Jack Kelly Clark

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Pellets made of finely powdered selenium metal mixed with iron, when inserted in the reticulum, or second stomach, of the lamb, slowly release selenium into the digestive system. Deficiency of the mineral can cause white muscle disease in lambs.

Selenium enhances lamb gains on sulfur-fertilized pastures

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Large responses to sulfur can occur when nitrogen is applied to many California rangeland soils. Giving lambs selenium in pellet form significantly improved gain on such pastures.

Selenium deficiency was detected in lambs on pastures during sulfur fertilizations experiments in northern California. Giving lambs selenium in pellet form significantly improved gain on sulfur-fertilized patures. The pellet, containing 0.5 gram of finely powdered selenium metal mixed with 9.5 grams iron, was inserted orally and lodged in the reticulum, where it slowly released selenium into the alimentary canal.

We conducted the experiments from 1980 to 1983 on nitrogen-fertilized grass pastures and subclover-grass pastures. Responses in the grazing animals were measured in gain per lamb, lamb gain per acre, and grass and clover forage production.

Sulfur and selenium are closely related chemically, and it has been reported that each can reduce the uptake of the other by plants. A similar replacement mechanism exists in animals. Outbreaks of white muscle disease in lambs, a selenium deficiency symptom, have been observed after application of sulfur fertilizer in Oregon.

This report describes the effects of sulfur fertilization on (1) the gains of selenium-supplemented lambs on pasture, (2) the blood sulfur and selenium levels of the lambs, (3) the concentrations of nitrogen and sulfur in pasture forage, and (4) the total lamb and forage production per acre on improved range pasture.

Methods

Ten pastures ranging in size from 0.8 to 1.8 acres each were established on Sutherlin soil at the University of California Hopland Field Station, which is about 90 miles north of San Francisco. Half of the pastures were sown with annual ryegrass and fertilized annually with 175 pounds per acre nitrogen in urea in split applications (one-third each in October, December, and February); the others were sown with subclover. Gypsum was applied annually so that one each of the two kinds of pasture received sulfur at the rates of 0, 10, 20, 40 and 80 pounds per acre. All pastures were fertilized annually with 100 pounds per acre of concentrated superphosphate (0-45-0).

To estimate forage production, we placed 10 cages (3 feet in diameter) in each pasture. A square foot area was clipped inside and outside the cages as they were moved at monthly intervals during the grazing season.

In 1980 through 1982, Targhee lambs born in January were placed on the pastures in February with their dams; the ewes were removed in April. In 1983, early-weaned Targhee lambs weighing 45 pounds were used.

Lambs were weighed and blood samples taken monthly. Lamb numbers were adjusted periodically so that those on the various pastures had access to an equal amount of forage. For example, on February 14, April 22, and May 20, 1983, forage available was 176, 217, and 260 pounds per lamb, respectively. Gain totals are reported here for the time that the lambs would normally be sold in June. Both lambs and ewes were treated routinely for internal parasite control.

Results

In 1983, we evaluated lamb gain per head from March 1 to June 21 after half the lambs on each pasture received selenium boluses. On the nitrogen-fertilized grass pastures, neither sulfur alone nor selenium alone gave a benefit, but the combination of sulfur and selenium improved lamb gain an average of 27 percent (table 1). On subclover-grass pastures, sulfur alone improved gain by 15 percent, selenium alone gave no benefit, but sulfur plus selenium yielded an additional 6 percent gain, small but statistically significant.

For the same period in 1983, lamb gain per acre on nitrogen-fertilized grass pasture increased by 53 percent from sulfur treatment alone and an additional 23 percent from the selenium boluses (fig. 1). On subclover-grass pasture, lamb gain per acre increased 39 percent from sulfur treatment alone and an additional 17 percent from the selenium boluses. Selenium boluses were used for the first time in these experiments in 1982, but they were administered midway through the grazing season. The results were similar, but the increases in gain were not as marked.

Blood levels in lambs. The blood serum sulfate level of lambs grazing on both kinds of pasture increased as sulfur rates became higher (table 2). Reducible sulfur in lambs on nitrogen-fertilized pasture stayed fairly constant where no sulfur was applied, but increased from March to June where the three highest rates of sulfur were applied. With lambs on subclover-grass pasture, the serum sulfate values increased from March to May and then decreased somewhat.

In the absence of sulfur fertilization, whole blood selenium in lambs remained above the critical level of 0.05 microgram per milliliter (μg/ml) throughout the grazing season. As sulfur serum levels increased in response to increasing sulfur fertilization, however, blood selenium decreased at all sampling dates on both kinds of pastures; as the season advanced, values dropped to 0.01 to 0.03 μg/ml, well below the critical level. This inverse relationship reflects the competing nature of these ionic forms of sulfur and selenium consumed in pasture forages.

