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Seasonal influence on follicular and luteal dynamics in dairy cows

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ABSTRACT

The objective of study was to investigate the influence of season, viz. summer, winter, and isothermic (spring and autumn season), on follicular and luteal dynamics in dairy cows. Thirty dairy cows (n=10 in each season) were subjected to the ultrasonographic examination of ovarian structures, i.e. follicle and corpus luteum, during two- and three-follicular waves in an estrous cycle using B-mode and colour doppler mode of ultrasonography. The daily temperature-humidity index (THI) was recorded to envisage its variation among different seasons. In results, the size of the dominant follicle was recorded to be significantly different in all seasons during the second follicular wave. However, all other parameters for follicle, i.e. day of wave onset, length of growth phase, duration of dominance, the maximum diameter of the largest sub-ordinate follicle, as well as luteal morphometric analysis had no significant difference among different seasons. On the other part, the THI varied significantly in different seasons with maximum THI in the summer (72.54), followed by the isothermic (64.7) and lowest in the winter season (54.12). As a part of summation, the seasonal impact was barely noteworthy on different aspects of follicular and luteal dynamics except for the size of dominant and sub-ordinate follicle in dairy cows.

Keywords: Follicular dynamics, Seasonal variation, Temperature-humidity index

Exploring the ovary and its structures in cows has received major research attention with the advent of ultrasonography (Luttgenau and Bollwein 2014). The fertility of dairy cattle is determined by successful follicular turnover, which leads to the ovulation of a competent oocyte from a healthy follicle. It has been reported that the effects of seasonal stress on reproductive function not only include reduced feed intake and its associated metabolic effect but, are due to the direct effect of stress on the hypothalamo-pituitary-ovarian (HPO) axis (Ronchi *et al*. 2001). Seasonal effects on the aspects of follicular dynamics have also been reported in *Bos taurus* beef (Jaiswal *et al*. 2009), *Bos taurus* dairy (Sartori *et al.* 2002), and *Bos indicus* breeds (Torres-Junior *et al.* 2008). Seasonal stress alters the follicular development pattern in cattle. Exposure of dairy cows to seasonal stress leads to a reduction in the size of the dominant follicles of the first and second follicular waves of the estrous cycle (Wilson *et al.* 1998a, b).

In cows suffering from seasonal stress, the size (Roth *et al*. 2000) and dominance of the dominant follicle reduce (Roth *et al*. 2001), and the number of medium-sized subordinate follicles increases (Sartori *et al*. 2002). All these effects on folliculogenesis result in a reduction in the quality of the oocytes (Shehab-El-Deen *et al*. 2010). Keeping in view these aspects, the present study was carried out to investigate the influence of season, viz. summer, winter, and isothermic, on follicular and luteal dynamics in dairy cows.

MATERIALS AND METHODS

This study was conducted at Livestock Farm Complex, CSKHPKV, Palampur (Zone-II of agroclimatic zones of Himachal Pradesh; Mid-hills and sub-humid zone), from May 2021 to April 2022 for a period of 12 months comprising three seasons including summer (May-August), winter (November-February), and isothermic season, i.e. spring (March and April) and autumn (September and October) season. The daily mean values of wet and dry bulb temperatures at 12:00 noon were recorded from a wet and dry bulb thermometer placed outside the animal shed. THI was calculated according to the equation reported by NRC:

$$THI = 0.72 \times (Tdb + Wdb)\ °C + 40.6$$

Where, Tdb, Dry bulb temperature (°C); Wdb, Wet bulb temperature (°C).

Thirty cows (Jersey crossbred; n=10 in each season) kept under standard feeding conditions, under natural light, housed in dry concrete sheds, and milked twice daily were selected for the study. Cows were clinically healthy and normal cyclic, with no history of reproductive abnormality. In order to analyze the impact of seasonal

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Table 1. Average values of dry bulb temperature, wet bulb temperature, and the temperature-humidity index (THI) during summer, winter and isothermic season (Mean±S.E.)

