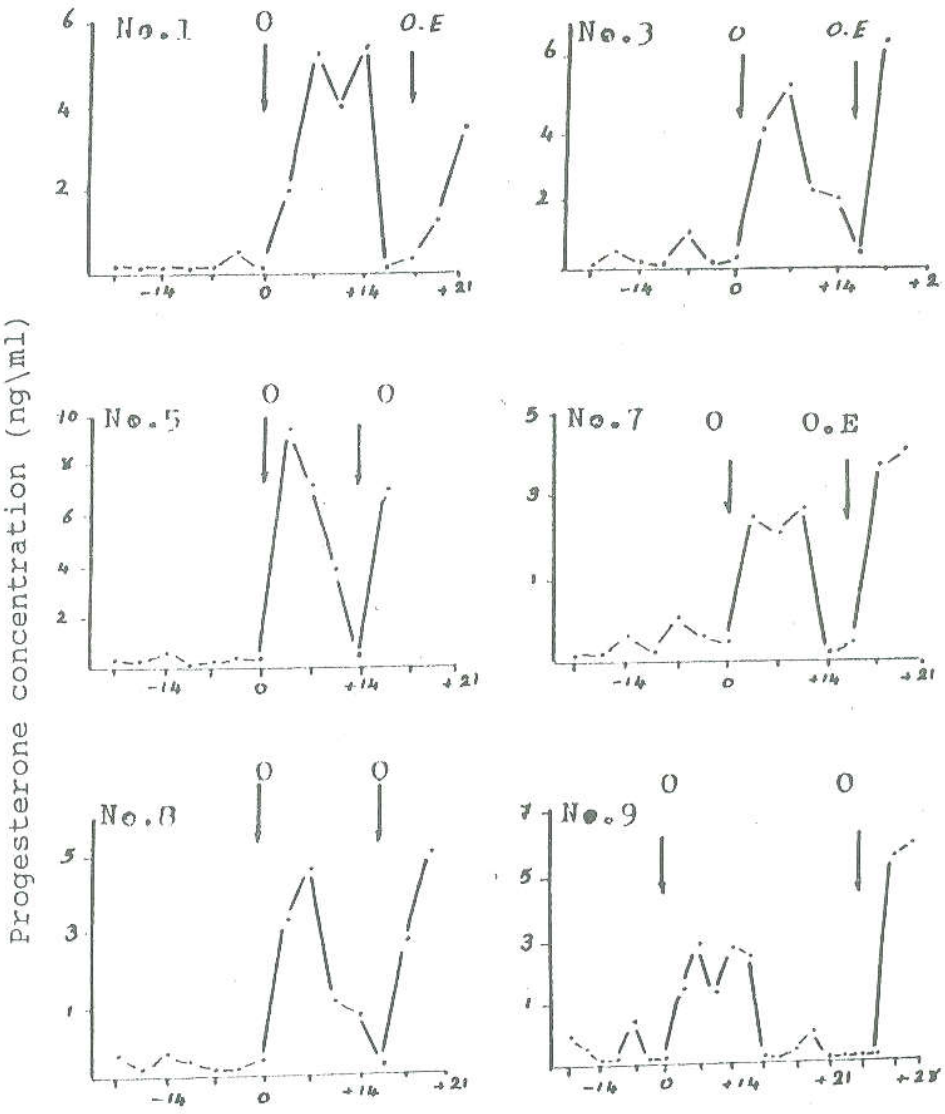

Figure 1: Progesterone concentration (ng/ml) before and after the pubertal ovulation for Friesian heifers.
Arrows point to ovulation (O) and oestrus (E).

