4.2. Heat stress in dairy cows in the central part of Ukraine and its economic consequences

Thermal stress remains an unacknowledged problem in domestic dairy farming, although the financial losses from its harmful influence in developed European countries are estimated at an average of more than 400 EUR per cow per year. Dairy cattle are very sensitive to heat stress, which results in a significant decrease in productivity. In addition, to economic losses leads to deterioration in animal health and the quality of milk received (St-Pierre et el., 2003; Malynyn & Sadovnykova, 2016).

Studies of recent years found, that the decline in cow productivity occurs under the influence of stress hormone – cortisol, the concentration of which during the development of heat stress, increases tens of times (Burjakov et el., 2016). Cortisol reduces the functionality of immune cells, worsens their reproduction, reducing the body's defense against infections. By suppressing the release of oxytocin, this hormone reduces milk yield and increases the amount of milk that remains in the udder. The probability and degree of severity of development of mastitis increases. Heat stress is accompanied by oxidative damage to the lipid envelopes of breast cells, which leads to an increase in somatic cells in milk. He also had a negative effect on the reproductive capacity of animals. The consequences can also be observed after the termination of exposure to heat stress. In particular, laminitis, white line disease and hoof disease are recorded in animals for several months after its action (Hansen & Arechiga, 1999; Bernabucci et el., 2002; Kuevda et el., 2016).

The manifestation of heat stress in cows depends on the temperature of the air and its humidity. A comfortable range of temperatures for them range from +5 ° C to +25 ° C (Fomychev et el., 2013; Petrusha & Dibirov, 2014). To determine the degree of influence of heat stress on animals, a special index THI (Temperature Humidity Index) is widely used, which is a combination of two variables, namely ambient temperature and relative humidity. Most researchers report that heat stress in cows occurs THI = 68 and higher (Fomychev et el., 2013; Pyron & Malynyn, 2015; Malynyn & Sadovnykova, 2016).

The purpose of our studies was to assess the likelihood of heat stress in the central part of Ukraine, and its impact on the productivity of dairy cows and possible economic losses.

During the warm period of 2017 (from May 1 to September 30), every day at different times of the day (four times), the air temperature and relative humidity were measured. The temperature-humidity index was determined by

the conventional method (Kibler, 1964). The yield of high-yielding Schwyz breed cows in the conditions one of the high-tech dairy complex in Dnipro (this is a commercial secret) was evaluated using the herd management system "Dairy Comp 305". Stat Soft software "Statistic 10" was used to process the obtained research data and assess the reliability of the indicators.

In monitoring studies of recent years, global warming is reported. This is a significant problem for dairy farming in most of Europe, especially for central and southern regions, as evidenced by recent research.

In connection with this, we conducted an analysis of the temperature dynamics of the air environment in the warm period (May-September) 2016-2017 in the central part of Ukraine (Dnipro). For this purpose, the archive material of the weather report was used (www.accuweather.com). It has been established that in recent years, compared with the long-term data (+26.4 ° C), the average temperature in the warm period of the year did not differ significantly: in 2016 it was lower by 0.1 ° C (td = 0.24; P <0.95), while in 2017 it increased by 0.6 ° C (td = 1.07; P <0.95).

