Eefect Of Heat Stress On Perfprmance Of Dairy Friesian Cows
2- Reproductive Performance

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Abstract: A total of 1243 available records collected for 581 Friesian cows during 8-year period from 1997 to 2004 were used to study heat stress on postpartum reproductive performance. Average temperature humidity index (THI) values confirm the presence of heat stress during the period from June to September (summer season). Heat stress during summer season resulted in significant (P<0.05) longer first estrus (FE), interval service (IS), days open (DO) and calving interval (CI), higher number of service per conception (NSC) and lower conception rate (CR). The most important long of FE, IS, DO and CI were going from 21.55, 63.39, 111.37 and 388.47 day in January to 24.62, 92.31, 146.93 and 425.03 day in July. The NSC increased from 2.44 to 3.02 and CR decreased from 78.69 to 63.29% with increasing THI from 57.98 in January to 80.40 in July.
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1. Introduction

Efficient reproductive performance of lactating dairy cattle in tropical/subtropical and arid environments throughout the world is impacted by a multiplicity of factors such as: the physical environment, social-economic status of producers, available nutrients, adaptability and genetic composition of cattle, intensive or extensive management systems, and available reproductive technology. Seasonal summer reductions in reproductive performance of lactating cows has been well-documented and is associated with decreased thermoregulatory competence of lactating dairy cows, partially due to intensive genetic selection for high milk production (Al-Katanani et al., 1999). Heat stress negatively impacts a variety of dairy parameters including reproduction and therefore is a significant financial burden in many dairy-producing areas of the world (St. Pierre et al., 2003).

The reproductive function is also severely affected by heat stress (Drost, 1999; Sonmez, 2005). Hyperthermal stress increases body temperature and compromises the uterine environment, thus reducing the likelihood of embryo implantation. It also leads to a high rate of embryonic mortality: this is one of the main causes of poor reproductive performance during summer (Rivera, 2001). Under the influence of high ambient temperatures, the endocrine interactions are impaired, the follicular development pattern changes, the quality of oocytes and embryos decreases (Wolfenson, 2000). A clear reduction in the pulse and amplitude of LH release has been reported (Gilad, 1993; Roth, 2000); hence the higher incidence of silent heat and anoestrus in cows and heifers during summer.

The objective of this study was to investigate the effect of heat stress during summer season on reproductive performance of Friesian cows under Egypt conditions.

2. Materials and methods

A 8-year period from 1997 to 2004, weather data was collected from the Sakha Animal Production Research Station, belonged to Animal Production Research Institute (APRI), Agricultural Research Center, located in Kafr El-Sheikh Province 140 km north Cairo (30^{o}56 N), Egypt. Collected data included average, minimum and maximum monthly temperatures and relative humidity. The THI index was calculated for all seasons using the formula developed by Kibler (1964). It is as follows: THI = 1.8 x Ta – (1-HR) x (Ta – 14.3) + 32, Where: Ta = Mean monthly ambient temperature in °C; HR = Mean monthly Relative Humidity on the basis to the unit value. Determined THI values were used to identify heat stress to examine the monthly variation of THI. The classification reported by Du Preez et al. (1990) was adopted to quantify the intensity of heat stress.

A total of 1243 available records of postpartum reproductive traits were collected for 581 Friesian cows. The cows have similar feeding systems and management strategies. The animals were provided with a basal ration consisting of concentrates and roughages according to the level of milk production (NRC, 1988), concentrate feed mixture, berseem (*Trifolium alexandrinum*) and rice straw in winter and concentrate feed mixture, berseem hay, corn silage and rice straw in summer.

The animals were housed in open sheds situated in yards and every yard was surrounded by a fence made of three iron tubes fixed in a horizontal position, each of 2 inches in diameter, with 50 cm in between (total height 1.5 meters). In each yard, the shaded part represented one third of the whole area of the yard. Yards were designed to allow free way to the milking parlour, which is located as usual in a middle position among yards.