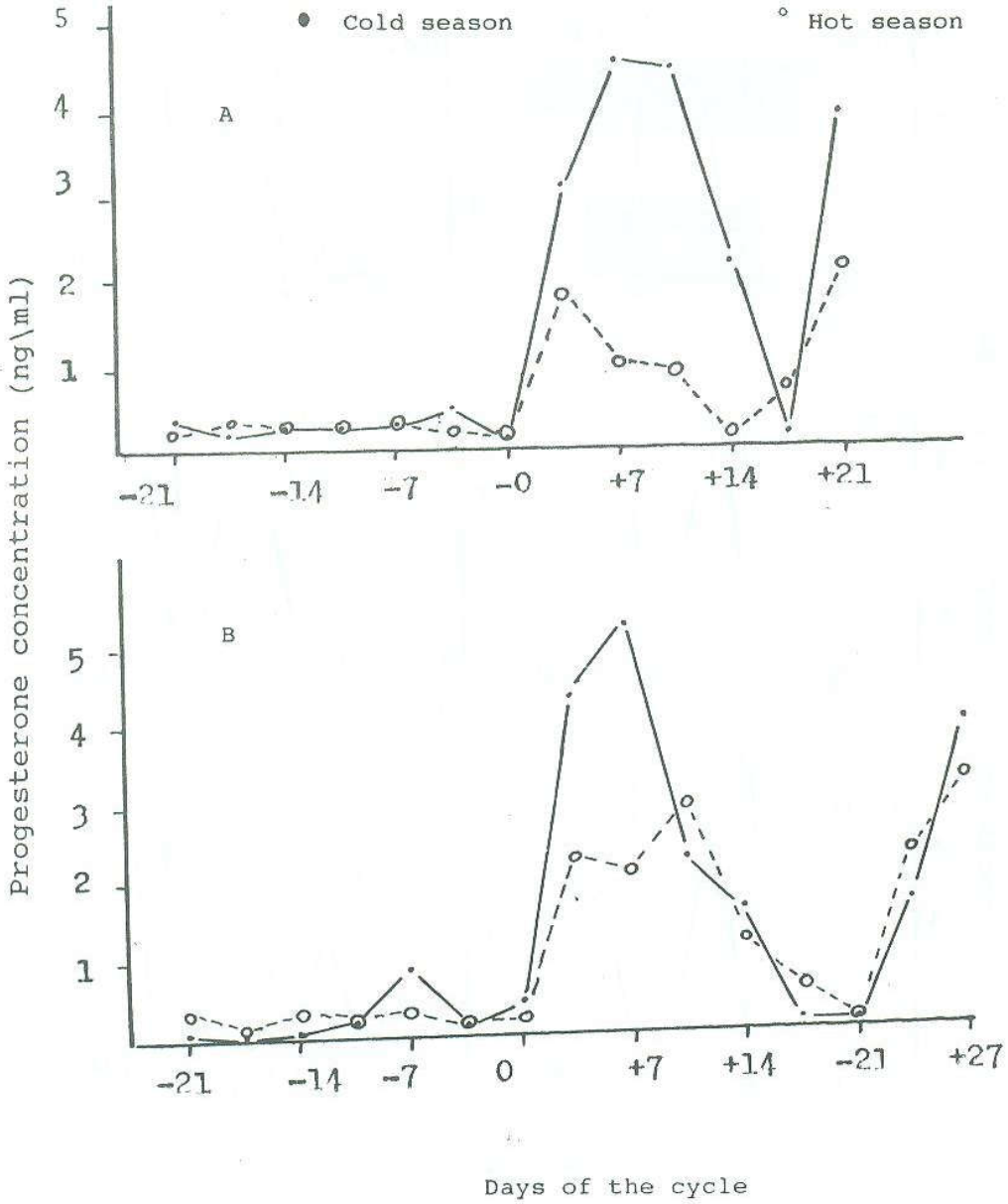

Figure 2: Effect of season at puberty on progesterone concentration (ng/ml) of short (A) and normal (B) cycles.

Season had an obvious effect on luteal function and consequently the cycles length. Progesterone concentrations at peak of short cycle length of Cc (n=9) and Ch (n=6) were 4.6 ± 0.9 ng/ml and 1.8 ± 0.3 ng/ml, respectively, by similar response it were 5.2 ng/ml for Cc (n=1) and 2.9 ± 1.0 ng/ml for Ch (n=6) in normal cycles.

4- Oestrous behaviour around puberty

Starting at 9 months of age the heifers began to show sexual behaviour particularly being attracted to the male, mounting and sniffing other females. The percentage of heifers which exhibited those sexual signs increased with puberty approach. The other signs (e.g. standing behaviour, vaginal mucus discharge ...etc.) were not observed until puberty occurrence.