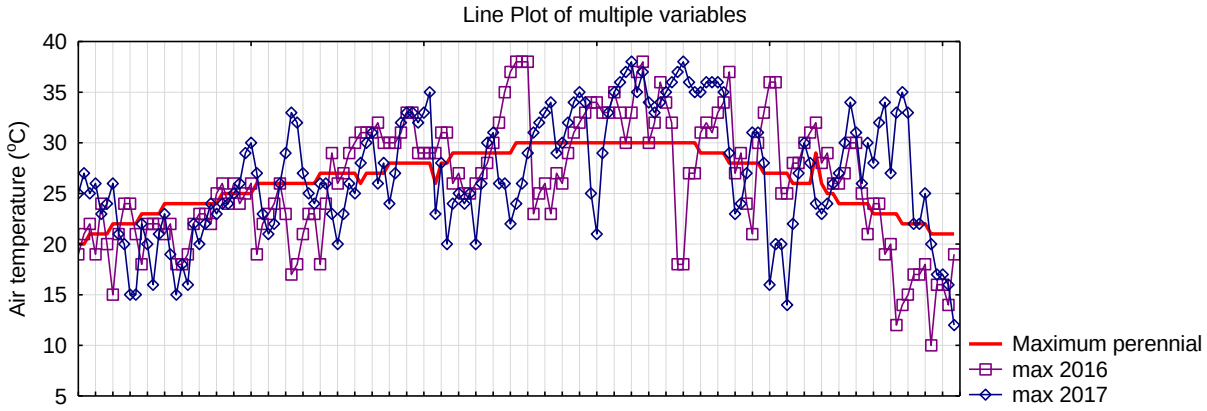


Fig. 1. Dynamics of maximum temperatures in the period from May to September

However, it should be noted that in some periods the temperature increase was significant. Specifically, the difference between the long-term data and the average temperature in August 2017 was +3.0 ° C and proved to be reliable (td = 2.89; P> 0.95). And in some periods of this month the temperature difference was +8.0 ° C. September of this year (2017) was especially hot. The difference between the long-term maximum and the temperature in certain periods of this month was + 10 ... +13 ° C, with its largest values at +35 ° C.

At high air temperatures, the temperature-humidity index (THI) is a common indicator of the assessment of heat stress (Kibler, 1964). To ensure comfortable conditions for animals, the THI value should be below 68. THI at 68-71 corresponds to low stress, 72-79 to moderate stress, 80 to 89 to severe stress and 90 to 99 to very high stress (Pyron & Malynyn, 2015).

We have studied the possibility of occurrence of heat stress in animals during the hot season of 2017 (from May to September). It is established (Table 1) that the value of the THI indicator directly depended on the temperature regime of the ambient air (r = 0.98, P> 0.95).

Table 1. Average parameters of the temperature-humidity regime of the environment in the warm period of 2017

Month	Temperature of air, °C		Humidity of air, %		THI	
	M	m	M	m	M	m
May	14.7	0.51	62.0	1.83	57.5	0.68
June	19.7	0.47	60.9	1.65	64.9	0.58
July	20.7	0.49	66.2	1.70	66.3	0.59
August	23.4	0.60	53.0	1.90	68.8	0.65
September	19.9	0.54	59.6	2.01	64.4	0.60

As can be seen from the data presented, the average THI in August corresponded to the level of low stress. However, during the hot period of the day, throughout the warm period of the year taken for evaluation (May-September), the animals could be in a state of thermal stress of one or another force. So, in May, the value of THI in which dairy cattle could be in a state of heat stress was 5 days, including 3 days corresponding to a small stress and 2 days to moderate stress (Figure 2).

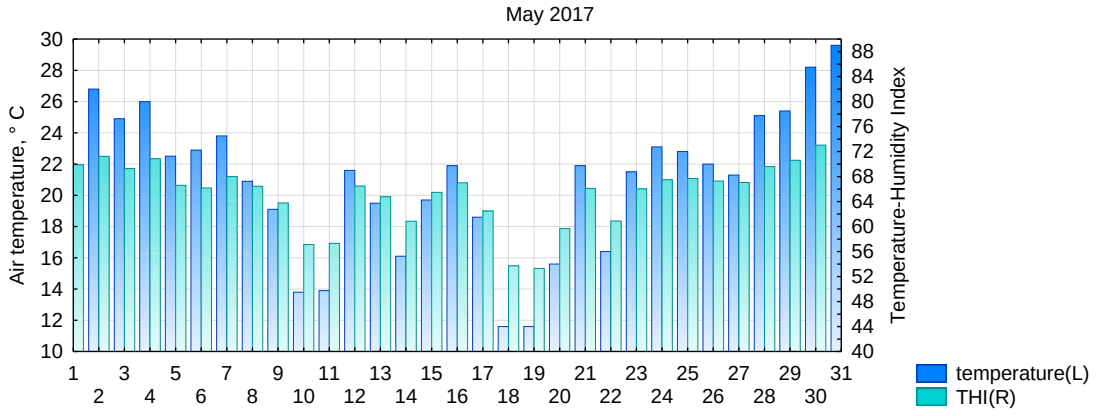


Fig. 2. Dynamics of air temperature in the hottest period of the day

In June (Figure 3), the value of THI in which dairy cattle could be in a state of heat stress was 25 days, of which 12 days corresponded to a low stress and 12 days to a moderate stress.