Sulfur and nitrogen levels in pasture. In both types of forage, the four-year average sulfur levels about doubled with increasing sulfur fertilization, and sulfur declined noticeably as the season advanced (table 3). Levels in forage not fertilized with sulfur were below the sulfur requirements of young growing lambs as given by the National Research Council (1975), while those in fertilized forage were above lamb needs. The sulfur level in feed for 44-pound early-weaned lambs should be about 0.26 percent if they are gaining 0.60 pound per day. The concentration should be 0.22 percent for 66-pound lambs gaining 0.66 pound per day.

The nitrogen level in the nitrogen-fertilized forage exceeded that in the subclover-grass forage in about half of the analyses (table 3). Levels declined in both

TABLE 1. Lamb gain in response to sulfur and selenium treatments in 1983

	Lamb gain			
	N-fertilized grass		Clover-grass	
Sulfur	No Se	Se	No Se	Se
	---------- lb/head ----------			
No S	30	27	38	37
S	30	36	44	46
CI*	4		5	

* Mean confidence interval at the 5% level for selenium comparisons.

TABLE 2. Seasonal effect of sulfur fertilization on reducible serum sulfur and whole blood selenium levels in lambs on N-fertilized grass or subclover-grass pasture

	Blood levels in lambs			
S rate	March	April	May	June
lb/a	---------- μg S/ml ----------			
	N-fertilized grass pasture			
0	30	34	36	30
10	37	41	46	30
20	49	60	65	69
40	54	60	65	70
80	53	64	67	72
CI	6	7	8	10
	Subclover-grass pasture			
0	29	39	46	34
10	45	50	53	35
20	38	49	52	43
40	50	56	60	49
80	51	65	68	57
CI	5	7	6	7
	---------- μg Se/ml ----------			
	N-fertilized grass pasture			
0	0.07	0.06	0.07	0.11
10	0.05	0.03	0.03	0.02
20	0.04	0.03	0.02	0.02
40	0.04	0.02	0.02	0.01
80	0.04	0.03	0.02	0.02
CI	0.01	0.01	0.01	0.01
	Subclover-grass pasture			
0	0.08	0.06	0.06	0.07
10	0.06	0.03	0.04	0.04
20	0.05	0.04	0.05	0.05
40	0.05	0.03	0.02	0.02
80	0.05	0.03	0.03	0.03
CI	0.01	0.01	0.01	0.01

NOTE: Data are averages for four years.

TABLE 3. Seasonal concentrations of sulfur and nitrogen in forage as affected by sulfur fertilization

	Forage concentrations			
S rate	March	April	May	June
lb/a	*%S in N-fertilized grass forage*			
0	0.16	0.14	0.13	0.10
10	0.23	0.20	0.18	0.13
20	0.25	0.21	0.21	0.20
40	0.27	0.23	0.24	0.19
80	0.33	0.29	0.27	0.26
CI	0.03	0.02	0.03	0.03
	%S in subclover-grass forage			
0	0.19	0.16	0.15	0.11
10	0.25	0.22	0.21	0.18
20	0.27	0.23	0.20	0.18
40	0.28	0.25	0.22	0.20
80	0.32	0.29	0.26	0.24
CI	0.02	0.02	0.02	0.02
	%N in N-fertilized grass forage			
0	4.2	3.6	2.8	1.9
10	3.6	3.3	2.6	1.8
20	3.1	2.4	2.5	1.6
40	3.3	2.6	2.6	1.6
80	4.5	2.6	2.4	1.6
CI	0.26	0.28	0.31	0.13
	%N in subclover-grass forage			
0	2.5	2.1	1.6	1.2
10	3.1	2.7	2.4	1.6
20	3.4	2.9	2.3	1.2
40	3.3	2.9	2.4	1.7
80	3.2	3.0	2.5	1.7
CI	0.2	0.2	0.3	0.3

NOTE: Data are averages for four years.

TABLE 4. Lamb scouring score on April 21, 1982, as related to the sulfur fertilization regime

	Scouring score * at S rate (lb/a):				
Pasture type	0	10	20	40	80
N-fertilized grass	0.3	0.7	2.6	1.9	2.9
Subclover-grass	0.1	0.1	0.4	0.8	1.1

* Rectal area: 0 = clean, 1 = soiled, 2 = soiled and matted, 3 = soiled and matted with fecal material.

kinds of forage as the season advanced. In nitrogen-fertilized grass, statistical analysis showed mildly negative relationships between nitrogen and sulfur; higher levels of nitrogen accumulated in the grass when sulfur levels were low enough to limit growth, but nitrogen concentrations tended to be lower when sulfur levels were high. In subclover-grass forage, the relationships were stronger and positive; increasing sulfur was accompanied by a corresponding increase in nitrogen, reflecting higher nitrogen levels in the subclover and a greater proportion of subclover in the forage.

Forage yield. Forage production on the nitrogen-fertilized grass pastures, averaged over four years, showed a strong response to sulfur fertilization (fig. 2). Maximum yield resulted from annual applications of about 40 pounds per acre of sulfur as gypsum. A water-soluble source of sulfur, gypsum is absorbed readily by roots but is also subject to leaching loss and has little residual value in high-rainfall areas. The subclover-grass pastures also responded well to sulfur fertilization, but production was lower and maximum forage yields occurred with 10 to 20 pounds per acre sulfur. With the self-reseeding clover providing the nitrogen, the subclover-grass pastures supply a more economical forage of high quality.

