Fertilization of Range Forage

use of exploratory plots on range may indicate kind of fertilizer needed for optimum nutrition of forage plants

John P. Conrad

Range fertilization experimental plots gave greatly increased yields during the past season—without additional fertilizer since the unfavorable growing season of 1949.

From 1941 to 1947 experimental plots and the resulting commercial range applications of fertilizers gave encouraging results. The drought and cold of the following 1947 to 1949 seasons allowed scant opportunity for bur clover and other legumes—in much of the state—to make satisfactory growth.

Because of the early fall rains of the 1950–51 season a favorable growing year again is in prospect.

Fertilizing a mixed stand of plants—as on California ranges—may have a marked effect on the different species present.

In general, nitrogen fertilizers will increase the growth of grasses and other nonlegumes at the expense of the legumes. In many regions the increases from nitrogen have been considered fairly satisfactory. In some other areas, phosphates, in addition to the nitrogen, are required to give maximum yield of nonlegumes.

A popular program is to apply the proper non-nitrogenous fertilizer or combinations of fertilizers to give the maximum growth of legumes. High protein legume growth, when yields are large, furnishes cheap nutritious feed in abundance and the plant residues and the animal droppings—rich in nitrogen—usually benefit succeeding crops of grasses.

A scientific approach to a range fertilization problem would require: *1*, a knowledge of the nutrient requirements of the various legumes in question together with the relative ability of each to obtain the required nutrients from the soil; and, *2*, a knowledge of the ability of the particular soil to furnish the desired legumes with essential nutrients in optimum amounts. Though considerable information along this line has been collected, it is, in general, insufficient to answer such questions in any given situation.

Consequently experimental applications of the most likely materials must be made to range plots to determine to which materials each legume may respond. This procedure has been followed in a number of cases over the state.

Treble superphosphate usually at 220 pounds per acre as a source of phosphorus, muriate of potash usually at 220 pounds per acre as a source of potassium, and gypsum usually at 440 pounds per acre as a source of sulfur have been applied singly and in all possible combinations in trials at a number of selected sites in the state.

Fertilization Results

Preliminary observations suggest that often large differences among the legumes may result from fertilization. On some of the San Joaquin series of soils in Sacramento County rose clover and crimson clover seem to respond to application of phosphates alone, while bur clover does not seem to respond similarly. In other locations bur clover may give better than adequate responses to phosphate fertilizers.

Marked responses of bur clover from the sulfur of gypsum greatly reduce the percentage and even the amount of lupines in the forage, while Tom Cat clover in the mixed forage—though increased in amount—did not vary much percentagewise following the gypsum applications.

A summary of the trials showed about 40% of the good responses were obtained from carriers of sulfur, about 40% from carriers of phosphorus, and about 20% from carriers of both elements.

At that time these good responses constituted about one third of the total number of trials established. Since then an increasing number of trials have been made in the areas in which no satisfactory growth has yet been obtained from any commercial fertilizer. Work in progress is directed toward finding treatments which will increase the growth of legumes, especially bur clover, in areas where no satisfactory program has been worked out.

Some of the results with potash were suggestive but additional trials—with more replications—are needed to determine the value of potash when applied in addition to sulfur and/or phosphorus.

Exploratory Trials

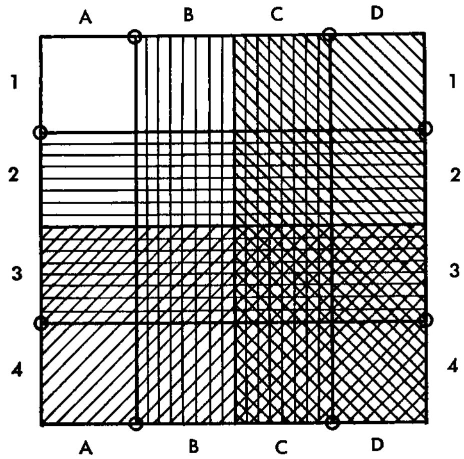
The diagram on the next page shows one of the simplest exploratory layouts for determining—by crop responses—what the nutrient deficiencies are at a given location.

Each trial should be fenced adequately and a large range may require several such trials as nutrient deficiencies may vary from place to place.

When results of the fenced plot trials seem satisfactory, parallel strips across the range can be made the second year

Continued on next page

Grass response to the nitrogen fixed by bur clover fertilized the previous year with gypsum at a rate of 440 pounds per acre and applied broadcast without any cultivation. The experimental area is near Santa Rosa. Note in the lower right foreground the response of bur clover obtained by the application of gypsum.



Exploratory layout to determine nutrient deficiencies on the range by plant response. The following materials and amounts are suggested for each 20′ x 80′ strip as follows:

Horizontal strips: 1–1, nothing applied horizontally. 2–2, 8 pounds treble superphosphate. 3–3, 8 pounds treble superphosphate and 8 pounds muriate of potash in turn applied uniformly. 4–4, 8 pounds muriate of potash.

