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THE EFFECT OF SOME ENVIRONMENTAL FACTORS ON MILK YIELD OF THE HOLSTEIN COWS RAISED IN A SEMI-ARID CLIMATE

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ABSTRACT

The aim of this study was to determine the influence of some environmental factors on dairy production of the 6307 Holstein cows raised in private farms which were affiliated to an agricultural cooperative "COPAG", in Souss-Massa region in south-West of Morocco. The results of the analyzed data of dairy control of these cows, collected between 2008 and 2012, were 6578.30±1619.06Kg, 7034.88±1842.07Kg and 325.10±42.96 days, respectively, for 305-days milk yield (305-dMY), Total milk yield (TMY) and the Lactation length (LL). The rank of lactation (RL), the year of calving (YC) and the calving season (CS) had very highly significant effects ($P<0.001$) on 305-dMY, TMY and LL. However, the analyzed effects of calving age (CA) were non-significant ($P>0.05$) for all the studied parameters.

The dairy production of the Holstein in semi arid climate showed a great variability. The effects were highly significant, regarding, the year and the season of calving. The production in the cold seasons was great rather than the hot ones, which confirmed a high sensitive to seasonal variations.

Keywords: Environmental factors, Heat stress, Holstein, Milk yield, Semi-arid climate

INTRODUCTION

The dairy sector plays an important role in the national economy and the socio-economic development in Morocco and particularly Souss-Massa region. This sector serves as a source of income generation for rural families. So as to develop this sector to satisfy the population needs of milk and to ameliorate the genetic pool of the national cattle herd, Moroccan state adopted a dairy politic based on the combination of the introduction of exotic breeds with high dairy performances and the extension of artificial insemination. So, the Holstein breed has been more introduced than the other dairy breed, since this race is considered the most productive in the whole world (Heins et al. 2012). However, the milk yield of the dairy cattle is limited by two

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basic factors; the genetic structure of the animal and non-genetic factors (Bakir et al. 2009; Albarrán-Portillo and Pollott 2011; Bakir and Kaygisiz 2013; Atasever and Stádník 2015). Since the environment genotype interaction plays an important role in the expression of the complete genetic value of the dairy cattle (Ravagnolo and Misztal 2002; Scholtz et al., 2010), which requires the determination of the non-genetic factors for an efficient management and for a precise estimation of the breeding values (Nyamushamba et al., 2013).

That was why many references reflect a great variability of the expression of dairy performances that concern Holstein cow between different environmental conditions. In temperate zones the Holstein produces between 7 and 10 tons (Wicks and Leaver 2006; García-Ispierto et al., 2007; Albarrán-Portillo and Pollott 2011). Whereas, in tropical and subtropical regions the average production varies between 2 and 4 tons and rarely exceeded 4 tons (Usman et al., 2013; Wondifraw et al., 2013). On the other hand, the Holstein cows produce between 5 and 6 tons under climatic conditions of the North Africa (Boujenane and Aïssa 2008; M'hamdi et al., 2012).

The aim of this study is to determine Holstein dairy performances: 305-dMY, TMY and the LL and to reveal the effects of some non-genetic factors; as rank of lactation, calving age, year of calving and calving season; on the production parameters. These results can be used to ameliorate the management of these dairy herd raised in Souss-Massa region characterised by semi arid climate.

MATERIALS AND METHODS

Area of study and climate: Souss-Massa region is situated in the south west of Morocco and it covers an area of about 2500 km² divided between 25% of plain and 75% of mountain. The plain, with an altitude between 0 and 700m, occupied a basin between the Atlantic Ocean of the west, the High-Atlas Mountains of the north and Anti-Atlas Mountains of the south. It has two main plains one of Souss with an area of about 4150 km² the other one in Chtouka-Massa which occupies 1260 km².

The climate is semi arid to arid characterized by a mild coastline climate in the west and semi-continental hot in the east. The climate aridity is mitigated by the proximity of the Atlantic Ocean with the influence of cold current of the Canaries, as well as the presence of the mountain barrier of the Anti-Atlas which protects the region from the hot sub-Saharan wind of the south. The average annual temperatures range from 14°C on the High-Atlas in the north to 20°C on the Anti-Atlas in the south. The average temperatures in Souss-Massa plain are relatively high to 19°C in winter and 27°C in summer. The region knows particularly in late spring and in summer

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unusual, waves of hot east wind with an average speed between 3 to 5 km/h which can increase the temperature until 49°C and cause a huge agricultural damage (MEMEE, 2015).

