WILL DAIRY COWS RESPOND TO BST IN THE TROPICS AND SUBTROPICS?

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SUMMARY

Cows administered BST in warm environments clearly respond with increased milk yield, water and feed intake, and heat production without adversely affecting rectal temperature or altering heat balance. BST treated cows under heat stress dissipate the increase heat load through increased respiratory and skin vaporization. The data clearly supports the homeorhetic role of BST. Even under heat stress, BST coordinates the physiological functions of the animal to support the increased production. Thus, heat intolerance appears not to be a consequence of BST use and assuming good feed, water and environmental management, the evidence suggests that BST can be used successfully in tropical and subtropical conditions.

INTRODUCTION

The efficiency of the dairy cow plays a major role in the profitability of the dairy enterprise. Bovine somatotropin (BST) increases lactation efficiency by increasing milk yield in dairy cows. As cows produce more milk, a greater proportion of the feed utilized for milk production, a valued commodity, and a lesser proportion for maintenance. These facts are well documented for short and long term studies with differing breeds and under various management programs and environmental conditions. Collectively, among the studies conducted by the four companies pursuing the marketing of BST, thousands of lactating dairy cattle have been administered the protein with no reports of catastrophic metabolic diseases despite the large increase in milk output. In fact, Cole et al., 1988 demonstrated that no difference in the incidence of health maladies among non-treated cows and cows receiving 1X (600 mg), 3X or 5X concurrent injections of sometribove (ST) biweekly from 60 d postpartum to dry off. Vicini et al., 1988 administered the equivalent of 2 year's worth of formulated BST (ST) s.c. into pregnant lactating dairy cows on day 0 and 7 of a 14-day study. The health of all cows was generally excellent. This demonstration of the safety of BST is even more impressive when one considers the fact that feed intake responses to BST lag the milk response by generally four to six weeks. How the animal is able to accomplish the large milk responses without negatively affecting its other functions is indeed a fascinating story that is still under investigation.

MODE OF ACTION

Research results continue to support the conclusion that BST is acting through established metabolic pathways in the dairy cow to produce the increase in milk production. Although the data has not provided clear definition of the metabolic pathways involved with milk response, a broad description of those actions can be made. BST is 1) pleiotropic in that it affects multiple tissues and has multiple biological effects; and 2) homeorhetic in that it coordinates metabolism to partition nutrients preferentially to the mammary gland for milk synthesis during lactation without negative consequences on the rest of the body (Bauman and Currie, 1980). Tyrrell et al., 1982 were the first to demonstrate through calorimetry studies that BST did not affect partial efficiency, which is metabolic efficiency of energy utilization in lactating dairy cows. BST does not alter the maintenance requirements but dilutes the maintenance cost by increasing milk output. In addition, no significant effect of BST on digestive efficiency or rumen function have been observed. Since feed intake lags the milk response by four to six weeks after treatment initiation, the increased nutrients needed for milk synthesis are derived primarily from body stores. This shift in deriving additional nutrients from body stores to support the increased milk yield is identical to what occurs in early lactation in the high producing cow.

BST, in effect, drives the milk production to a new peak utilizing the same metabolic processes for achieving peak milk production in early lactation. To sustain this level of elevated response, the cow must increase feed intake before body reserves are depleted. This means managing the BST treated cow like any high producing cow. Managing the cow to optimize feed intake and to have her at the proper body condition will be similar to the management strategies already employed for obtaining maximum performance and sustaining good body condition in cows milked three times per day.

HEAT STRESS CONCERN

Environmental tolerance of lactating dairy cows administered BST has been a concern. Tyrrell et al., 1982 showed that BST increased heat production of lactating dairy cattle but the increase in heat production is accounted for by the energy requirement for the increase in milk produced. A BST treated animal produces no more heat at a given level of production than an untreated animal at the same production level. Thus, one would expect a BST treated cow to deal with heat stress just like an nontreated cow at a similar production level. However, Kronfeld 1987 indicated that since somatotropin cows produce more heat than untreated cows a potential heat tolerance problem may arise. This assumes that under heat stress conditions, the BST treated cow will not be able to dissipate the additional heat load resulting in an elevation of body temperature. The following discussion will prove that this assumption is erroneous and that cows will respond with increased milk yields from BST administration.

RESULTS FROM STUDIES CONDUCTED IN WARM ENVIRONMENTS

Several short and long term studies have now been conducted examining the effect of BST production responses of lactating dairy cattle in Florida, Mississippi, Missouri, Southern California and Arizona. Results of these studies are presented Table 1. The experiments by Zoa-Mboe et al., 1986, Staples et al., 1988 and Mollet et al., 1986 resulted in much lower milk responses due to daily BST treatment than the other studies. In the short term experiments, the duration of treatment may not have been long enough to see the maximum effect. Zoa-Mboe et al., 1986 and Staples et al., 1988 observed elevated respiration rates and rectal temperatures in all treatment groups indicating that the cows were suffering from heat stress. However, no significant BST effect on these parameters was observed. Mollet et al., 1986 attributed the variable response of BST treatment to a period of high ambient temperature and humidity with a concurrent reduction in feed intake.

Clearly, in the long term studies BST significantly increased milk output (Table 1). Milk composition was unaffected. Chalupa et.al., 1988 found that primiparous and multiparous cows responded similarly to BST treatment. These research workers concluded that under commercial conditions in Southern California, BST increased milk yield with no adverse effect upon health and reproduction. Collectively, the results indicate a significant milk production response to BST in hot environments and similar to those reported in more temperate climates.