Vertical strips: A–A, nothing applied vertically. B–B, 16 pounds gypsum. C–C, 16 pounds gypsum and 4 to 8 pounds ammonium nitrate. D–D, 4 to 8 pounds ammonium nitrate.

Just before the stakes are pulled if two or three handfuls of borax are spread in a circle of about two feet diameter around each stake as indicated by an open circle the killed growth makes the plot easy to find later.

using the best fertilizer or combination of fertilizers to determine whether the responses at the exploratory location would be general over the field. At the same time rates could be varied to get experience with regard to the best rates of application.

The parallel strips might be one width of the fertilizer distributor and from 100 yards to 500 or 600 yards apart.

As a result of the two years of exploratory testing—plots and strips—commercial applications may be indicated for the third year.

Many stockmen believe that for the first year of commercial fertilization not more than one third of the grazing area in any one range should be fertilized so as to stimulate greatly the legume growth. In the following years the other thirds in succession may be fertilized. If the legumes on the whole range responded markedly to the fertilizer it might be unsafe to pasture animals because of the danger of bloat. The first fertilized area—if increased growth of legumes has been obtained the first season—will ordinarily produce high amounts of grasses during the second season after fertilization. In this way two thirds of the grazing land always will be in a stand of plants which will not encourage bloat.

Application of Fertilizers

Satisfactory responses have been obtained by broadcast applications of fertilizers on the surface of the soil. Some data on some locations, however, point to the desirability of incorporating such materials as phosphates and potash compounds below the surface of the soil—as by banding.

Level or undulating lands usually can be fertilized by means of surface applicators. Steeply rolling to very hilly or rough land can be serviced adequately only by airplane. Many thousands of acres throughout the world have been successfully fertilized in this way.

The cost of applying phosphates at the rate of 220 pounds per acre might not run over $7.00 to $8.00 per acre. If sulfur or gypsum alone is all that is required the cost per acre may be less than half as much. Usually quite adequate amounts were applied in the experimental exploratory tests. Experience may show that these rates can be somewhat reduced.

The application of one particular nutrient—if it increases the growth of plants—usually creates a greater demand by the plants for the remaining nutrients. In turn this increased demand may make some other nutrient or nutrients deficient. So long as this second nutrient can be determined and the cost of supplying it is not excessive no great concern need be given to this factor.

Certain high-priced truck crop land has been known to have been fertilized so heavily that toxic concentrations of residual materials have accumulated. On range land this is not so likely as each nutrient applied must be justified by its own contribution to the maximum yield.

In some places, the long-continued application of either sulfate of ammonia or sodium nitrate has resulted in toxic residual conditions arising in the soils. If non-nitrogenous fertilizers are used to increase the legume growth little difficulty need be anticipated.

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Effects of a Single Application of Gypsum to Uncultivated Range on Dublin Clay Adobe, near Santa Rosa, Sonoma County

Year	Crop	Unfertilized Dry Matter lb./A.	Unfertilized N lb./A.	Unfertilized Crude Protein lb./A.	Gypsum—440 lb./A. Dry Matter lb./A.	Gypsum—440 lb./A. N lb./A.	Gypsum—440 lb./A. Crude Protein lb./A.
Single Plots 1946		**3675**	**67.5**	**422**	**6140**	**180.7**	**1130**
1947	**Legumes**	**100**	**2.7**	**16**	**650**	**20.1**	**126**
	Nonlegumes	**3625**	**44.6**	**279**	**5950**	**107.7**	**673**
	Total	**3725**	**47.3**	**295**	**6600**	**127.8**	**799**
1948	**Legumes**	**800**	**26.1**	**163**	**2050**	**68.1**	**426**
	Nonlegumes	**3290**	**43.1**	**269**	**5200**	**71.8**	**449**
	Total	**4090**	**69.2**	**432**	**7250**	**139.9**	**875**
1949	**Nonlegumes**	**2710**	**28.5**	**178**	**4310**	**47.8**	**299**

Effects of Treble Superphosphate at 220 Pounds per Acre when Applied to Dryland Range on a Goldridge Soil near Petaluma, Sonoma County

Treatment	Crop	Dry Matter lb./A.	Nitrogen lb./A.	Crude Protein lb./A.
Unfertilized	**Legumes**	**225**	**6.0**	**37.5**
	Nonlegumes	**2500**	**32.0**	**200.0**
	Total	**2725**	**38.0**	**237.5**
Fertilized	**Legumes**	**3900**	**123.6**	**772.5**
	Nonlegumes	**1950**	**32.6**	**203.8**
	Total	**5850**	**156.2**	**976.3**

Effects of Phosphate and Gypsum (Containing Sulfur) when Applied to Dryland Range on a Goldridge Soil near Petaluma, Sonoma County

Treatment	Dry Matter Legumes lb./A.	Dry Matter Nonlegumes lb./A.
Unfertilized check	**550**	**3500**
Treble superphosphate 220 lb./A.	**2530**	**3325**
Gypsum 440 lb./A.	**2450**	**3675**
Both Treble superphosphate 220 lb./A. and Gypsum 440 lb./A.	**5025**	**2250**