

Impact of Increased Milking Frequency in Early Lactation and its Effect on Lactation Persistency With and Without rbST

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Take Home Messages

1. Cows milked 3X daily produced more milk and energy corrected milk (ECM) than cows milked 6X daily for 7 or 21 days after calving during the first 9 weeks of lactation.
2. Cows milked 3X daily produced more milk and ECM than cows milked 6X daily for 7, 14, or 21 days after calving from week 10 to 44 of lactation.
3. Cows milked 6X for 21 days after calving and later given rbST (at 63 DIM) produced 7.7 lbs per day more milk from week 10 to 44 of lactation compared to cows milked 6X for 21 days after calving and not given rbST.
4. Typical reproductive, herd health and reasons for leaving the herd parameters were not impacted by increased milking frequency or rbST administration.

Introduction

Traditionally, dairy farms have milked cows two (2X) or three times daily (3X) however, some producers are currently milking cows four (4X) or six times daily (6X) during early lactation, followed by 2X or 3X milking thereafter. Producers implementing such practices have reported varying results from higher/lower peak milk yields and greater/less 305-day productions to no differences. Recently, there has been a lot of interest in milking fresh cows more frequently during early lactation in an attempt to increase peak milk and overall lactation milk yield. Although at times recommended and occasionally practiced on dairy farms, the effects of increased milking frequency (IMF) on production parameters are poorly understood. Some researchers (Bar-Peled et al., 1995, Sanders et al., 2001; Hale et al., 2003) have reported an increase in milk yield of 7.7, 10.9, and 16.1 lbs/day when cows were changed from 2X to 3X, 2X to 4X, or 3X to 6X respectively, with minimal or no effects on milk composition. The mechanisms responsible for the increase in milk yield have not been identified but recent research suggest an increase in mammary epithelial cell (MEC) number (Hale et al., 2003), reduction in MEC apoptosis (Li et al., 1999), and/or increased cell activity (Knight et al., 1992). Although IMF has been demonstrated to increase milk synthesis in mid to late lactation (Erdman and Varner, 1995) its effects on milk yield in early lactation (immediately postpartum) is not clear.

Dahl et al., (2004) compared nine cows assigned to 6X milking at freshening (calving during the spring and fall of 2001) to 17 others (that freshened within two months) milked 3X using retrospective Dairy Herd Improvement Association (DHIA) monthly records. They reported that cows milked 6X had higher yields of milk (121 vs. 104 lbs/day) than cows milked 3X for the first 2 monthly test dates and continued to produce more milk (105 vs. 100 lbs/day) from the 3rd test date through the 6th monthly test.

In addition, cows milked 6X for 21 days after freshening peaked in milk production earlier (56 vs. 101 days in milk (DIM)) compared to cows milked 3X. Overall, cows milked 6X produced ~2,465 lbs more milk than the cows milked 3X for the entire lactation.

Somatotropin is secreted from the anterior pituitary and is found in higher concentrations in genetically superior cows (Kazmer et al., 1986) and bovine somatotropin (bST) has been demonstrated to increase milk yield by 10-15% per cow (Bauman and Vernon, 1993). In mid to late lactation, combining IMF and bST enhanced production compared to the response to IMF or rbST alone. Thus indicating that the two galactopoietic tools are additive and probably increase milk synthesis via different mechanisms (Knight et al., 1992; Speicher et al., 1994). Studies have shown that IMF (4X vs. 2X) of fresh cows increased milk yield during the IMF period as well as throughout the entire lactation even after IMF has ceased (Hale et al., 2003). However, few studies have looked at the time period necessary to have a positive effect immediately and subsequent on milk yield. There have been discrepancies over the length of time that a cow needs to be milked more frequently in order to have a positive effect on subsequent milk yield. No studies have looked at the effects of IMF (6X vs. 3X) during the first 7, 14, or 21 days after calving, followed by bST administration at 63 DIM on high producing multiparous cows. Study objectives were to 1) determine if cows milked 6X during early lactation would produce more milk during IMF than cows milked 3X; 2) evaluate the time necessary to milk cows 6X postpartum to have a positive impact on peak and total milk yield throughout the entire lactation, and 3) to determine if IMF in early lactation and bST use are additive.

