Heat stress is detrimental to cows; protected B vitamins can help

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AT A GLANCE

Studies show supplementing B vitamins during times of heat stress can reduce milk loss and improve reproductive performance.

Dairy cows are very susceptible to heat stress and will adapt by reducing their milk production. Only half of that milk reduction is explained by a lower dry matter intake; other metabolic changes are involved, including a shift in the use of glucose by the mammary gland to other tissues, reducing its availability for milk production, a reduction in rumination and nutrient absorption, and an increase in maintenance needs to dissipate heat.

Heat stress is particularly detrimental to modern-type high-producing cows selected intensively for productivity. They have a large body mass, which implies a high metabolic heat production to meet their maintenance needs; this factor explains partly why they are less tolerant to heat. Even if management has improved to reduce the effect of heat stress, the economic loss related to heat stress is still close to $1 billion in the U.S. This loss of revenue is due to a reduction in milk production, butterfat yield and reproductive performance.

At which temperature can we identify if a cow is suffering from heat stress?

A tool called the temperature-humidity index (THI) was developed to identify when heat stress will negatively affect the performance of dairy cows. Both temperature and humidity should be considered, since the combination is worse for dairy cows. For the same temperature, the THI will increase with humidity and vice versa. The THI is a color-coded chart showing various levels of heat stress severities, with the heat stress threshold at a THI of 68 and severe heat stress at 90.

At THI 68, dairy producers need to start adjusting management and nutrition to minimize the impact of heat stress on their dairy herd. An example of THI 68 is a temperature of 73.4ºF with a humidity of 40 percent (Figure 1, page 45). The temperature and humidity measurements should be done in the cow barn,

Continued on back

FIGURE 1 Adjusting management and feeding to minimize heat stress in dairy cows

Temp.		% Relative humidity																				
ºF	ºC	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
72	22.0	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71	72	72
73	23.0	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72	73	73
74	23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	74	74
75	24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
76	24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76
77	25.0	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
78	25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	76	77	77	78
79	26.0	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78	78	79
80	26.5	68	69	69	70	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79	79	80
81	27.0	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80	80	81
82	28.0	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82
83	28.5	69	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	82	83
84	29.0	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84
85	29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85
86	30.0	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85	86	87
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86	87	88
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87	88	89
90	32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90
91	33.0	73	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91
92	33.5	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90	91	92
93	34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91	92	93
94	34.5	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92	93	94
95	35.0	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	35.5	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96
97	36.0	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97
98	36.5	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95	96	98
99	37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96	98	99
100	38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98	99	100
101	38.5	77	79	80	81	82	83	84	86	87	88	89	90	92	93	94	95	96	98	99	100	101
102	39.0	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100	101	102
103	39.5	78	79	81	82	83	84	86	87	88	89	91	92	93	94	96	97	98	99	101	102	103
104	40.0	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101	103	104
105	40.5	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97	99	100	101	102	103	105
106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103	104	106
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104	106	107
108	42.0	81	82	83	85	86	88	89	90	92	93	94	96	97	98	100	101	103	104	105	107	108
109	43.0	81	82	84	85	87	89	89	91	92	94	95	96	98	99	101	102	103	105	106	108	109
110	43.5	81	83	84	86	87	89	90	91	93	94	96	97	99	100	101	103	104	106	107	109	110
111	44.0	82	83	85	86	88	90	91	92	94	95	96	98	99	101	102	104	105	107	108	110	111
112	44.5	82	84	85	87	88	90	91	93	94	96	97	99	100	102	103	105	106	108	109	111	112
113	45.0	83	84	86	87	89	91	92	93	95	96	98	99	101	102	104	105	107	108	110	111	113
114	45.5	83	85	86	88	89	92	92	94	96	97	99	100	102	103	105	106	108	109	111	112	114
115	46.0	84	85	87	88	90	92	93	95	96	98	99	101	102	104	106	107	109	110	112	113	115
116	46.5	84	86	87	89	90	93	94	95	97	98	100	102	103	105	106	108	110	111	113	114	116
117	47.0	85	86	88	89	91	93	94	96	98	99	101	102	104	106	107	109	111	112	114	115	117
118	48.0	85	87	88	90	92	94	95	97	98	100	102	103	105	106	108	110	111	113	115	116	118
119	48.5	85	87	89	90	92	94	96	87	99	101	102	104	106	107	109	111	112	114	116	117	119
120	49.0	86	88	89	91	93	95	96	98	100	101	103	105	106	108	110	111	113	115	117	118	120

- **Stress threshold – Respiration rate exceeds 60 BPM. Milk yield losses begin. Reproductive losses detectable. Rectal temperature exceeds 101.3°F**
- **Mild-moderate stress – Respiration rate exceeds 75 BPM. Rectal temperature exceeds 102.2°F**
- **Moderate-severe stress – Respiration rate exceeds 85 BPM. Rectal temperature exceeds 104°F**
- **Severe stress – Respiration rate 120-140 BPM. Rectal temperature exceeds 106°F**

B vitamins, cont'd from front

not by simply using the local weather station. The length of the heat stress will impact performance and recovery will take weeks.

Dairy cows will start to reduce their milk production when the THI is at 68 – sometimes even at a lower THI. This was demonstrated in a study done at the University of Arizona with cows producing 77.2 pounds of milk daily. The milk production dropped by 4.85 pounds of milk per day when the minimum THI was, on average, 68 (65 to 73). This suggests cooling dairy cows should start when the minimum daily THI is at 65. The maximum impact on milk production will occur 24 to 48 hours following heat stress.