Reproductive parameters as the periods from calving to first estrus and first service, days open, calving interval, number of insemination per service and conception rate were recorded for each animal. The data were subjected to statistical analysis using general linear models procedure adapted by SPSS (2008) with one-way ANOVA. Duncan test within program SPSS was done to determine the degree of significance between the means.

3. Results and discussion

Environmental conditions

Mean monthly maximum and minimum temperature (Ta), relative humidity (RH) and calculated temperature humidity index (THI) by the experimental period are shown in Table. Average THI values ranged between 57.98 and 80.40, suggesting the lack of cold stress, but confirm the presence of heat stress for the four months period going from June to September (THI > 72). These high THI values indicate that most dairy herds are exposed to the negative effects of heat stress. These results were greater than the suggested critical threshold of 72 for Holstein cows (Johnson, 1985). The upper critical temperature for Holsteins is 25 ^{o}C (Berman et al., 1985). Figure 1 indicates that dairy cows are exposed to heat stress from June to September with THI values varying between 76.62 and 80.40. Similar trends were observed for Egypt where THI values were higher than 72 for four to six months (Johnson, 1985). Ben Salem and Bouraoui (2009) reported that summer heat stress prevails in Tunisia for four to five months going from May to September with THI values being greater than 72. The upper temperature for lactating cows was 25 ^{o}C and the relative humidity greater than 80% indirectly affects the upper critical temperature (Kume et al., 1998).

Reproductive traits

Results of reproductive traits are presented in Table (2) and Fig. (2-7). Results on monthly variation of mean first estrus (FE), interval service (IS), days open (DO) and calving interval (CI) indicate that FE, IS, DO and CI were the longest during the summer season when THI values are the highest. The most important long of FE, IS, DO and CI were going from 21.55, 63.39, 111.37 and 388.47 day in January to 24.62, 92.31, 146.93 and 425.03 day in July. Moreover, the number of service per conception (NSC) was higher during the hot summer season averaging 2.94, which increased from 2.44 to 3.02 with increasing THI from 57.98 in January to 80.40 in July. However, conception rate (CR) decreased with increasing heat stress during summer season (65.01%), which decreased from 78.69 to 63.29% with increasing THI from 57.98 in January to 80.40 in July. The reproductive function is also severely affected by heat stress (Du Preez et al., 1991; Drost, 1999; Sonmez, 2005). It also leads to a high rate of embryonic mortality: this is one of the main causes of poor reproductive performance during summer (Rivera, 2001). Under the influence of high ambient temperatures, the endocrine interactions are impaired, the follicular development pattern changes, the quality of oocytes and embryos decreases (Wolfenson, 2000). It seems that FSH secretion from the pituitary gland is not impaired in animals exposed to high ambient temperatures. In contrast, a clear reduction in the pulse and amplitude of LH release has been reported (Gilad, 1993; Roth, 2000); hence the higher incidence of silent heat and anoestrus in cows and heifers during summer. Chronic thermal stress leads to delayed ovulation, low conception rate, as well as to a higher rate of abortions (Bolocan, 2009).

Table 1. Ambient temperature, relative humidity and temperature humidity index during the year month in north Delta, Egypt.

Month	Temperature °C			Relative Humidity %			Temperature humidity index		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
January	18.33	9.44	13.89	75.41	38.83	57.12	64.00	51.96	57.98
February	19.44	10.00	14.72	77.05	39.63	58.34	65.81	52.60	59.20
March	21.67	12.22	16.94	78.67	44.36	61.52	69.43	55.15	62.29
Winter	19.81	10.55	15.18	77.04	40.94	58.99	66.41	53.24	59.82
April	25.55	15.00	20.27	83.25	48.88	66.07	76.11	58.64	67.37
May	28.39	17.58	22.99	86.05	53.58	69.82	81.14	62.12	71.63
June	31.11	21.11	26.11	88.78	60.24	74.51	86.11	67.29	76.70
Spring	28.35	17.90	23.12	86.03	54.23	70.13	81.12	62.68	71.90
July	32.67	23.78	28.23	91.16	66.35	78.76	89.18	71.61	80.40
August	31.67	22.78	27.22	89.43	64.32	76.87	87.17	69.98	78.57
September	30.56	21.67	26.11	87.76	62.23	74.99	85.02	68.22	76.62
Summer	31.63	22.74	27.19	89.45	64.30	76.87	87.12	69.94	78.53
October	27.33	18.89	23.11	83.71	56.15	69.93	79.07	63.99	71.53
November	23.89	15.00	19.44	79.87	50.15	65.01	73.07	58.65	65.86
December	19.44	11.11	15.28	75.30	43.04	59.17	65.72	53.82	59.77
Autumn	23.55	15.00	19.28	79.63	49.78	64.70	72.62	58.82	65.72