Puberty onset was accompanied with high incidence of quiet ovulation and weak oestrous activity. With repetition of oestrous cycles, the incidence of this poor sexual libido decreased successively leading to strong oestrous activity (Table 3).

Oestrous behaviour signs during the first three consecutive oestrous cycles showed a wide variation in their frequency of occurrence. During the first ovulation cycles, standing behaviour was not the major heat behaviour sign, mounting other female was the more frequent one, while the vaginal mucus discharge was the least. In the second and third cycles, incidence of all behavioral signs showed increase in their percentages particularly standing behaviour (Table 4).

In pubertal ovulation; heifers of Cc had a higher percentage of quiet ovulation than those of Ch, but in the next ovulations opposite trend was observed (Table 3). Oestrous behaviour showed a gradual increase in strength from the first to the third oestrous cycles in both classes. There were no differences, due to the season, in the percentages of weak oestrous activity during the first three oestrous cycles. Among heifers which showed oestrous activity in their pubertal ovulation, heifers of Ch exhibited more pronounced behavioral signs than those of Cc, particularly in their receptivity to the male (33.3 vs. 9.1, respectively). Mounting behaviour had the highest percentage of

occurrence during all the oestrous cycles, especially for the animals of Cc.

Table 3. Effect of season on the intensity (%) of oestrous behaviour in the first three oestrous cycles post-puberty

Intensity	Season						Overall		
	Cold			Hot					
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Quiet ovulation	63.6	20.0	0.0	41.7	33.3	0.0	52.2	27.3	0.0
Weak oestrus	27.3	10.0	25.0	25.0	8.3	11.1	26.1	9.1	18.1
Moderate oestrus	0.0	0.0	0.0	0.0	8.3	0.0	0.0	4.6	0.0
Strong oestrus	9.1	70.0	75.0	33.3	50.0	88.9	21.7	59.0	81.9

Table 4. Development of oestrous symptoms (%) for the first three oestrous periods in cold (C) and hot (H) season in pubertal Friesian heifers

Oestrus symptoms category	Oestrous								
	1st			2nd			3rd		
	C	H	T	C	H	T	C	H	T
Changes of external genitalia									
a- Vulva hyperaemia	9	50	30	60	58	59	88	89	88
b- Vaginal mucus discharge	9	25	17	60	33	46	88	67	77
Female self behaviour pattern									
c- Mounting other females	36	50	43	80	50	65	100	100	100
d- Sniffing females genitalia	18	50	34	80	50	65	100	100	100
Muted behaviour with the male									
e- Following oestrous females	18	42	30	80	67	73	88	100	94
f- Standing behaviour	9	33	21	70	58	6	88	89	88

T = Overall %

DISCUSSION

The increase in age of Friesian heifers at puberty in the present work (16.9 months) than those reported before in the temperate zone (about 12 months; Young et al., 1978; Bone et al., 1980 and Grass and Houser, 1981) is attributed mostly to the differences in environmental conditions (particularly climatic and nutrition) between the temperate zone and the Egyptian subtropical conditions. The previous investigations in Egypt also reported younger pubertal age (about 13 months; El-Keraby, 1970 and El- Gaafrawy, 1979) than the present finding. This because the research workers depended upon the symptoms of sexual behaviour for determining puberty onset without actual detection of ovulation. This reliance, only, on sexual behaviour results in false determination since the dairy heifers start to exhibit signs of oestrous behaviour several weeks before the first ovulation (Marrow et al., 1976). In the present work onset of puberty was ascertained more precisely by determination of plasma progesterone concentration along with observing sexual behaviour. The insignificant slight difference in puberty age (17.0 ± 0.6 vs. 16.4 ± 0.7 months) of heifers of Gh and Gc , respectively may be attributed to the almost equal pubertal body weight (222.6 vs. 225.8 kg). The equal weight of both groups clarifies that the puberty is a function of body weight rather than age. The same concept was reported by Schillo et al. (1982 and 1983a) where they found that body weight prior to puberty was related to pubertal age while season of birth had no significant effect on body weight at puberty.