Cows and Treatments

Three hundred multiparous Holstein cows calving at Stotz Dairy (Buckeye, AZ), were separated into five treatment groups at freshening, beginning on November 4, 2003 and ending February 2, 2004. Cows were fed a TMR to provide 100% of NRC (2001) requirements daily at 0400 and 1630 (Table 1). Cows milked 3X were housed separately from cows milked 6X in typical Arizona dry lot corrals (pens were side by side directly behind the parlor; Table 2) with shades over the mangers. Protocols for handling of animals for this investigation were approved by The University of Arizona Institute of Animal Care and Use Committee.

The five treatment groups were: 1) cows milked 3X/day through 305 DIM, 2) cows milked 6X/day to 7 DIM and then 3X/day through 305 DIM, 3) cows milked 6X/day to 14 DIM and then 3X/day through 305 DIM, 4) cows milked 6X/day to 21 DIM and then 3X/day through 305 DIM, and 5) cows milked 6X/day to 21 DIM and then 3X/day through 305 DIM. Cows assigned to treatments 1, 2, 3, and 4 were administered rbST (Posilac™, Monsanto, and Saint Louis, MO) at 63 DIM. Treatment five did not receive rbST. The 3X group was milked every 8 hours and groups 2-5 (6X) were milked approximately every 4 hours during the IMF regimen.

Measurements

Daily milk weights were measured electronically by Boumatic computer software (Madison, WI) for each cow's milking throughout the 305 d lactation. Monthly milk composition analysis and SCC was done at Arizona DHIA (Tempe, AZ). Pen dry matter intake (DMI) was monitored and recorded using PROFEED2000® (DairyWorks, Tempe, AZ) feed management software. Cows were scored for body condition at freshening and at 28 day intervals. Body condition scores (BCS) were based on a 5 point scale (Wildman et al., 1982) ranging from 1 = very thin to 5 = excessively fat. Blood samples were collected from the coccygeal vein from a subset of cows (n=15) from treatments 1 and 4 at 7, 14, 21, and 28 ±1 DIM, to measure plasma non-esterified fatty acid (NEFA) concentrations. Feed samples were

taken weekly and wet chemistry analyses were conducted by Dairy Nutrition Services Laboratory, Tempe, AZ.

All performance data were analyzed for the first nine weeks after calving and then from week 10 to 44 to evaluate the effects of IMF during early lactation and the potential carry over effects after peak milk. Treatments 1, 2, 3, and 4 were analyzed to evaluate the impact of IMF and treatments 4 and 5 were analyzed separately to determine the impact of 6X milking for 21 days after calving with and without rbST administration beginning at 63 DIM.