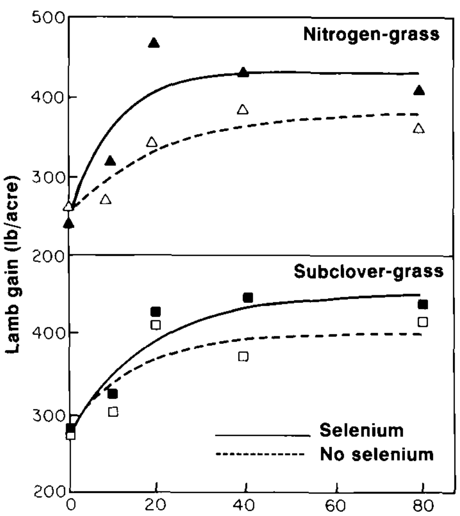

Fig. 1. On both types of pasture, selenium increased lamb gain per acre over the increase from sulfur fertilization alone.

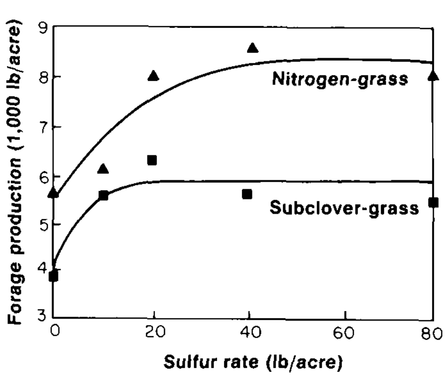

Fig. 2. Forage production responded well to sulfur. The percentage increase over four years was roughly equal on both pastures.

Lambs available for the project in 1982 were not vigorous because of poor breeding and wintering conditions. The weather was cool and wet during March and April, and some of the lambs carried a heavy parasite load and were scouring (dysentery). This combination of conditions put the animals under some stress. Lambs in the sulfur-fertilized pastures scoured more (table 4) and gained less during this period than those grazing the pastures with no added sulfur. Scouring can be a symptom of selenium deficiency. Lambs in the plus-sulfur treatments had selenium blood levels below 0.05 μg/ml after the first month on pasture (table 2).

Conclusions

The Sutherlin soil series (Ultic Haploxerolls) is one of many California annual rangeland soils that are often deficient in sulfur, and large responses to sulfur can occur if nitrogen is supplied by either legumes or fertilization. The objective of this study was to determine the effects of the sulfur level in pasture forage on lamb gains, and to relate these gains to forage sulfur and to blood sulfur and selenium.

Sulfur fertilization increased forage production and sulfur concentrations in the forage (and nitrogen in subclover-grass forage). Applied sulfur also increased blood-serum reducible sulfur levels but decreased blood selenium in lambs.

Gains per lamb were greater on sulfur-fertilized pasture when other factors such as low selenium, low nitrogen, or heavy parasite load did not limit growth. On sulfur-fertilized pastures, lambs that were not given selenium boluses had blood selenium levels below 0.05 μg/ml, which is considered the minimum for lamb health. Lambs on unfertilized pastures had blood selenium values above the minimum. Treating the lambs with selenium increased gains on sulfur fertilized pasture.

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Testing to predict

Gregory Encina Billikopf

Agricultural employees in general, and harvest workers in particular, usually are not hired through a careful selection process. Most get jobs on a first-come-first-hired basis. Harvest crews often develop into very skilled teams on which workers who are not productive drop out. In many other cases, however, wide ranges in crew member capabilities remain.

This study of a tomato harvest crew was conducted to determine whether a work-sample test, when workers would be doing their best because they know they are being studied, could be used to predict work performance when they do not think they are being observed. Such a test, if it helped to predict employee performance on the job, could be an improvement over chance-hiring and might result in the selection of fewer, more productive workers.

There are at least two reasons to hire workers carefully rather than hire indiscriminately and later fire those who do not work out. First, legally, it is a complicated process to fire workers. Second, and perhaps more important, no matter how poorly workers perform, mass-firing of the unsatisfactory workers may create morale and productivity problems among those who stay.

Benefits to the farmer from hiring fewer, more productive workers may include: (1) reduced paper work; (2) fewer supervisors needed; (3) lower overhead for costs not associated directly with performance (such as vacation, health insurance); (4) a stabilized work force as a result of increasing the length of the working season for those who are hired; (5) not having to pay the difference when workers do not pick enough to make minimum wage; and (6) less likelihood of workers setting very low production levels to avoid working themselves out of a job, protect slow workers from being embarrassed or fired, or prevent their employers from lowering the piece rate.

The study

This study took place in the summer of 1986 on a San Joaquin Valley farm, where the green tomato harvest is done by hand. Farm workers pick into two buckets, which they carry to trailers with bins; they are given a chip for every pair of buckets delivered and are paid according to the number of chips they collect in a day. To avoid possible damage to the tomatoes, picking cannot begin until the fruit is dry, so the starting time varies with weather conditions.