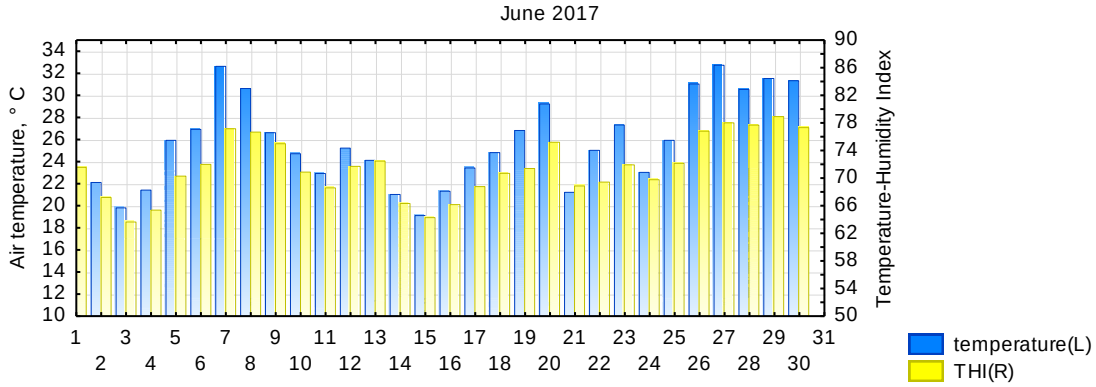


Fig. 3. Dynamics of air temperature in the hottest period of the day

In July (Figure 4), the value of THI during the period of maximum temperature rise, during the day at which dairy cattle could be in a state of heat stress was 22 days. However, the degree of manifestation of a possible stress reaction increased. During this period, the animals could be in a state of thermal stress of strong action (THI> 80) one day; 18 days corresponded to mild stress and only 3 days – a state of low stress.

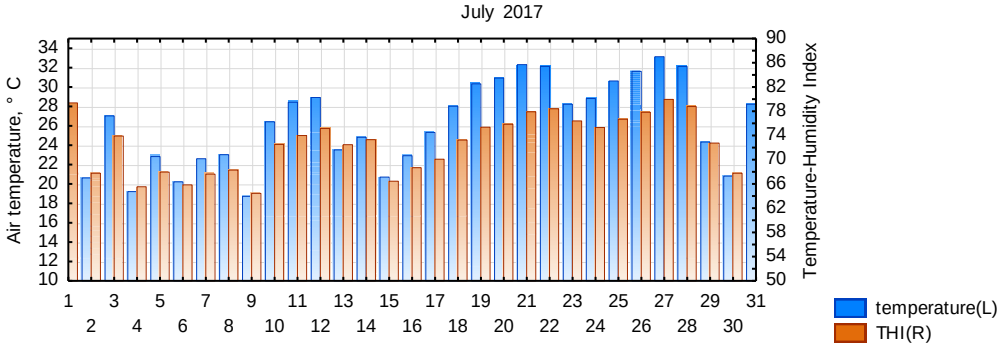


Fig 4. Dynamics of air temperature in the hottest period of the day

The hottest was August 2017 (Figure 5). The number of days when dairy cattle could experience the heat stress of a strong effect was 7 days, moderate - 17 and only 2 days a little stress. In this case, the THI value exceeding the comfort zone of the animals (68) this month was observed for 26 days.

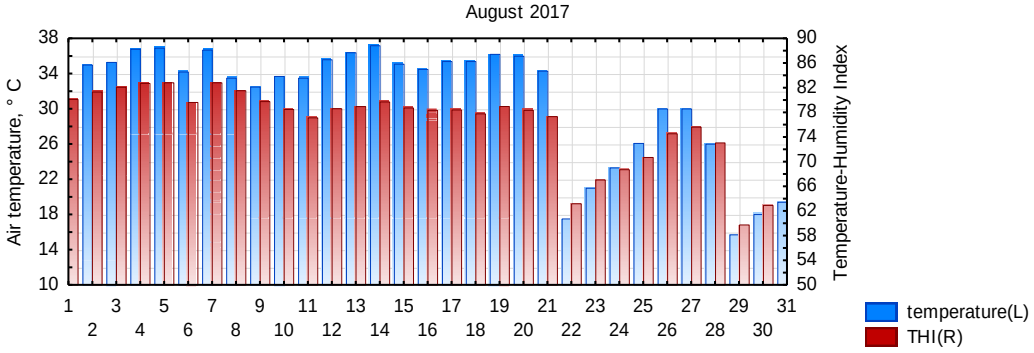


Fig. 5. Dynamics of air temperature in the hottest period of the day

Despite the long-term trend of temperature decrease, September, the year 2017 was characterized by significant maximum daily temperatures, the highest of which was raised to +33 ... + 35 ° C and higher (Figure 6).