Table 2. Reproductive traits for the different months of the year.

Month	FE (day)	IS (day)	DO (day)	CI (day)	NSC	CR %
January	21.55^{c}	63.39^{b}	111.37^{b}	388.47^{b}	2.44^{b}	78.69^{a}
February	21.66^{c}	65.60^{b}	114.05^{b}	391.54^{b}	2.63^{ab}	77.88^{ab}
March	21.89^{bc}	65.60^{b}	116.65^{b}	393.37^{b}	2.65^{ab}	77.78^{ab}
Winter	21.70^{B}	64.86^{C}	114.02^{C}	391.13^{C}	2.57^{C}	78.12^{A}
April	22.69^{abc}	72.17^{ab}	122.43^{ab}	399.65^{ab}	2.67^{ab}	75.00^{ab}
May	22.75^{abc}	77.69^{ab}	124.47^{ab}	401.78^{ab}	2.74^{ab}	72.83^{ab}
June	22.99^{abc}	80.10^{ab}	133.70^{ab}	410.60^{ab}	2.79^{ab}	72.73^{ab}
Spring	22.81^{AB}	76.65^{B}	126.87^{B}	404.01^{B}	2.73^{B}	73.52^{B}
July	24.62^{a}	92.31^{a}	146.93^{a}	425.03^{a}	3.02^{a}	63.29^{b}
August	23.96^{a}	90.69^{a}	144.88^{a}	423.37^{a}	2.93^{a}	63.64^{ab}
September	23.81^{ab}	88.47^{a}	139.50^{ab}	416.56^{ab}	2.88^{a}	68.09^{ab}
Summer	24.13^{A}	90.49^{A}	143.77^{A}	421.65^{A}	2.94^{A}	65.01^{C}
October	23.10^{abc}	80.60^{ab}	135.41^{ab}	411.64^{ab}	2.86^{a}	72.41^{ab}
November	22.88^{abc}	77.13^{ab}	131.80^{ab}	409.00^{ab}	2.77^{ab}	74.29^{ab}
December	22.71^{abc}	73.44^{ab}	123.59^{ab}	399.94^{ab}	2.74^{ab}	75.00^{ab}
Autumn	22.90^{AB}	77.06^{B}	130.26^{B}	406.86^{B}	2.79^{B}	73.90^{B}

$^{a, b, c, d:}$ Values in the same column with different superscripts differ significantly ($P<0.05$).

$^{A, B, C:}$ Values in the same column for seasons with different superscripts differ significantly ($P<0.05$).