The precipitations are generally characterized by their weakness, their irregularity and a bad distribution spatial-temporal from 180 mm/year in the plain to 600 mm/year in the north in the High-Atlas peak. On the plain, the precipitation decrease from north to the south and from the west to the east recording averages of about 280 mm on the plane of Souss, 265mm on the plane of Massa and 180 mm on the plane of Tiznit in the south (MEMEE 2015). The Humid season starts from November to March, when the region gets 70 to 75% of annual rain. The dried season, between April to October, the region receives 30% of annual rain. The average of the raining days was about 30 days per year in the plain and 60 days per year in the High Atlas Mountain. The quantity of the rain varies from one year to another, so the precipitation of the most humid year reach up to three times the annual average and until 15 times of the driest year.

The economy of Souss-Massa is based on marine fishing, the tourism and especially the agriculture. The region presents a potential irrigable lands, about 250000 ha. This sector is dominated by a modern agriculture with irrigated areas of about 143000 ha, principally situated on the plains of Souss (114310 ha) and Massa (27105 ha). The forage crops are essentially constituted of forage corn and alfalfa which occupies an irrigated area about 21844 ha. So, the livestock farming represents 28 % of the agricultural production of the region (MEMEE, 2015).

Conditions of breeding: The Holstein of the agriculture (AG) cooperative (COP) «COPAG» contains about 80000 heads in which 40000 milk cows are distributed in the four provinces of Souss-Massa region. This herd is the result of the heifer born locally and some heifer introduced in the region either from other region of Morocco or imported from France, Germany, Canada and Netherlands. The most used mode of reproduction at the level of member farms is the artificial insemination carried out by a team of inseminators of «COPAG». The seeds were imported from France, Canada, Germany and USA. In case of the failure of the third artificial insemination, the conceptions were assured by natural service by brood bulls, selected on the basis of their conformation and the milk production of their mothers.

The studied Holstein cows were raised in 118 herds with different size between 5 to 373 cows by herds. In these cattle farms, the majority of cows are kept in free stalls and divided into two large lots, one for the cows in lactation and other for the dried cows. The cows in lactation are divided into groups in paddocks depending on the cow’s physiological stage to facilitate the control of distributed food rations and managerial interventions. These cowsheds contain enough number of waterier, from square to trough (70 cm/head), sleeping area and exercise.

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The feed of the milk cows differs according to their physiological stage and the level of their production. It is essentially composed of green feed or kept as hay or as silage in some silos produced in the farms. The forage contains essentially the field corn and the alfalfa. As a result, the region has cultivated in an area of about 21844 ha. The animals also receive concentrated food whose composition varies depending on the physiological state of cow (Soybean meal, rapeseed colza, sunflower meal, corn kernels and the dehydrated root beet pulp and concentrated vitamin minerals). The farmers are still using composed feeds made by an internal unit of production.

The cows are raised in controlled farms and the farmers try to offer favorable conditions for the production. But the climate in this region is considered to be the major constraint for the development of dairy sector. the region is known by annual average temperatures between19°C (winter) and 27°C (summer) but hot sub-Saharan winds, especially in spring and summer, increase the temperatures until 49°C which cause acute thermal stress which limits the production. Even if there is enough equipment and technical provisions to reduce the effect of heat stress. The high temperatures diminish the welfare of animals. This situation has become worse in the last decade because of the effects of climate change on the land.

Data and statistical analysis: The data base was outcome after the results of the official milk control performed between 2008 and 2012 within the cooperative «COPAG» in the province of Taroudant belonging to the agriculture region of Souss-Massa. The analyzed data that concerns 9194 lactations of the 6307 Holstein cows belonging to 118 herds.

The official milk-recording program in Morocco adopted the A4 protocol recommended by International Committee for Animal Recording (ICAR). It is the most control used internationally and which is realized by a certified technician (A) in a monthly frequency of 4 weeks (ICAR 2012). The estimation of milk and fat quantities are interpolated by the Fleischmann method. Then the cumulative quantities are standardized to 305 days for the cows with long lactations with the exception of records of cows with lactations less than 305 days.

The study of the effects of non-genetic factors based on the YC, CS, RL and AC of different parameters of milk production, including 305-dMY, TMY and the LL, the data is classified according to the studied parameters:

- The lactation Ranks are constituted of 6 groups from the 1st to the 6th rank.
- Four seasons of calving were created: winter including the months of December to February, spring from March to May, summer from June to August and autumn from September to November.