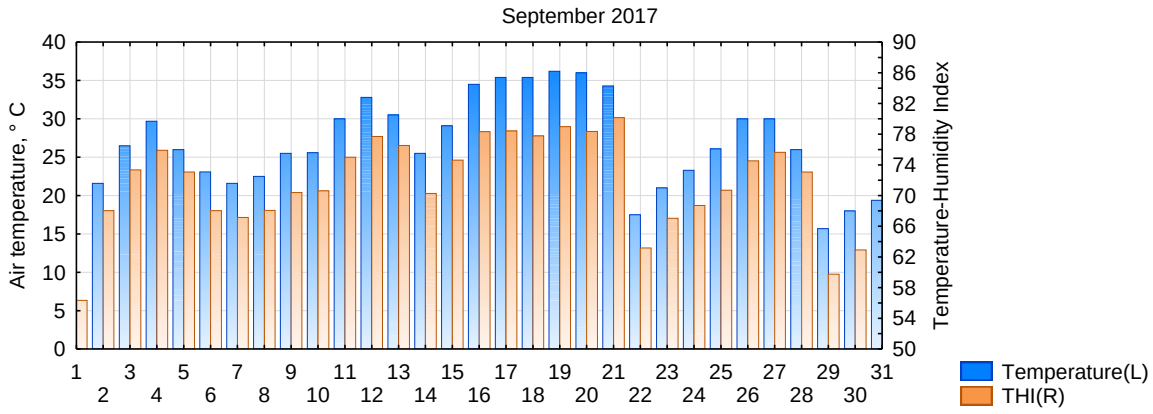


Fig. 6. Dynamics of air temperature in the hottest period of the day

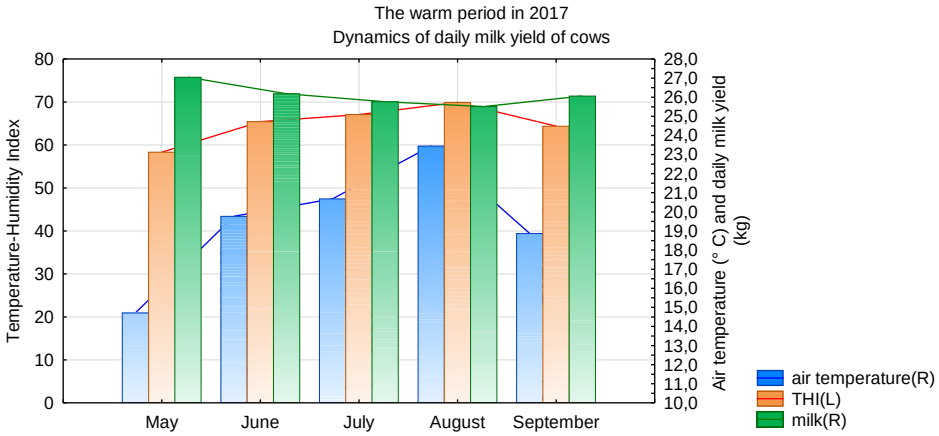
At the same time, the THI value, in which animals could be exposed to severe heat stress, was recorded for 1 day, moderate stress of 15 days and a slight stress of 6 days. In general, the number of days exceeding the conditions of comfort for animals in September was 22 days.

Thus, the index THI, which exceeded the value of comfort for dairy cows in the warm period in 2017 (from May to September inclusive), recorded over 100 days. This amounted to approximately 35% of the warm period of the year. Of these, 73 days were recorded during the hot summer period.

The hot season is a special problem for highly productive cows that are kept in "cold" barns all year round, as the temperature and humidity regime in them is as close as possible to the environmental conditions (Vysokos et al., 2015; Dogel' & Medvedskyj, 2017).