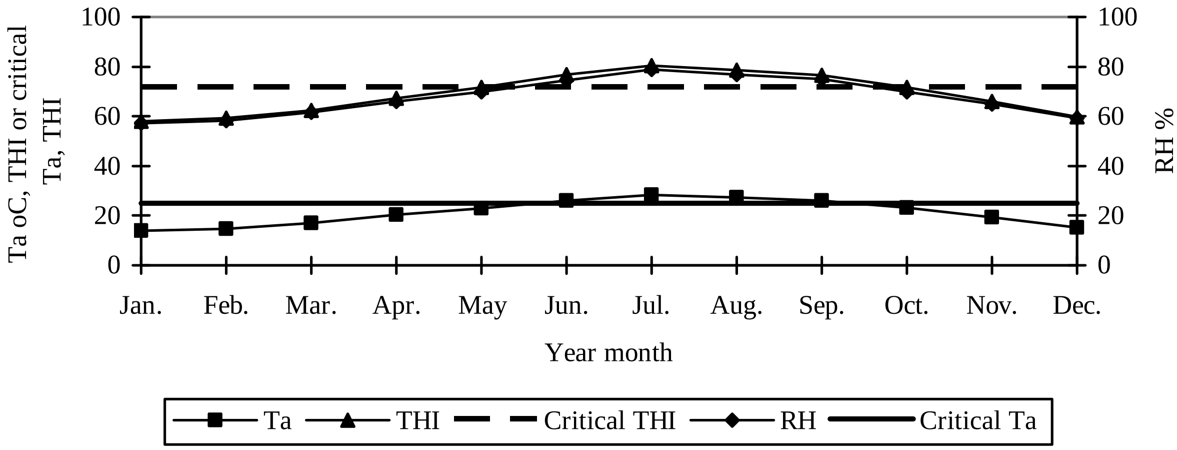

Fig. 1. Ambient temperature, relative humidity and temperature humidity index during the year month in north Delta, Egypt.

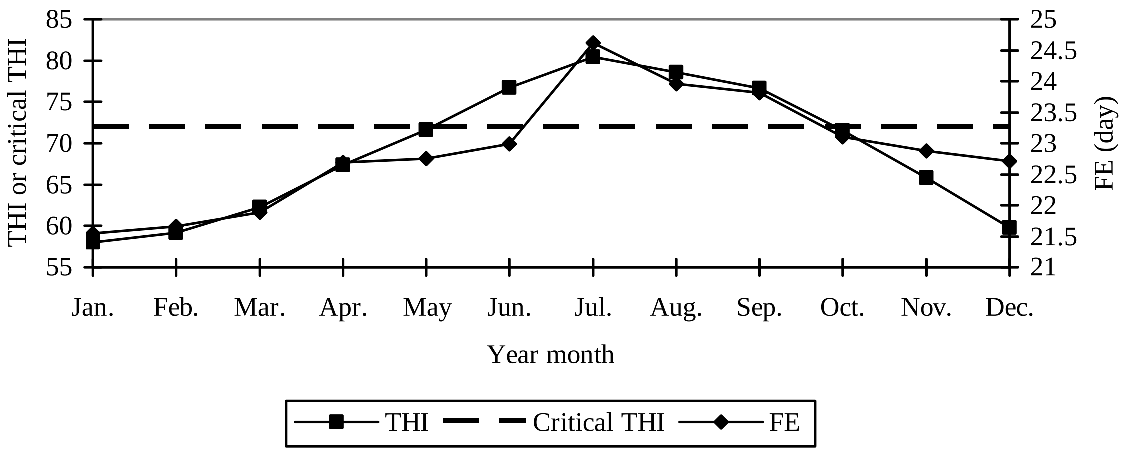

Fig. 2. Effect of heat stress on first estrus.