Increased milking frequency results

Cows milked 3X daily tended ($P = 0.08$) to produce more milk (95.3 vs. 91.4 and 90.4 lbs/day; Figure 1 and Table 3) and more ($P < 0.01$) energy corrected milk (ECM) (99.3 vs. 93.9 and 91.8 lbs/day; Table 3) during the first nine weeks of lactation compared to cows milked 6X for 7 or 21 days after calving, respectively. There was no difference between yields of milk among IMF treatments (85.5, 83.6, 84.9, 83.9 lbs/day) after week nine (Table 3 and Figure 2). Yields of ECM were higher after week nine for cows milked 3X daily compared to 6X for 21 days after calving (86.2 vs. 84.3 lbs/d). However, 3X cows had similar yields of ECM as those milked 6X for 7 or 14 days after calving, (84.5 and 86.3 lbs/d; Table 3). Percentages of milk fat (3.80) and protein (2.90) did not differ between treatments during the first nine weeks after calving (Table 3). However, cows milked 3X daily had increased ($P = 0.01$) yields of fat (3.71 lbs/d) compared to cows milked 6X for 7 or 21 d PP (3.44 and 3.38 lbs/day; Table 3). In addition, cows milked 3X or 6X for 7 or 14 days after calving produced more ($P < 0.01$) protein (2.79, 2.71, and 2.78 lbs/d) compared to cows milked 6X for 21 days after calving (2.57 lbs/d). Somatic cell count (257 cells/ml) and BCS (3.60) did not differ between treatments during the first nine weeks after calving (Table 3). However, SCC were higher ($P = 0.02$) between week 10 and 44 for cows milked 3X and 6X for 21 after calving compared to cows that were milked 6X for 14 days after calving (595,000 and 526,000 vs. 294,000 cells/ml; Table 3). Plasma harvested for NEFA concentration (489 vs. 464 $\mu\text{eq/L}$) from a subset of cows assigned to the 3X and 6X 21 treatments were similar (Table 3) were similar, suggesting that cows milked 3X were mobilizing similar amounts body tissue as cows milked 6X for 21 days after calving.

Increased milking frequency with and without rbST results

Milk yield did not differ between cows milked 6X for 21 days that were going to receive rbST starting at 63 DIM compared to those were not going to be given rbST (Figure 3 and Table 4). Cows given rbST and milked 6X for 21 days after calving produced more ($P < 0.01$) milk (84.0 vs. 76.3 lbs/d Figure 4) and ECM (84.3 vs. 76.8 lbs/d) compared to cows milked 6X 21 days after calving that were not given rbST between weeks 10 and 44 of lactation (Table 4). There was no difference in fat (3.71) or protein (2.86) percentages or yields of fat (3.43 lbs/day) during the first nine weeks after calving between the two treatments milked 6X for 21 days (Table 4). Somatic cells (226 cells/ml) and BCS (3.58) were also similar between the two treatments during the first nine weeks after calving. Percentages of fat (3.62) and protein (2.91) were not effected by rbST administration, however yields of fat (3.03 vs. 2.77 lbs/day) and protein (2.46 vs. 2.21 lbs/day) were higher ($P < 0.01$) for cows given rbST and milked 6X for 21 after calving compared to cows not receiving rbST (Table 4). Somatic cells in milk (528,000 vs. 252,000 cell/ml) were increased and BCS was decreased (3.53 vs. 3.56) for cows given rbST after being milked 6X for 21 days after calving compared to cows not receiving rbST and milked 6X for 21 days after calving.

Reproductive, herd health and reason for leaving the herd parameters

The percentage of cows pregnant (37, 43, 40, 31, and 32%) within 65 d of the voluntary waiting period (80 DIM), average DIM at pregnancy (125, 124, 127, 127, and 127) and average service per conception (2.33, 2.03, 2.24, 2.47, and 2.31) did not differ between treatments ($X^2 = 0.96$). The number of cows that were sent to the hospital during the 305 day trial for mastitis (50, 65, 58, 67, and 60), digestive disorders (9, 9, 6, 6, and 13), respiratory issues (9, 6, 9, 3, and 0), lameness (19, 15, 6, 18, and 10), and/or retained placenta (13, 6, 12, 6, and 13), were not affected by milking frequency or somatotropin treatments ($X^2 = 0.49$).

Conclusions

Our data clearly indicate that there was no performance, reproductive, herd health, or culling advantage from milking cows 6X daily for 7, 14, or 21 days after calving compared to 3X milking alone. We found that cows receiving rbST (at 63 DIM) produced 7.7 lbs per day more milk compared to cows milked 6X for 21 days after calving and not given rbST. Although there is scientific evidence to support 4X vs. 2X milking for 21 days after calving followed by 2X milking thereafter and/or 6X milking for 42 days after calving followed by 3X, 6X milking for 7, 14, or 21 days after calving does not appear to be effective. More research needs to be conducted to evaluate milking intervals (hours between milkings) during different IMF regimes and the number of days that 4X and/or 6X milking might be done after calving to elicit the potential increases in milk and subsequent carryover effects that are currently less than consistent across the industry.