In an effort to better define the effects of heat stress on the cow's capability to respond to BST, Missouri workers housed cows under controlled environmental climatic conditions. Mohammed and Johnson, 1985, housed six Holstein cows (90 to 120 d postpartum) in climatic rooms for four treatment periods. Five days were assigned for each treatment of thermoneutrality at 64.9°F and 75% relative humidity (RH), heat stress (84°F and 53% RH), heat stress and BST administration (16.6 mg/d), followed again by heat stress without BST (84°F and 55% RH). Each period was preceded by at least three days of adjustment. The results are shown in Table 2. Heat stress resulted in significant reductions milk yield, milk fat % and heat production with a significant increase in rectal temperature. Cows administered BST under heat stress increased milk output, milk fat % and heat production as compared to controls. No effect of BST was observed on rectal temperature or water intake during the five days.

Johnson et al., 1988 further examined the milk production and heat balance of BST treated cows under controlled summer conditions. Twelve lactating Holstein cows were given daily injections, (6, saline; 6, sometribove) for a 30 day period under seasonal heat (72-95°F, and 60-65% RH) and then placed in a climatology laboratory. The climatic conditions were set for thermoneutrality, (TN: 52-72°F, 30-50% RH) and then for ten days under heat stress (H: 77-95°F, 50-65% RH). Cows in the TN environment never exceeded the temperature humidity index of 72, which is the upper critical point for milk yield in Holstein cows. Cows in the seasonal and controlled heat stress environments spent about 14 hours each day above the critical point. The results are shown in Table 3. Milk production was increased 16 lbs under heat conditions, which was similar to the response under TN conditions, even though milk production dropped 10 lbs/day for both groups when under heat stress. Heat production, feed intake and water intakes were also increased in sometribove treated animals when subjected to both environments. However, respiratory and skin vaporization heat loss were also increased. The net effect of the increased heat loss was no net gain in rectal temperature as shown in Table 3. Despite a 16 lb/day increase in milk yield during the heat, the treated cows displayed no impairment of their ability to maintain rectal temperature or its increased feed intake. Clearly, sometribove treatment is not adversely affecting feed intake, milk production or health under heat stress conditions in this study. If anything, the treated cows appear to be more heat tolerant than the contemporary control if we define heat tolerance as the ability to dissipate a heat load or even the ability to sustain milk production under heat stress conditions. This short term study is corroborated by the long term studies shown in Table 1. Huber et al. 1988 also demonstrated significantly increased milk yields with no adverse effects on health with 30 Holstein cows treated with sometribove (500 mg once each 14 days for 36 weeks starting 60 days postpartum) under Arizona environmental conditions (Table 4). No other significant effects were observed.

Table 1

Responses of Lactating Dairy Cows to BST in Warm Environments

Reference	Treatment Length (Wk)	N	Dose mg/d	Milk Response lbs/d	Milk Response Percent
Elvinger et al, 1987 (Florida)	39	9	6.25	9.7	21
		9	12.5	11.9	26
		9	25	18.1	39
Hutchison et al., 1986 (Mississippi)	27	6	13.5	18	31
		6	27	16	27
		6	40.5	11	16
Mollet et al., 1986 (Missouri)	27	6	13.5		12.6
		6	27		2.2
		6	40.5		4.4
Chalupa et al., 1988 (California)	29	30	10.3	8.8	
		30	20.6	11.0	
		30	30.9	11.0	
Zoa-MBoe et al., 1986 (Florida)	4	13	25	3.1	5.5
Staples et al., 1988 (Florida)	1.4	5	37	6.4	17.5

Table 2

Effect of Bovine Somatotropin Administered Daily for Five Days in Lactating Cows in Missouri

	Treatment			
Parameter	TN	H1	H + BST	H2
Milk, lbs/d	51.7[a]	45.1[b]	46.9[c]	41.8[d]
Milk fat, %	3.51[a]	3.10[b]	3.36[c]	3.28[d]
Rectal temperature, °F	101.8[a]	104.0[b]	104.4[b]	103.6[c]
Heat production, kw/h	.90[a]	.70[bc]	.77[c]	.68[b]
Water intake, gal/d	17.1	17.4	17.0	16.7

[a,b,c] Means in the same row with different superscripts differ ($P<.05$).

TN = Thermoneutral, H = heat stress, RH = relative humidity.

TN at 64.9°F, 75%RH; H1, H + BST and H2 at 84°F, 55% RH.

Mohammed and Johnson, 1985.

Table 4

Lactational Performance of Dairy Cows in Arizona Treated With a Prolonged-Release Formulation of Methionyl Bovine Somatotropin (Sometribove) for 36 Weeks in Arizona

	Treatment		
Parameter	Control	Sometribove	Change
Milk, lbs/d	60.1[a]	65.1[b]	5.0; 8.4%
3.5% FCM, lbs/d	58.5[a]	63.4[b]	4.9; 8.3%
Milk fat, %	3.40	3.43	0.03; 0.9%
Milk protein, %	3.08	3.10	0.02; 0.6%
Dry matter intake, lbs/d	49.3	51.5	2.2; 4.5%
Energy balance, Mcal/d	8.6	8.6	---- -----
Services/conception	2.0	2.1	0.1; 5%

[a,b] Values with differing superscripts are significantly different (P<.05).

Huber et al., 1988

CONCLUSION

Cows administered BST in warm environments clearly respond with increased milk yield, water and feed intake, and heat production without adversely affecting rectal temperature or altering heat balance. BST treated cows under heat stress dissipate the increase heat load through increased respiratory and skin vaporization. The data clearly supports the homeorhetic role of BST. Even under heat stress, BST coordinates the physiological functions of the animal to support the increased production. Thus, heat intolerance appears not to be a consequence of BST use and assuming good feed, water and environmental management, the evidence suggests that BST can be used successfully in the tropics and subtropics.

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