Season	Dry bulb temp. (°C)	Wet bulb temp. (°C)	THI
Summer	26.25±1.0^{x} (24.06-27.96)	18.11±1.1^{a} (14.96-19.87)	72.54±0.11^{x}
Winter	14.82±1.31^{y} (13.96-18.36)	3.95±1.5^{c} (0.93-8.03)	54.12±0.34^{z}
Isothermic	21.96±1.22^{x} (18.58-23.83)	11.5±2.01^{b} (6.8-16.6)	64.7±0.38^{y}

^{x,y,z} Values with superscripts in same column differ significantly ($p \leq 0.01$). ^{a,b,c} Values with superscripts in same column differ significantly ($p \leq 0.05$).

variation on follicular and luteal dynamics, all the cows in different seasons were subjected to trans-rectal sonography for examination of ovaries and uterus, i.e. at 48 h interval during an estrous cycle. Further analysis of these ovarian structures such as the dominant follicle and corpora lutea was done with ultrasonographic morphometry via an inbuilt caliper in the ultrasound machine. A follicle was categorized as a dominant follicle (DF) when its diameter reaches at least 9-10 mm or above. However, the follicles originating from the same pool but becoming atretic following dominance were considered subordinate follicles. Some other aspects on follicular dynamics such as the day of wave onset, the maximum diameter of the dominant follicle (mm), the day of maximum diameter of the dominant follicle, length of the growth phase, duration of dominance, the maximum diameter of the largest sub-ordinate follicle (mm), were studied. Similarly, luteal dynamics was studied using maximum diameter of corpus luteum (CL), day of maximum diameter, and day of onset of regression of CL. The recorded data were statistically analyzed using one-way ANOVA and linear correlation and regression analysis with NCSS 2020, USA (Version 22.0.4) software.

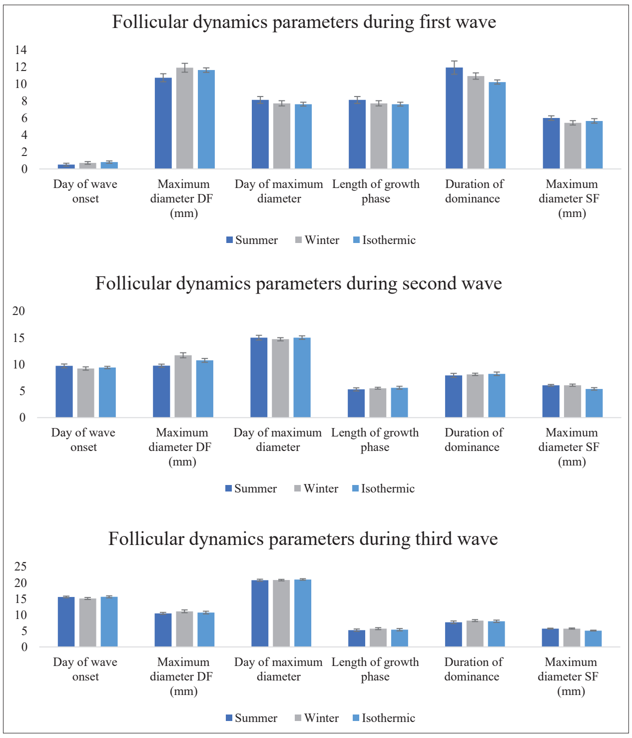

Fig. 1. Values of follicular dynamics parameters in different follicular waves during different seasons (Mean±S.E.)

RESULTS AND DISCUSSION

In this study, the dry bulb temperature was significantly higher ($p \leq 0.01$) in the summer and isothermic season as compared to the winter season, however, the wet bulb temperature was significantly different ($p \leq 0.05$) in the summer, winter, and isothermic seasons. Similarly, the temperature-humidity index was significantly different ($p \leq 0.01$) in different seasons with the summer season having a higher THI followed by the isothermic and winter seasons (Table 1). The temperature-humidity index varied significantly in the three seasons but not up to an extent that would result in heat stress in cattle (Mortan *et al.* 2007, Schuller *et al.* 2014).