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- For the year of calving, the lactations were divided into 5 groups from 2008 to 2012.
- The age of calving is shared by 6 groups (Gi): G1 (AC ≤ 30 months), G2 (30 months < AC ≤ 42 months), G3 (42 months < AC ≤ 54 months), G4 (54 months < AC ≤ 66 months), G5 (66 months < AC ≤ 78 months) and G6 (AC > 78 months).

The study of variability of milk production based on environmental factors has been made following the general linear model (GLM) approach including the fixed effects: RL, CA, YC and CS. For the multiple comparisons of means, we used the comparison test of Newman-Keuls. These statistical analyzes were performed using the software SAS version 9.2 (SAS 2008).

The used GLM model of the following: $\mathbf{Y_{ijklm} = m + A_i + B_j + C_k + E_l + e_{ijklm}}$

Where the symbols of this model are:

Y_{ijklm}: the measured values at year of calving (i), season of calving (j), calving age (k) and lactation number (l),

m: Mean of total observed values,

A_i: Effect of year of calving (i = years between 2008 and 2012),

B_j: Effect of season of calving (j = winter, spring, summer and autumn),

C_k: Effect of age at calving (k = G_1, G_2, G_3, G_4, G_5 and G_6),

E_l: Effect of lactation number (l = 1, 2, 3, 4, 5 and 6) and

e_{ijklm}: The residual error.

RESULTS AND DISCUSSION

Descriptive statistics: Means and standard deviations of 305-dMY, TMY and LL are presented in the table 1. The studied Holstein herd is significantly young with the CA in about 44.42±17.17 months. The production shows a big variability, however the average of 305-dMY is 6578.30±1619.06 kg and the TMY has recorded an average of 7034.88±1842.07 Kg with high coefficients of variation, whereas these cows have recorded an average of LL (325.10±42.96 days). This quantity produced by Holstein is very high to the national average milk production of local dairy breeds of Morocco (Tidili, Brown of Atlas and Oulemes-Zear). Which is between 794 kg and 933 kg per lactation (Boujenane *et al.,* 2004; Boujenane 2002) with short length lactation (78 days) varied between 6 to 300 days (Boujenane 2002).

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Table 1: Least square means and standard errors for 305-dMY, TMY, LL and CA

Parameters	Mean ± SD	Min	Max	CV (%)
Total milk yield (kg)	7034.88 ±1842.07	1968.70	15612	26.18
305-Days Milk Yield (kg)	6578.30±1619.06	1968.70	12855.10	24.61
Lactation length (days)	325.01±42.96	240	412	13.21
calving age (months)	44.42±17.17	18.67	115.10	38.65

n: number of lactations, SD: standard deviation, Min: minima, Max: maxima, CV: coefficient of variation

The quantity of 305-dMY recorded during this study is lot less than the one reported in the temperate countries or many references have reported in 305-dMY between 7980±54.20 Kg and 9200±1026Kg (Wicks and Leaver, 2006; García-Ispierto *et al.,* 2007; Albarrán-Portillo and Pollott, 2011). Other studies have reported that the milk production of Holstein cows demonstrated a considerable fall in the tropical and subtropical countries. So, Holstein has registered low average; between 2554kg and 3978kg (Javed *et al.* 2004; Ríos-Utrera *et al.* 2013; Usman *et al.* 2013), while this amount of milk is comparable to the one reported by many studies under climatic conditions similar to the studied region; between 5523kg and 6810kg (M'hamdi *et al.,* 2012; Sahin *et al.,* 2012; Bakir and Kaygisiz 2013; Bouallegue *et al.,* 2013). The LL recorded during this study was longer than the one found by certain researchers (Javed *et al.,* 2007; Bakir *et al.*, 2009; Wondifraw *et al.*, 2013) but It is shorter than the one found by other researchers (Kaya *et al.*, 2009).

The analysis of variance has showed a very highly significant effect of YC, CS and RL (P<0.001) on all studied parameters, 305-dMY, TMY and LL, whereas the effect of the CA on these studied production parameters is non-significant (p>0.05).

The effects of calving season: The calving season shows a highly significant effect (P<0.001) for all the studied parameters of production 305-dMY, TMY and LL (table 2). However the cold and rainy season, autumn and winter, are the favorable seasons for the quantity of TMY and 305-dMY. However the hot and dried seasons, spring and summer, have disadvantaged the production. This shows that milk production is highly sensitive to the seasonal variations. Many researchers have stated that the CS has a significant impact on 305-d MY and TMY (Katok and Yanar 2012; Bouallegue *et al.,* 2013). On the contrary others have found a non-significant effect on the CS (Bakir *et al.,* 2009).

