RANGE IMPROVEMENT WITH ANNUAL CLOVERS

VS.

FERTILIZATION OF RESIDENT RANGE

William J. van Riet

Seeding Central California foothill ranges with annual legumes is one method to bring about increased range forage yields. Fertilization with nitrogen and perhaps phosphorus or sulfur is another practice which may increase range forage yields. Just which of these practices will bring the greatest forage increase under identical conditions is not well documented. As fertilizer prices and availability vary,we need to know comparative yield responses of several fertilization alternatives. A third area which needs closer attention is production responses in successive years for each of these potential range improvement practices. This is true because differing amounts of rainfall may alter the growth response due to fertilizer, and may also change the response of one range improvement practice in relation to another.

PROCEDURES

A four-year experiment was established October 17, 1973, on a ranch in northeastern Stanislaus County to compare 12 possible range improvement practices. They are listed in table 1. The 7 clover treatments were seeded with 15 pounds per acre of a rose and subterranean clover mixture and fertilized every other year. The grass treatments were fertilized every year. Fertilizers were all applied in the autumn. The soil was slightly acid (pH 5.52) and low in phosphorus (3.6 ppm P), typical of many rangeland soils. Plots were clipped in February and in May of 1974 and 1975. Because low winter rainfall prevented winter growth in 1976 and 1977, they were clipped only in April. Rainfall for each year was: 1973-74, 18.28 inches; 1974-75, 12.26 inches; 1975-76, 6.06 inches; 1976-77, 6.46 inches. Normal or average is about 13.5 inches at this location. Oven-dried weights were obtained as well as crude protein percentages.

RESULTS AND DISCUSSION

Table 1 summarizes the yields for the four-year period. At this site, 375 pounds per acre of 18-46-0 applied yearly or seeding to clovers and fertilizing with 18-46-0 or 16-20-0 every other year gave the most growth response. However, seeding clover without ever fertilizing resulted in the least expensive yield increase with an average of 588 pounds of additional forage per acre per year, costing $23.81 per ton (dry basis).

Of special interest is a comparison of the yields during the first two years of the trial when rainfall was normal (table 2), and the third and fourth years when record low rainfall occurred (table 3). During the two normal years, the clover seeded plots yielded 605 pounds per acre per year more than the average of all the resident grass plots ($P < .01$). During the two dry years, the grass plots fertilized with nitrogen yielded 689 pounds per acre per year more than the average of all the clover plots ($P < .01$). Costs favored unfertilized clover seeding during normal years over all other practices, but during the dry years rainfall apparently was not sufficient to cause the annual clovers to produce enough to be an economical practice. While nitrogen fertilizer did not cause especially economical increases in the dry years, the increases were greater and more economical than seeded clovers. They were also more economical than fertilizing with nitrogen during the normal rainfall years.

Why did we apparently have greater yield responses to applied nitrogen-bearing fertilizers in such extremely low rainfall years compared to more normal years? Apparently, the first few inches of rain are sufficient to cause the plants to efficiently utilize the applied nitrogen. Further rains bring additional plant growth after most applied nitrogen is gone from the root zone. In order to effectively utilize applied nitrogen on rangeland, a rancher will have to graze during the early part of the season.

In this trial during the two normal years, there was more grass growth than clover growth in all nitrogen-fertilized treatments at the February cutting. Nitrogen-fertilized grass plots yielded 833 pounds while clover plots averaged only 414 pounds per acre dry matter in February 1974 and 1975. Therefore, it was the spring growth that followed which caused the clover plots to finish with highest total yields for the normal precipitation years. Perhaps most nitrogen fixation by clover (and their Rhizobia) occurs during spring. Clovers grow later and in warmer temperatures.