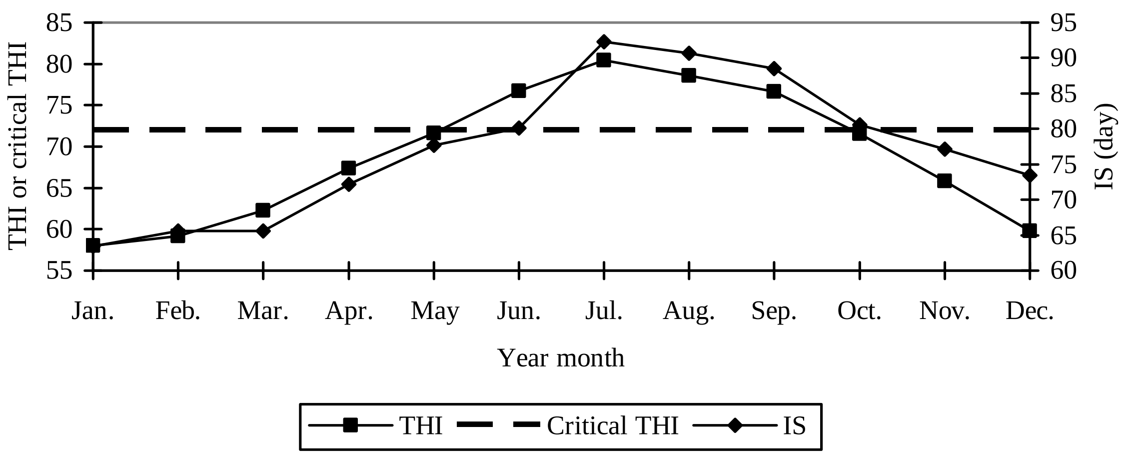

Fig. 3. Effect of heat stress on interval service.

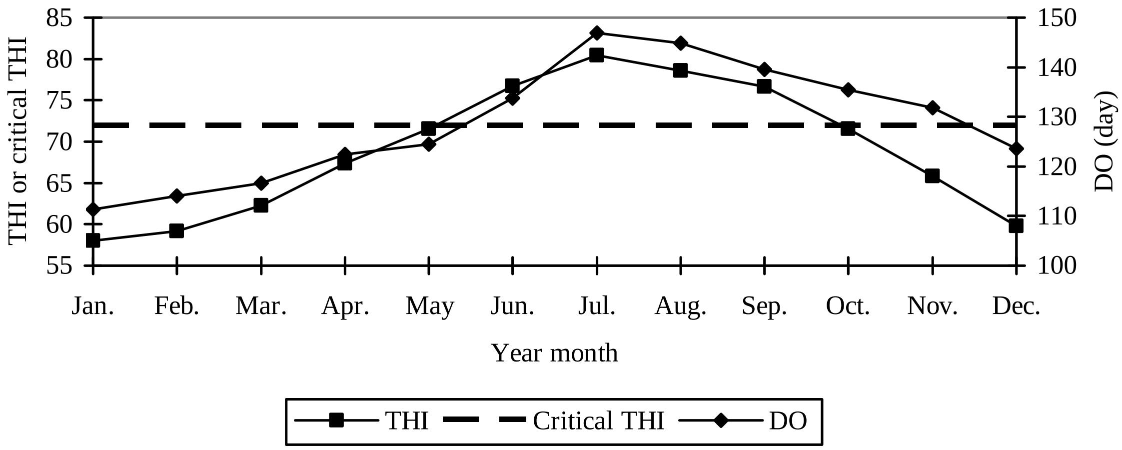

Fig. 4. Effect of heat stress on days open.

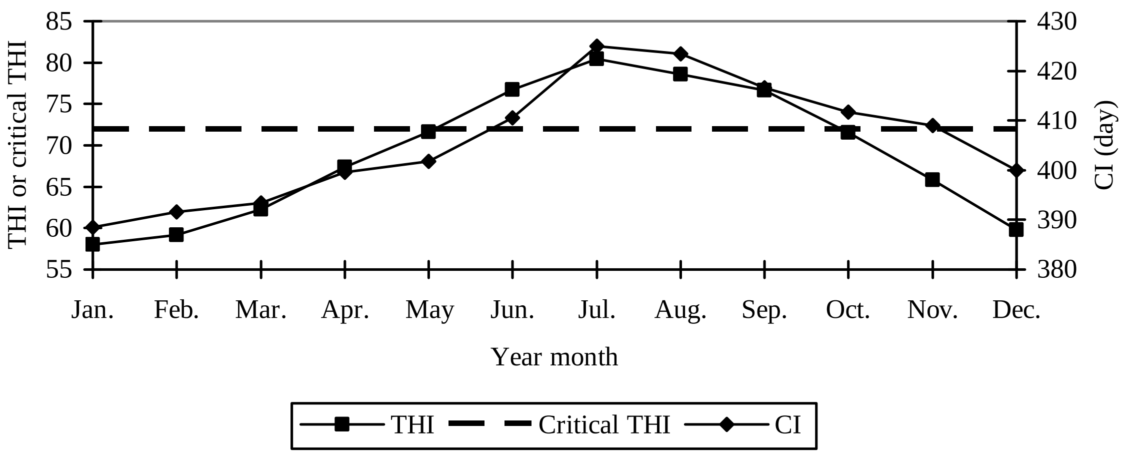

Fig. 5. Effect of heat stress on calving interval.