Acknowledgements

The authors would like to thank the United Dairymen of Arizona (Tempe, AZ), for funding this trial and Monsanto dairy business for making Posilac available during allocation. We appreciate Tom Thompson and the employees of Stotz dairy for their help, Dave Henderson for statistical support, and Arnaldo Burgos of Dairy Nutritional Services (Chandler, AZ) for diet formulations and analysis.

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Table 1. Total mixed ration fed during the experimental periods.

Item	Close-up	Fresh	High
Dry Matter %			
Alfalfa Hay	33.8	36.7	25.0
Alfalfa Greenchop	10.0	11.7	14.8
Soybean Meal	-	2.6	3.3
Corn Silage	25.3	14.6	12.2
Molasses	-	3.7	2.8
Tallow	0.3	0.5	0.9
Energy II	0.4	0.7	2.0
Whole Cottonseed	2.4	4.4	4.8
Barley	24.2	21.4	31.5
Protein, Vitamin, Mineral Premix	3.6	3.7	2.7
Nutrition Composition			
Dry Matter, %	52.6	53.9	53.9
Crude Protein, %	16.6	17.4	16.6
RUP, % of Crude Protein	26.6	30.9	30.1
NEL, Mcal/lb	1.65	1.67	1.81
NDF, %	32.7	30.0	27.3
ADF, %	22.0	20.4	17.6
Fat, %	3.4	4.2	5.8
NFC, %	36.9	37.5	40.5

¹Vitamin and mineral mix was formulated to meet or exceed NRC, 2001 requirements.

Table 2. Impact of facility on cows milked 3 or 6 times daily during early lactation.

Item	Milking Frequency	
	3X	6X
Number of cows in Pen		
Average	39	44
Range	20-70	1-70
Walking distance (meters)		
One way	51	123
Per day	307	1480
Time Out of pen (minutes)		
Average	195	390
Range	180-225	270-450
Time milking (minutes)		
Range	60-75	45-75

Table 3. Performance of cows milked 3 times (control) or 6 times daily for 7, 14 or 21 days post partum followed by 3 times daily thereafter.

Item	6X milking (days post partum)				SEM	P Value
	0	7	14	21		
First nine weeks postpartum						
Milk, lbs	95.3	91.4	95.7	90.4	2.5	0.08
ECM, lbs	99.3 ^a	93.9 ^{bc}	97.9 ^a	91.8 ^c	1.6	< 0.01
Fat, %	3.90	3.77	3.77	3.74	0.12	0.50
Fat, lbs	3.71 ^a	3.44 ^{bc}	3.61 ^{ac}	3.38 ^b	0.11	0.01
Protein, %	2.90	2.95	2.89	2.85	0.06	0.40
Protein, lbs	2.79	2.71	2.78	2.57	0.06	< 0.01
SCC ²	347	255	136	288	119	0.32
BCS	3.60	3.63	3.58	3.57	0.03	0.29
NEFA, μ eq/L	489	-	-	464	73	0.74
Week nine to week 44						
Milk, lbs	85.5	83.6	84.9	83.9	1.6	0.60
ECM, lbs	86.2 ^{ac}	84.5 ^{ad}	86.3 ^c	84.3 ^d	0.9	0.04
Fat, %	3.63	3.64	3.69	3.60	0.07	0.70
Fat, lbs	3.11	3.05	3.13	3.03	0.06	0.27
Protein, %	2.93	2.95	2.95	2.93	0.04	0.82
Protein, lbs	2.51	2.46	2.50	2.46	0.03	0.26
SCC ²	595 ^a	362 ^{bc}	294 ^b	526 ^{ac}	111	0.02
BCS	3.54 ^a	3.57 ^b	3.54 ^a	3.53 ^a	0.01	< 0.01

Means with unlike superscripts within row differ ($P < 0.05$).