We studied the influence of high temperatures and THI in the warm period of 2017 on the milk yield of the Schwyz breed cows in the conditions of year-round keeping in the "cold" barn of the industrial dairy complex (Dnipro). A moderate degree of negative correlation was established between air temperature and milk yield per day ($r = -0.45$, $P > 0.95$), as well as by the index of THI and milk yield ($r = -0.49$; $P > 0.95$).

It was found that in comparison with the most favorable weather conditions in May (THI = 58), when the average daily yield for a herd of cows was 27 kg, the yield of cows in June (THI = 65), July (THI = 66), August (THI = 69) and September (THI = 64) "fell" by 3.0% ($td = 5.4$, $P > 0.999$); 4.6% ($td = 7.9$, $P > 0.999$); 5.5% ($td = 6.3$, $P > 0.999$) and 3.5% ($td = 5.9$, $P > 0.999$). This was manifested in a decrease in the average daily milk yield in the herd in June, July, August and September, respectively, by 0.85; 1.39; 1.54 and 0.99 kg (Figure 7).



To prevent the effects of high temperatures in the barns of the dairy complex, active ventilation is used using the longitudinal arrangement of the fans. However, their independent use (without air humidification) proved to be insufficiently effective. As a consequence, for the period from June to September 2017 inclusive, losses per cow amounted to 146 kg of milk. Given the average price of milk sales in Ukraine (in terms of euro at the rate of the National Bank), as a result of high temperatures in the hot season of 2017, the company incurred a loss in the dairy herd at a rate of 37.5 thousand €, or 39.5 € per 1 cow.

Studies conducted by specialists from Lallemand Animal Nutrition (Pyron & Malynyn, 2015), confirm that the problem of heat stress in cattle is relevant for all European countries. Loss of farmers in Europe in the summer on average is 3 kg of milk / cow / day. In particular in Spain, Italy and southern France, milk cows are exposed to heat stress for most of the day (from 13 to 18 hours). In this case, the loss of milk productivity for the southern regions of Europe is huge - up to 5.5 kg of milk per cow per day. In the north of France, in Switzerland, the Czech Republic, Poland, where cattle breeders are usually not concerned with the problem of heat stress, the cows were under stress conditions from 6 to 10 hours a day. And even in cool Britain, heat stress affected animals for 2 hours a day.

In reducing the effect of heat stress on lactating dairy cows, three main directions can be formulated: modification of the environment, creation of genetically resistant breeds of cattle and improvement of methods of digestive control (West, 2003; Burjakov et el., 2016; Golovan' et el., 2017).

Naturally, one of the effective methods of preventing heat stress is to reduce the temperature in the habitats of animals. The use of awnings, fans, sprinklers is the most effective way to reduce body temperature in animals, especially in the locations of animals before milking (Pyron & Malynyn, 2015; Yvanov et el., 2016).

In studies performed in Israel, the results of which were published back in 1988, it was shown that the combination of wetting and forced ventilation can reduce the daily increase in rectal temperature by 0.3 ° C and increase the yield of cows by 3.6 kg / day (Wolfenson et el., 1988).

Sufficiently effective is the combination of active ventilation with air humidification, proposed by employees of the Dnepropetrovsk State Agrarian and Economic University (Pugach et el., 2016). The advantages of using fog-type systems on farms include automatic maintenance of an optimal microclimate (humidity / temperature), elimination of dust and pathogenic bacteria, neutralization of unpleasant odors. During evaporation, excessive air humidification does not occur, so the litter remains dry, unlike less efficient systems. There is also the possibility of using a set of equipment for disinfection of the wide-area premises of the industrial complex (Vysokos et al., 2017).

The obtained results confirm that in the conditions of the central part of Ukraine during the warm period of the year the probability of occurrence of heat stress in dairy cows is high. The THI indicator, which exceeded the comfortable value for dairy cows in the warm period of 2017 (May-September) was recorded for 100 days. As a result of high temperatures in the hot season of 2017, the loss for the dairy herd amounted to 37.5 thousand EUR, or 39.5 EUR per 1 cow. Considering the high probability of occurrence of heat stress when keeping animals in "cold" premises for a year, it is advisable to use active ventilation systems with humidification to prevent it.

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