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Table 2: Effect of season of calving on 305-dMY, TMY and LL of Holstein cows

		305-dMY (Kg)	TMY(Kg)	LL (days)
Calving season	n	Mean ± SD	Mean ± SD	Mean ± SD
Winter	2957	6572.52±1635.75[b]	6966.04±1806.06[b]	321.34±42.35[c]
Spring	1754	6354.93±1505.33[c]	6870.56±1766.75[b]	328.99±45.23[a]
Summer	1868	6394.86±1517.86[c]	6879.40±1778,27[b]	326.28±42.97[b]
Autumn	2615	6865.68±1699.36[a]	7334.00±1939.74[a]	325.89±41.75[b]

305-dMY: 305-Days Milk Yield , TMY: Total milk yield, LL: Lactation length, SD: standard deviation; n: number of lactations, [a,b,c]: Means within columns with different superscript are significantly different (p < 0,05)

So, the productive quantity of the calving in autumn are more superior than the ones obtained in spring and summer. However, TMY and 305-dMY the highest were observed by the cows having fall calving 7334±1939.74 kg and 6865.68±1699.36 kg, respectively. While the weakest are the ones of spring and summer calving which are 6870.56±1766.75 kg and 6354.93±1505.33 kg for the spring and 6879.40±1778.27kg and 6394.86±1517.86 kg for summer, named respectively. Many studies have found that the calving of cold seasons “winter and / or spring” produce more milk than the calving of hot seasons “summer and / or spring”(Bakir *et al.*, 2009; Zhao *et al.*, 2012; Ríos-Utrera *et al.*, 2013). In the other hand many studies have marked non-significant effect of the CS on the LL (Wondifraw *et al.* 2013), on the contrary, other studies have revealed its significant effect on LL (Bakir *et al.*, 2009) which is consistent with the result of this study.

These records can be explained by the climatic effects of the region, for that the region of Souss-Massa knows a cold and rainy season starting from November to March, matches Autumn and Winter which promotes the milk production. The hot and dry season last from April to October which corresponds the beginning of spring and the summer disadvantages the production of Holstein cows. According to Hahn (1981) the adequate thermal interval for feeding Holstein cattle is between 4°C and 24°C. For that the production of lactating cattle would be highest if the temperature is between 15°C to 24°C (Atrian and Shahryar, 2012; Allen *et al.*, 2013).

The immediate responses to heat load are increased respiration rates, decreased feed intake and increased water intake (Bernabucci *et al.*, 2010). When the environmental temperatures exceed the thermal comfort range for cows, they start to sweat too much (Berman 2005; Atrian and Shahryar, 2012; Bernabucci *et al.*, 2014)and will eat less which leads to a low milk yield (Atrian and Shahryar, 2012). However the effects of thermal stress on the cattle can be observed above 24°C and milk production decreases after 27°C (Johnson 1965; Johnson and

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Vanjonack, 1976). The thermal stress may reduce food intake, the weight gain, the efficiency of reproduction, the production of milk and increase the sensibility to diseases (West *et al.,* 2003; Dikmen and Hansen, 2009; Atrian and Shahryar, 2012).

In the studied region, the average temperature hovers near 19°C during the raining and cold season, while in hot and dried season the average temperatures mark 27°C in summer and can reach 40°C with the arrive of hot Saharan occasional winds (MEMEE, 2015). Thereby at the end of spring and summer the thermal stress provokes the decrease in the production, whereas the drop of the temperature during the autumn and winter optimizes the production of livestock. Consequently, the cows calving in the autumn and winter produce more milk than the cows calving in summer and spring. Many authors have reported that the submission of Holstein cows to ambient temperatures exceeding 40°C under subtropical and tropical conditions cause production fall of milk and mark a yield of 3 to 4 tons per lactation (Ríos-Utrera *et al.,* 2013; Usman *et al.,* 2013).

The effects of year calving: The year of calving has a highly significant effect (P < 0.001) for all the parameters of the studied production (table 3). So, we perceive that the milk production varies considerably from one year to another. The highest values of parameters 305-dMY, TMY and LL were obtained in 2008 that are respectively, 6787.60±1815.71 kg, 7247.78±2009.61 kg and 324.66±43.48days. Whereas the lowest values for 305-dMY, TMY and LL are recorded in 2012 and are respectively equal to 6184.45±1429.89 kg, 6530.04±1606.60 kg and 315.62±41.88 days.