Table 4. Performance of cows milked 6 times daily for 21 days post partum followed by 3 times daily thereafter.

Item ¹	6X milking (days post partum)			
	21 rbST	21 No rbST	SEM	<i>P</i> Value
First nine weeks postpartum				
Milk, lbs	90.4	94.6	2.6	0.12
ECM, lbs	91.8	95.5	1.6	0.03
Fat, %	3.74	3.68	0.13	0.68
Fat, lbs	3.38	3.48	0.12	0.38
Protein, %	2.85	2.86	0.06	0.80
Protein, lbs	2.57	2.70	0.05	0.02
SCC	288	164	125	0.34
BCS	3.57	3.59	0.04	0.79
Week nine to week 44				
Milk, lbs	84.0	76.3	2.0	< 0.01
ECM, lbs	84.3	76.8	0.9	< 0.01
Fat, %	3.60	3.64	0.07	0.63
Fat, lbs	3.03	2.77	0.06	< 0.01
Protein, %	2.92	2.90	0.04	0.53
Protein, lbs	2.46	2.21	0.03	< 0.01
SCC	528	252	102	< 0.01
BCS	3.53	3.56	0.01	0.03

¹Both groups were milked 6 times daily for 21 days post partum and then 3 times daily thereafter, on day 63 rbST was administered to the treatment labeled 21 rbST.

Table 5. Reproductive, herd health and culling parameters.

Item	6X milking (days post partum)				
	0	7	14	21	21 No rbST
Reproduction					
% Pregnant by VWP+65 d ¹	37	43	40	31	32
DIM @ Pregnant	125	124	127	127	127
Times Bred	2.33	2.03	2.24	2.47	2.31
%, and total cows that visited hospital					
Mastitis	50 (16)	65 (22)	58 (19)	67 (22)	60 (18)
Digestive	9 (3)	9 (3)	6 (2)	6 (2)	13 (4)
Respiratory	9 (3)	6 (2)	9 (3)	3 (1)	0
Lame	19 (6)	15 (5)	6 (2)	18 (6)	10 (3)
Retained placenta	13 (4)	6 (2)	12 (4)	6 (2)	13(4)
Other ²	0	0	9 (3)	0	3 (1)
%, and total that the left herd					
Diarrhea	25 (1)	0	0	25 (1)	50 (2)
Downer	14 (1)	30 (2)	30 (2)	14 (1)	14 (1)
E. Coli Mastitis	0	33 (2)	0	17 (1)	51 (3)
Lame	13 (2)	44 (7)	13 (2)	25 (4)	6 (1)
Pneumonia	50 (2)	25 (1)	25 (1)	0	0
Reproduction	25 (1)	25 (1)	0	0	50 (2)

¹Percent pregnant within 65 days of the voluntary waiting period, ²the two on the 6X milking for 14 days postpartum were downers and one had a skin condition, the one on 6X milking for 21 postpartum No rbST was also a downer.