Short of feeding livestock and measuring weight gains, range forage quality is difficult to assess. Crude protein (CP) values were obtained as perhaps the best of several poor alternatives to estimate forage quality. Crude protein was estimated each year at the time of the spring harvest. The check plots averaged 8.32% crude protein for the four years. The average crude protein of all grass treatments was 10.34% and of all clover treatments was 8.58%. This was interesting since one would expect clover to have more protein than grass. However, all grass plots except the check received nitrogen. The average crude protein of all nitrogen treatments (regardless of whether grass or clover) was 10.41%, while the average of all other treatments was 8.21%. Nitrogen fertilization did more to increase protein values than did seeding clover to the range in this experiment.

Because yields were being measured all four years, an unintended side observation from this work was made which was helpful in answering several queries regarding the effect of the drought on rangeland of this area. The check plots produced 22% of the 1974-75 yield during 1976, and only 16% in 1977. Another four-year experiment near Knights Ferry, a similar rainfall area, produced 35% of the 1974-75 two-year average in 1976, and 52% in 1977 on the check plots. Check plot data is used because it is more typical of surrounding unimproved rangeland. This clipping data demonstrates the variable effects of the drought, but also the severity of it to rangeland in the Stanislaus area.

It can be concluded that under normal rainfall of 12 or more inches and probably over a long period, including both low and high rainfall years, seeding a mixture of annual clovers without fertilization may produce as economical yield increase as any alternative tested in this trial in this Central California area. Adding a nitrogen-phosphorus fertilizer every other year will probably increase production, but not necessarily at a cost one could afford.

Resident range fertilization with nitrogen-phosphorus fertilizer can bring about good yield increases but at a much higher cost than seeding to annual clovers. The benefits of resident grass fertilization with nitrogen-bearing fertilizer are early grass growth and increased protein content. If winter forage is needed, grass fertilization may have more value to the range livestock operator than if he is interested in spring or total feed production.

TABLE 1

YIELD & COST SUMMARY OF FOUR YEARS
1974, 1975, 1976 & 1977

Treatment	Av. Dry Weight /Acre Per Year	Lbs. Over Check	Cost/Year	Cost/Ton Over Check
333 lbs./A 18-46-0	3507.6^{v}	1063	$34.30	$ 64.52
Clover + 175 lbs./A 18-46-0	3324.3^{vw}	880	16.25	36.94
Clover + 400 lbs./A 16-20-0	3187.5^{vwx}	743	25.20	67.83
Clover - no fertilizer	3032.5^{wxy}	588	7.00	23.81
375 lbs./A 16-20-0	2985.4^{wxy}	541	29.50	109.16
Clover + 200 lbs./A Treble Superphosphate	2947.9^{wxy}	504	15.25	60.57
Clover + 400 lbs./A Single Superphosphate	2920.3^{wxy}	476	16.30	68.52
180 lbs./A Ammonium Nitrate	2874.5^{wxyz}	430	14.50	67.48
300 lbs./A Ammonium Sulfate	2829.3^{xyz}	385	13.75	71.42
Clover + 500 lbs./A Gypsum	2783.8^{xyz}	339	9.36	55.29
Clover + 400 lbs./A soil sulfur	2647.2^{yz}	203	10.50	103.57
Check	2444.4^{z}			

vwxyz
Means not sharing a common superscript differ from one another significantly ($P < .01$).

TABLE 2

YIELD & COST SUMMARY OF FIRST TWO YEARS (NORMAL) - 1974 & 1975

Treatment	Av. Dry Weight/Acre Per Year	Lbs. Over Check	Cost/Year	Cost/Ton Over Check
Clover + 175 lbs./A 18-46-0	5255.4^{x}	1159	$16.25	$ 28.05
Clover - unfertilized	5144.1^{xy}	1047	7.00	13.37
Clover + 200 lbs./A Treble Superphosphate	5050.0^{xy}	953	15.25	32.00
Clover + 400 lbs./A 16-20-0	4915.9^{xyz}	819	25.20	61.54
Clover + 400 lbs./A Single Superphosphate	4879.1^{xyz}	782	16.30	41.66
Clover + 500 lbs./A Gypsum	4806.7^{xyz}	710	9.36	26.37
333 lbs./A 18-46-0	4727.0^{xyz}	630	34.30	108.89
Clover + 400 lbs./A soil sulfur	4518.6^{xyz}	422	10.50	49.82
300 lbs./A Ammonium Sulfate	4461.0^{xyz}	364	13.75	75.45
180 lbs./A Ammonium Nitrate	4285.1^{yz}	188	14.50	154.26
Check	4096.7^{z}	---	---	---
375 lbs./A 16-20-0	4095.9^{z}	-0.8	29.50	---