Table 3: Effect of year of calving on 305-dMY, TMY and LL of Holstein cows

Calving year	n	305-dMY (Kg)	TMY(Kg)	LL (days)
		Mean ± SD	Mean ± SD	Mean ± SD
2008	828	6787.60±1815.71^{a}	7247.78±2009.61^{a}	324.66±43.4^{b}
2009	1502	6605.22±1736.10^{b}	7116.53±1957.40^{ab}	328.90±42.2^{a}
2010	2209	6674.77±1652.03^{ab}	7177.29±1898.89^{ab}	328.65±43.8^{a}
2011	3192	6625.08±1537.23^{b}	7074.05±1761.17^{b}	325.32±42.3^{ab}
2012	1463	6184.45±1429.89^{c}	6530.04±1606.60^{c}	315.62±41.9^{c}

305-dMY: 305-Days Milk Yield , TMY: Total milk yield, LL: Lactation length, SD: standard deviation, n: number of lactations, ^{a,b,c}: Means within columns with different superscript are significantly different (p < 0,05)

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Between the years can touch the food intake, sanitary maintenance renewed of the reform of livestock, the selection of brood stock, and the conduct of reproduction. Thus many studies have reported a great fluctuation of the production depending on the years and have highlighted that the YC have a high significant influence on 305-dMY, TMY and LL (García-Ispierto *et al.*, 2007; M'hamdi *et al.*, 2012; Sahin *et al.*, 2012; Bakir and Kaygisiz, 2013), on the other hand researchers have noted a non-significant effect (Usman *et al.*, 2013).

The effects of the rank of lactation: The statistical analysis revealed a high significant influence (P<0.001) of the parity for all the studied parameters (table 4). However the primiparous cows have produced the lowest 305-dMY and TMY, respectively, 6143.89±1463.18 kg and 6635.07±1715.04kg. Then these quantities have experienced a net increase until a maximum production in the 3rd lactation with 305-dMY and TMY, respectively 7000.66±1634.46 kg and 7431.36±1858.10 kg. After the third lactation, we observe a gradual drop of the production with the increase of the RL to record in the 6th lactation 6753.20±1551.33 kg and 7031.67±1738.34 kg, respectively for 305-dMY and TMY.

Table 4: Effect of lactation number on 305-dMY, TMY and LL of Holstein cows

		305-dMY (Kg)	TMY(Kg)	LL (days)
Rank of lactation	n	Mean ± SD	Mean ± SD	Mean ± SD
1	3619	6143.89±1463.18^{b}	6635.07±1715.04^{c}	325.52±42.4^{a}
2	2619	6777.57±1663.91^{a}	7225.57±1889.83^{ab}	325.31±43.7^{a}
3	1744	7000.66±1634.46^{a}	7431.36±1858.10^{a}	324.51±42.8^{a}
4	799	6857.38±1661.10^{a}	7280.99±1880.98^{ab}	325.03±43.8^{a}
5	319	6810.83±1627.04^{a}	7221.92±1836.20^{ab}	325.89±41.7^{a}
6	94	6753.20±1551.33^{a}	7031.67±1738.34^{b}	312.19±39.1^{b}

305-dMY: 305-Days Milk Yield, TMY: Total milk yield, LL: Lactation length, SD: standard deviation; n: number of lactations, $^{a, b, c}$: Means within columns with different superscript are significantly different ($p < 0.05$).

For the LL we note that the 5 first lactations do not present a significant difference and have recorded similar duration with a maximum in the 5th lactation with duration of 325.89±41.73 days but at the 6th lactation the LL knew an astonished fall towards 312.19±39.13 days.

Many researchers have revealed a significant effect of the RL on the quantity of milk (Zhao *et al.*, 2012; Ríos-Utrera *et al.*, 2013; Wondifraw *et al.*, 2013). Whereas other studies have reported a non-significant effect of the parity (Tekerli and Gündoğan 2005).So, the maximum production of milk has been reached in the 3rd lactation which is in line with several researchers

(Sahin *et al.*, 2012; Bakir and Kaygisiz, 2013; Ríos-Utrera *et al.*, 2013), but other researchers have stated that the maximum production happens in the 2nd lactation (Bakir *et al.*, 2009; M'hamdi *et al.*, 2012; Zhao *et al.*, 2012) and for others the 5th lactation (Wondifraw *et al.*, 2013).