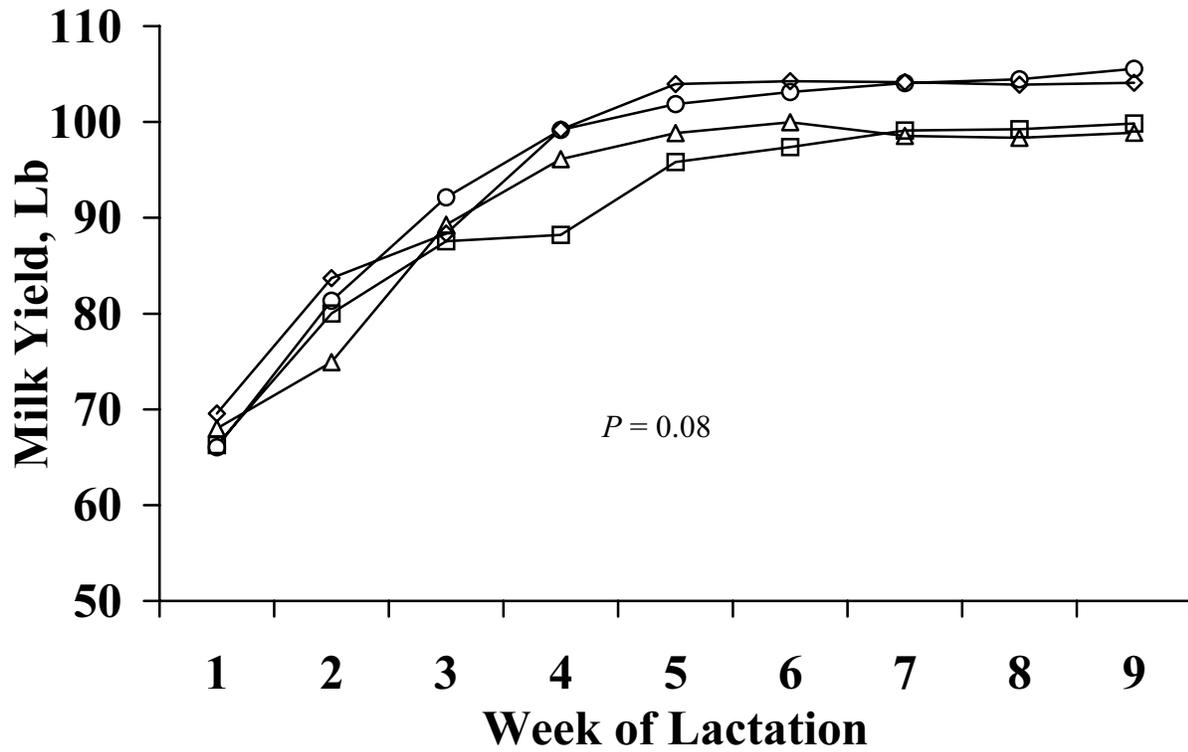


Figure 1.

Key: ○ = 3 times per day milking, △ = 6 times per day milking for 7 days postpartum, ◇ = 6 times per day milking for 14 days postpartum, □ = 6 times per day milking for 21 days postpartum.