xyz

Means not sharing a common superscript differ from one another significantly ($P < .01$).

TABLE 3

YIELD & COST SUMMARY OF LAST TWO YEARS (DRY) - 1976 & 1977

Treatment	Av. Dry Weight/Acre Per Year	Lbs. Over Check	Cost/Year	Cost/Ton Over Check
333 lbs./A 18-46-0	2288.2^{v}	1496	$ 34.30	$ 45.84
375 lbs./A 16-20-0	1874.8^{vw}	1083	29.50	54.50
180 lbs./A Ammonium Nitrate	1463.8^{wx}	671.7	14.50	43.19
Clover + 400 lbs./A 16-20-0	1459.0^{wx}	667	25.20	76.13
Clover + 175 lbs./A 18-46-0	1393.3^{xy}	601	16.25	54.08
300 lbs./A Ammonium Sulfate	1197.5^{xyz}	405	13.75	67.81
Clover + 400 lbs./A Single Superphosphate	961.4^{yz}	169	16.30	192.90
Clover - no fertilizer	921.0^{z}	129	7.00	108.52
Clover + 200 lbs./A Treble Superphosphate	845.8^{z}	54	15.25	564.81
Check	792.1^{z}	---	---	---
Clover + 400 lbs./A soil sulfur	775.8^{z}	-16	10.50	---
Clover + 500 lbs./A Gypsum	760.9^{z}	-31	9.36	

vwxyz

Means not sharing a common superscript differ from one another significantly ($P < .01$).

TABLE 4

EARLY & TOTAL SEASONAL YIELDS IN 1974 & 1975

Treatment	Av. Dry Weight/Acre/Year (Lbs.) February	February & May
Check - no fertilizer - no seed	596.5	4096.7
180 lbs./Acre Ammonium Nitrate	843	4285.1
333 lbs./Acre 18-46-0	930	4727.0
300 lbs./Acre Ammonium Sulfate	857	4461.0
375 lbs./Acre 16-20-0	704	4095.9
Rose and Subclover, unfertilized	454	5144.1
Clover + 175 lbs./Acre 18-46-0	494.5	5255.4
Clover + 200 lbs./Acre Treble Superphosphate	385	5050
Clover + 500 lbs./Acre Gypsum	349.5	4806.7
Clover + 400 lbs./Acre Single Superphosphate	445	4879.1
Clover + 400 lbs./Acre 16-20-0	395.5	4915.9
Clover + 400 lbs./Acre Soil Sulfur	373.5	4518.6
ALL GRASS PLOTS	786	4333
ALL CLOVER PLOTS	413.9	4938.5
UNFERTILIZED GRASS (CHECK)	596.5	4096.5
NITROGEN-FERTILIZED GRASS PLOTS	833.5	4392.3
CLOVER PLOTS	413.9	4938.5

COSTS ASSUMED FOR THIS STUDY

18-46-0	$200/Ton
16-20-0	$152/Ton
Treble Superphosphate	$165/Ton
Single Superphosphate	$ 88/Ton
Ammonium Nitrate	$150/Ton
Ammonium Sulfate	$ 85/Ton
Gypsum	$ 14.85/Ton
Soil sulfur	$ 70/Ton
Fertilizer application charge	$ 1/Acre

Clover establishment costs including seed, seeding, land preparation, etc., are $28/acre, spread over the four-year period of the trial are $7/acre/year.