The effect of calving age: The age of calving has showed a non-significant effect (P > 0.05) for all the parameters of the analyzed production 305-dMY, TMY and LL (table 5). This may be explained by the relative youth of the studied herd whose 88.15% of analyzed lactations have a CA ≤ 5.5 years. However we find that the young cows which have an age ≤ 30 months have produced weak quantities 305-dMY and TMY, note respectively, 6098.23±1415.45 kg and 6585.35±1664.89kg.

Table 5: Effect of calving age on 305-dMY, TMY and LL of Holstein cows

		305-dMY (Kg)	TMY(Kg)	LL (days)
Calving age	n	Mean ± SD	Mean ± SD	Mean ± SD
Age ≤ 30 months	2571	6098.23±1415.45	6585.35±1664.89	325.15±42.44
30 < Age ≤ 42	2250	6501.78±1606.11	6955.79±1831.61	324.36±43.21
42 < Age ≤ 54	1906	6869.93±1653.73	7322.69±1887.08	326.36±42.84
54 < Age ≤ 66	1378	6962.08±1649.22	7390.55±1877.14	323.47±43.23
66 < Age ≤ 78	610	6853.12±1703.93	7282.89±1910.70	325.19±43.97
Age > 78 months	479	6899.90±1685.51	7334.88±1896.64	327.96±42.87

TMY: Total milk yield, 305-dMY: 305-Days Milk Yield, LL: Lactation length, SD: standard deviation, n: number of lactations

Production increases gradually with the progress of the age of cows, thus the cows having an age between 4.5 and 5.5 years old (305-dMY and TMY) and have recorded the greatest quantities 6962.08±1649.22 kg and 7390.55±1877.14 kg. After this age we notice a relative decrease of the production with the progress of the age was observed. So, Bakir *et al.* (2009) and Çilek (2009) have mentioned that the Holstein cows produces small amount of milk at lower ages to 3 years then increases gradually with the age to reach the maximum of production at the age of maturity between 5.5 and 7.5 years. This may be explained by the growth of the cows and the development of its breast tissue until maturity.

The productivity of the Holstein cow is low in this region where the climate with high temperatures. These high temperatures lead to heat stress, which causes unbalanced hormonal and metabolic (Morand-Fehr and Doreau, 2001). Exposure of cows to high temperatures decreased thyroid hormones levels to avoid excessive heat production by the animal (Muller,

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1994a). Since these hormones control thermo-genesis by avoiding heat production (Habeeb *et al.*, 1992). Heat production by homoeothermic is associated with respiration and oxidation of nutrients (Morand-Fehr and Doreau, 2001). Through the adverse conditions of heat stress, the rate of basic metabolism is reduced following a reduction of the energy of the latter but at the same time there is an increase in the metabolism of water and electrolytes (Collier *et al.*, 2012).

This change in metabolic activity is regular with decreased ingestion, growth, and milk production through heat stress conditions (Beede and Collier, 1986; Muller, 1994b). In contrast, water consumption by cows increases with heat stress, which is used as a route to dissipate heat by breathing and sweating (Muller, 1994b). In addition, dairy cows reduce ingestion to reduce heat production associated with ruminale fermentation, masticator activity, movement and movement related to foraging, and muscular activity of the digestive tract (Chilliard *et al.*, 1995; Morand-Fehr and Doreau, 2001). Ingestion begins to decrease and the cow's maintenance needs increase when the ambient temperature exceeds 25°C. But when the temperature exceeds 27°C there is a drop in milk production (West 1999), because the energy balance of the cow has become negative (Baumgard and Rhoads, 2013).

CONCLUSION

In the region of Souss-Massa in the South West of Morocco the dairy performances of Holstein cows present a great variability and they are influenced by non-genetic factors in a very highly significant way. Among the unfavorable factors the thermal stress caused by the high temperatures in late spring and summer which limits the production of this race. Heat stress is a negative factor that reduces the profitability of dairy farms in the region and leads to a significant decrease in milk production in dairy cows, in addition to that metabolic and behavioral disorders of these cows. Although these factors limiting the productive potential of this breed, the 305-dMY and TMY are more superior than the ones recorded in other regions of Morocco. This is due to the amelioration of the conditions of farming with a better food and a modern management of breeding which may minimize the environmental effects and weaken the seasonal differences.

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