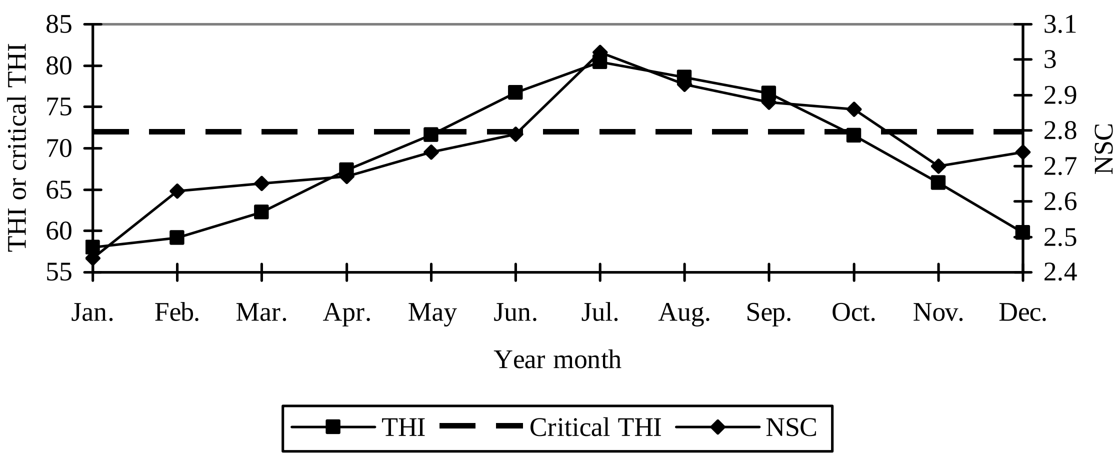

Fig. 6. Effect of heat stress on number of service per conception.

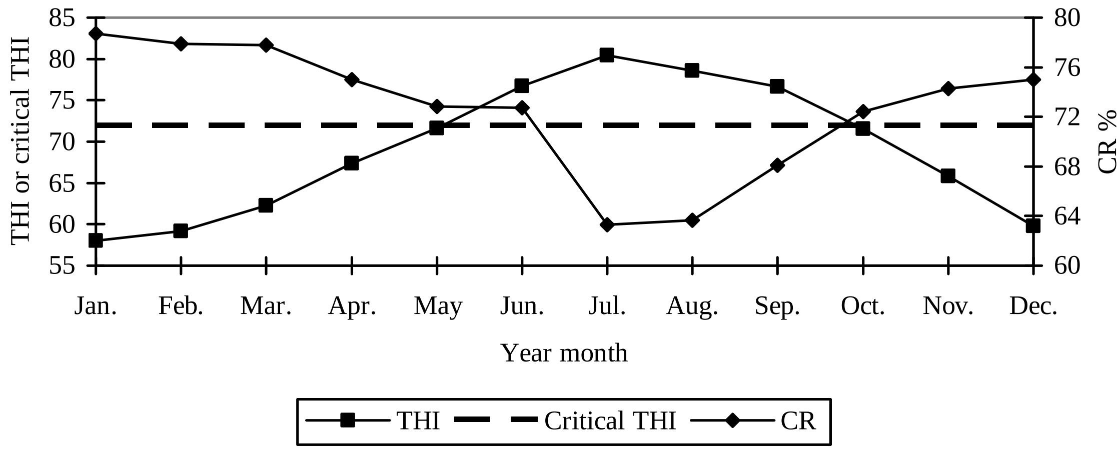

Fig. 7. Effect of heat stress on conception rate.

4. Conclusions

From these results it could be concluded that expose Friesian cows in Egypt to heat stress during the period from June to September increased reproductive periods and number of service per conception and decreased conception rate. Management strategies are needed to minimize heat stress and attain optimal animal reproductive.

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