The incidence of quiet ovulation in high percentage especially during the first ovulation is most probably due to the absence of high progesterone concentration during the previous period preceding the first ovulation (Rutter and Randel, 1986). Treatment of CNS with progesterone during the pre-ovulation period is necessary to enhance the ability of the female to show sexual behaviour (Bulman and Wood, 1980). Increasing of vigorous oestrous expression, obtained in this work, with ovarian function progress agree with the reports of Swanson et al. (1972) and Dufour (1975) which may be attributed to the increase of female experience (Alexander et al., 1980) and the maturation of

endocrinological system.

Increase of sexual behaviour in heifers of Ch than Cc agrees with Gwazdauskas et al. (1983) and Pemington et al. (1985) reporting that cold temperature inhibits oestrous activity than hot temperature. Contradictory results were reported by De Silva et al. (1981) and Zakaria et al. (1981).

Schillo et al. (1983 b) and Kamwanja and Hauser (1983) found that pulsatile secretion of LH commences approximately one week prior to first ovulation. The increase of first pre-ovulatory surge of LH is associated with an elevation in progesterone concentration which is found in the present work (Figure 1). This progesterone elevation play a key role in the stimulation of pre-ovulation LH discharge (Gonzalez Padilla et al., 1975).

ACKNOWLEDGEMENT

The authors would like to thank Dr. M.M. Shafie Professor of Animal Physiology, Faculty of Agriculture, Cairo University for his interest and critical discussion in this work.

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البلوغ الجنسى لعجلات الفريزيان فى المناطق تحت الاستوائيه ، مصر.

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استخدم فى هذه الدراسه ٢٣ عجلة فريزيان عمر تسعة شهور قسمت الى مجموعتين تبعا لموسم الولادة - المجموعة الاولى (٦ عجلات) ولدت خلال الموسم الحار من السنة ، أما المجموعة الثانيه (١٧ عجلة) فقد ولدت خلال الموسم البارد من السنة .

تمت مراقبة الشياع بالتشميم ٣ مرات يوميا لتحديد بداية ظهور النشاط الشبقى ، كما تم جمع عينات دم بشكل منتظم بمعدل مرتين اسبوعيا (كل ٣ - ٤ أيام) لتقدير مستوى هرمون البروجستيرون فى الدم المحيطى لتحديد موعد التبويض . فى حالات التبويض الصامت ثم تحديد يوم التبويض بطرح ثلاث أيام من التاريخ الذى تم فيه ارتفاع مستوى هرمون البروجستيرون الى ≤ ١نانوجرام / سم٣ . أما فى حالات الشياع فقد اعتبر التبويض مصحوب بالشياع إذا ماتبع الشياع ارتفاع فى مستوى هرمون البروجستيرون فى الدم المحيطى خلال الايام الخمس التاليه لحدوثه . وقد أظهرت النتائج أن :-

١- المتوسط العام لعمر البلوغ كان ١٦,٩ ± ٠,٧ شهر بمتوسط وزن ٢٢٣,٤ ± ٥,٢ كجم ، أما موسم الولادة فلم يكن له تأثير معنوى على عمر البلوغ .

٢- صاحب البلوغ زياده تكرار نسبة التبويض الصامت وكذلك مظاهر الشبق الضعيفة ، ومع تكرار دورات الشبق قلت نسبة حدوث التبويض الصامت وزادت قدرة الحيوانات على إظهار علامات الشبق .

٣- العجلات التى بلغت جنسيا فى الموسم البارد كانت نسبة تكرار التبويض الصامت بها أعلى منها فى العجلات التى بلغت جنسيا خلال الموسم الحار .

٤- مع تكرار دورات المبيض بعد البلوغ زاد متوسط طول دورات المبيض تدريجيا حيث بلغ مع الدورة الثالثة ٢٠,١ ± ١,١ يوم .

٥- كان استسلام الانثى للذكر هو أكثر مظاهر الشبق تكرارا فى الدورات التاليه للبلوغ وإن كان هذا المظهر ليس هو الاكثر تكرارا فى التبويض الاول.