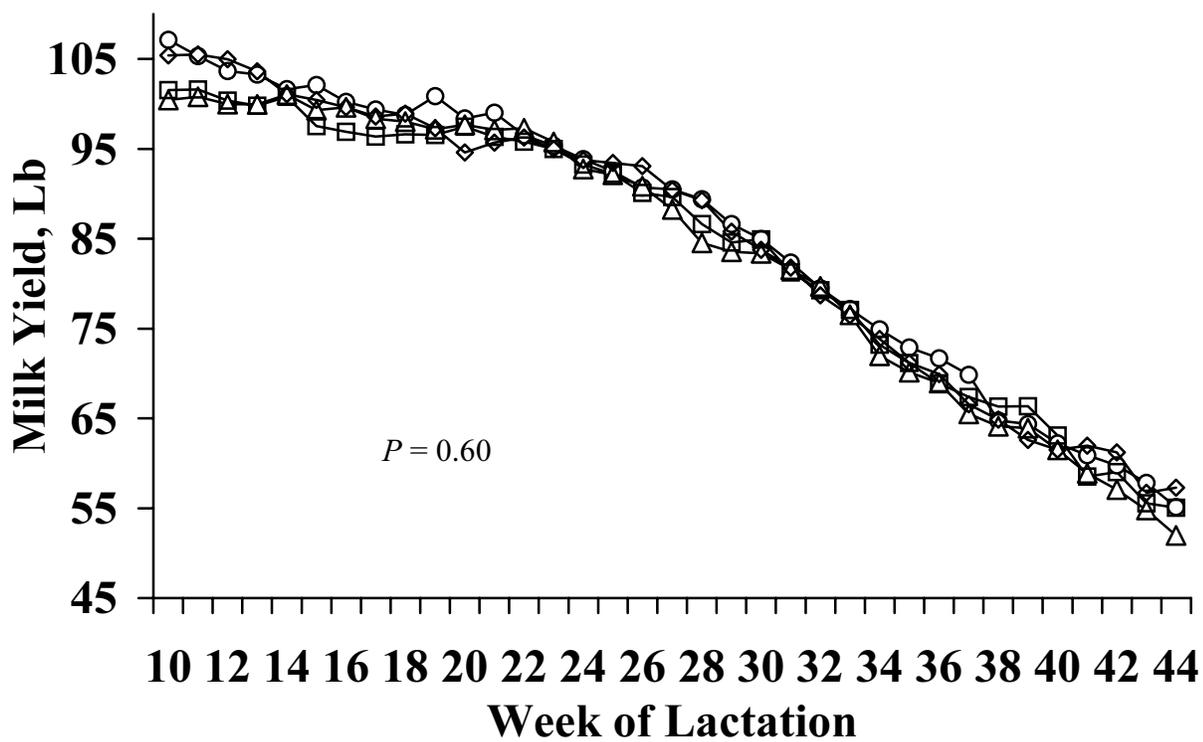


Figure 2.

Key: ○ = 3 times per day milking, △ = 6 times per day milking for 7 days postpartum, ◇ = 6 times per day milking for 14 days postpartum, □ = 6 times per day milking for 21 days postpartum.

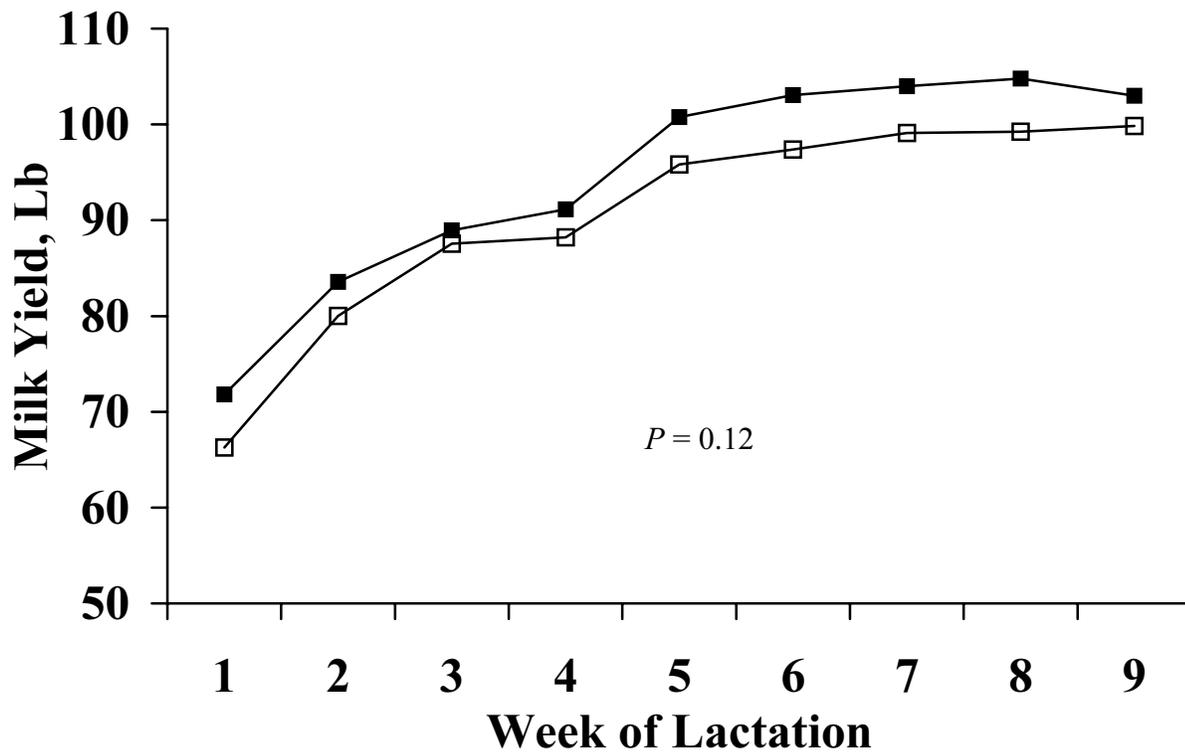


Figure 3.