Heat-stressed cows will adapt differently than unstressed animals. They will not mobilize body fat tissue to meet the energy demand for milk production, even if the dry matter intake is reduced and not sufficient to meet the energy requirement. This was shown in a controlled study when dry matter was reduced to the same extent for heat-stressed cows than cows under thermoneutral environment; the blood non-esterified fatty acids of cows under heat stress did not increase compared to cows under thermoneutral environment.

Dry cow heat stress negatively impacts the dam and the calf's future performance

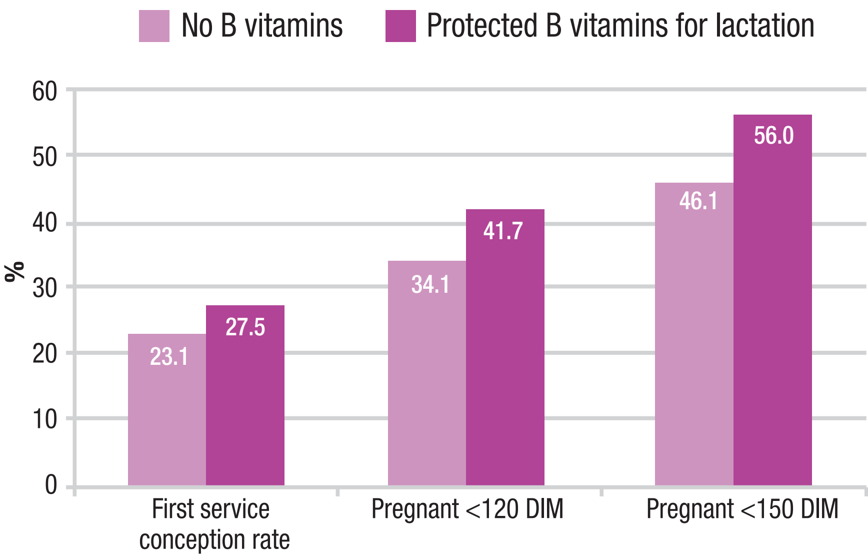
Mammary gland development during the dry cow period is compromised when cows are under heat stress, which will negatively impact their future milk performance. A summary of various studies with dairy cows under heat stress conditions during the entire dry period resulted in a decrease in milk production of almost 8.8 pounds per day during the subsequent lactation. When heat stress was only during the close-up period, milk was also decreased but to a lesser extent: 4.85 pounds per day.

Calves born from cows experiencing heat stress during the dry period will have a lower birthweight and a lower weight and height at 12 months old. These heifers will become pregnant later and will require more services per conception than heifers from cows not under heat stress conditions. Their first-lactation yield will also be reduced by 11 pounds per day at least for the first 245 days in milk.

Heat stress preceding and during the breeding period affects the cow and its future progeny

When cows are under heat stress, their expression of heat is depressed due to a lower production of estradiol, and the quality of the ova is reduced. Lower-quality ova may influence the viability of the embryo. Early embryo development up to day six is impaired when the body temperature of the dairy cow reaches 102°F. This explains the lower pregnancy and conception rates observed during summer months when cows are under heat stress. It takes 40 to 60 days following heat stress before fertility returns to normal.

FIGURE 2 Effect of protected B vitamins on reproductive performance during heat stress



Recent studies showed an association between heat stress during the breeding period and the subsequent milk production of their progeny. The future milk production of heifers born from the heat-stressed cows was 180.77 to 879.64 pounds less during their entire lactation than heifers from cows under thermoneutral environment.

What can be done to reduce the impact of heat stress on dairy cows?

The use of cooling systems and a reduction of stocking density are sound management tools to reduce the extent of heat stress during summer months. Providing clean water, along with some nutritional adjustment to the ration, will alleviate the risk of reduced performance.

The supplementation of some protected B vitamins in the diet during the transition and lactation period is also beneficial to reduce the negative impact of heat stress. B vitamins are essential nutrients and have specific functions in the energy and protein metabolism of the dairy cow, in the immune response, follicular development and early embryonic survival. Some B vitamins, like biotin (B8), cobalamin (B12), pantothenic acid (B5) and riboflavin (B2), are also important enzyme co-factors involved in glucose synthesis, which is occurring in the liver. Liver function is crucial, and some B vitamins like folic acid, B12 and choline are nutrients involved in the mechanism to reduce the risk of fatty liver.

Feeding protected B vitamins improved milk and reproductive performance under heat stress

Increased milk production and milk components yield, along with improved energetic efficiency, was observed when early lactation cows were supplemented with a specific blend of protected B vitamins during the summer in California (folic acid, pyridoxine, pantothenic acid and biotin).

A study conducted during the summer in the north of Mexico, where reproductive performance is usually drastically reduced due to heat stress, showed improved reproductive performance when the ration of dairy cows was supplemented with a blend of protected B vitamins during the lactation period (Figure 2).

The dairy cow will adapt to heat stress by modifying its metabolism to reduce heat expenditure. Milk production and reproductive performance will be negatively impacted, resulting in a loss of profit for the dairy producer. Supplementing a blend of protected B vitamins during the transition and the lactation period is an innovative tool to provide ammunition to dairy cows to counteract heat stress impact and improve performance.

References omitted but are available upon request.

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