Follicular dynamics is one of the most important subjects in ovarian physiology and the study on follicular dynamics establishes reference for estrus, follicular wave, follicle, and luteal characteristics and steroid profiles during the entire estrous cycle. In our study, the first wave emerged on day 0.5±0.16, 0.7±0.15, and 0.8±0.13, the second wave emerged on day 9.7±0.36, 9.2±0.32, and 9.4±0.22, and the third wave emerged on day 15.55±0.27, 15.1±0.31 and 15.6±0.3 in summer, winter and isothermic season respectively which did not differ significantly ($p>0.05$) (Fig. 1). Also, no seasonal effect on the length of the estrous cycle, the number of follicular waves, or the distribution of cows with 2, 3, or 4 follicular waves per estrous cycle was seen. However, the follicular function was influenced by season since the dominant follicle was larger sized during the winter season followed by the isothermic and summer season. This could be attributed to the nutritional status of the animal during different seasons as feed intake was more in the winter season and less in summer which could have altered follicular growth (Mackey *et al.* 2000).

The maximum diameter of the sub-ordinate follicle, its growth rate, atresia rate, and persistence during the second follicular wave were significantly higher ($p \leq 0.05$) in the summer and winter as compared to the isothermic season. Similarly, the maximum diameter of the sub-ordinate follicle and its growth rate during the third follicular wave was higher ($p \leq 0.05$) during the summer and winter as compared to the isothermic season (Fig. 1). This could be due to an increase in FSH concentration which got elevated in the stressful environment and led to an increase in the size of the sub-ordinate follicles. This finding was also in congruence with the findings of Beam and Butler (1997)

Table 2. Parameters of corpus luteum during estrous cycle in summer, winter and isothermic season (N=30) (Mean±S.E.)

Parameter	Summer	Winter	Isothermic
Pre-ovulatory follicle diameter	11.12±0.14	11.66±0.347	11.7±0.22
Maximum diameter of CL	19.68±0.31	19.69±0.24	19.83±0.19
Day of maximum diameter	14.4±0.58	14.1±0.43	14.5±0.22
Day of onset of regression	16.14±0.11	15.71±0.15	15.8±0.14
Inter-estrus interval (days)	21.42±0.51	21.71±0.23	21.6±0.17

and Stagg *et al.* (1998) who reported an increase in the size of the sub-ordinate follicles during the summer and winter seasons and led to the early emergence of the follicular wave.

In cattle, seasonal influence on the size of the corpus luteum and its functionality has been reported by Rhodes *et al.* (1982), Badinga *et al.* (1994), and Wilson *et al.* (1998b). Such influence on the CL size are mainly represented by a deleterious effect of stress on reproductive physiology (Biggers *et al.* 1987, Dobson and Smith 1995, Wilson *et al.* 1998b, Wolfenson *et al.* 2002) including reduction of CL size, weight, and functionality (Fernandez-Novo *et al.* 2020). In this study, no significant difference ($p>0.05$) was recorded for the maximum diameter of CL, day of maximum diameter, and day of onset of regression of CL (Table 2), which was not in agreement with the findings of Stahringer *et al.* (1990) who reported a reduction in size and functionality of the corpus luteum during the winter season. However, the findings of the current study were in concurrence where no seasonal effect on CL size was found in some studies (Howell *et al.* 1994, Satheshkumar *et al.* 2015, Peralta-Torres *et al.* 2017).

In peroration, the average temperature and relative humidity variation during different season, i.e. summer, winter and isothermic, did not affect the estrous cycle length or morphometry of corpus luteum except significant variation in size of dominant and sub-ordinate follicle during second follicular wave.

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