Key: □ = 6 times per day milking for 21 days postpartum not to receive somatotropin (rbST),
 ■ = 6 times per day milking for 21 days postpartum going to receive somatotropin (rbST)

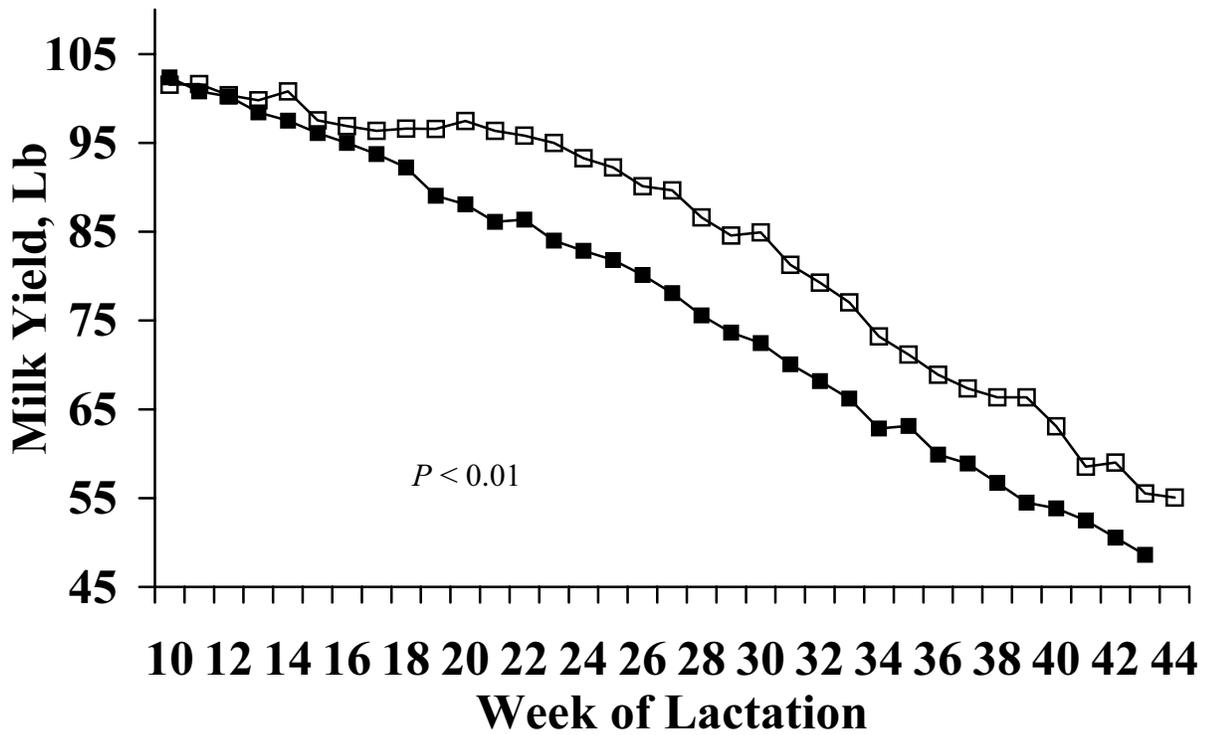


Figure 4.

Key: □ = 6 times per day milking for 21 days postpartum no somatotropin (rbST),
 ■ = 6 times per day milking for 21 days postpartum receiving somatotropin (rbST)