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FERTILIZATION OF NONSEEDED ANNUAL GRASSLAND

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Why Fertilize

Annual grassland soils without legumes are nitrogen deficient. To increase winter forage and total production, nitrogen must be added by a legume or nitrogen fertilization. Phosphorus and sulfur deficiencies are also widespread. In some areas, molybdenum deficiencies are quite common. Deficiencies of potassium, boron, and lime occur on acid soils, but are not widespread. Usually these latter deficiencies become evident only after adequate amounts of P and S have been applied on legume pastures. This leaflet describes nitrogen fertilization of annual grassland that does not contain a significant natural or seeded legume component.

Many studies throughout the state indicate that nitrogen fertilization can substantially increase total annual production, but the most important benefit of nitrogen fertilization is the increased production during the winter and early spring. This early feed is extremely valuable because it replaces expensive hay or other energy supplements for livestock. For the rancher dependent on annual grassland for his winter and spring feed the onset of the green season is awaited with great urgency each year. Nitrogen fertilizer can increase winter forage production before the spring flush of growth, and effectively replace two to six weeks of supplemental feeding during the winter. Nitrogen fertilization will also increase the spring feed, but this is usually not a forage short season for the range livestock producer in California.

The decision to apply nitrogen fertilizer to grassland is based on:

1. The need to extend the green forage season by increasing winter forage production.

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2. The need to increase total production without large increases in forage quality, and an ability to fully utilize the increased feed.

3. The absence of native or seeded legumes in significant amounts.

4. Average annual rainfall of 12 to 30 inches.

5. Expectation of an adequate productivity response to generate a return on the fertilizer investment.

6. The desire to invest capital in a short-term improvement, or have the flexibility of a year-to-year decision.

If precipitation exceeds 30 inches, an annual legume seeding should be considered instead of nitrogen fertilization. An annual legume seeding has a high initial cost, but is frequently less costly than nitrogen fertilization if costs are amortized over the life of the stand. Annual legumes also improve forage quality substantially.

What to Apply

Ammonium sulfate (21-0-0), ammonium phosphate (16-20-0) and urea (40-0-0) are most frequently applied on annual rangeland. Ammonium sulfate is frequently used because sulfur deficiencies are widespread on annual rangeland and it is less expensive than 16-20-0 containing both sulfur and phosphorus. Where sulfur and/or phosphorus are deficient, application of these nutrients should be considered. When the soil contains adequate levels of these nutrients urea may be used.

Nitrate nitrogen tends to leach too rapidly, and is often lost early in the first year before it can be utilized by the forage plants. Although urea is an inexpensive N source, volatility losses can reduce its effectiveness if soil pH is greater than 7 and if applied too early in the fall when soil temperatures are still high. Chicken manure and other manures can be satisfactory sources of N where transportation and spreading costs do not prohibit their use. Manures are longer lasting N sources because the N is released slowly as the organic matter decomposes.

Soil and Plant Tissue Testing

Soil and plant tissue testing can help to answer the question of what nutrients to apply in addition to nitrogen. Your farm advisor can advise you on the need for these tests. Commercial agricultural testing laboratories, listed in the Yellow Pages, can conduct needed soil and plant tissue tests. The bicarbonate P test is commonly used to determine soil phosphorus. In California a level of less than 5 ppm indicates a marked deficiency requiring a large phosphate fertilizer input, usually around 100 to 200 pounds per acre of triple superphosphate. If the level is from 5 to 10 ppm, a smaller amount is recommended, usually 50 to 100 pounds per acre of triple superphosphate.

The soil test for S is not a reliable indicator of sulfur deficiency. Where legumes are present, the tissue tests for sulfur may be used to determine sulfur need. Sulfur and phosphorus deficiencies may occur together. Triple superphosphate contains no sulfur so application of a mixture of triple superphosphate and elemental S (0-36-0-20) can take care of both P and S deficiencies.

Although K is generally not considered deficient in most California range soils, it can be measured reliably by a soil test. If soil test levels (exchangeable K) vary from 0 to 75 ppm K, apply 50 to 80 pounds per acre K; if the level is 75 to 150 ppm, apply 30 to 50 pounds of K; and if the soil test K is greater than 150 ppm, apply no K (see Bulletin 1897).

When to Apply

In the 12 to 30-inch rainfall zone, nitrogen is generally applied in the fall to lengthen the green feed period by increasing winter growth. The amount and distribution of rainfall, as well as temperature, are principle factors governing the timing of application. Nitrogen is not profitable in central and southern California, where annual rainfall is less than 12 inches annually, because reduced soil moisture restricts growth.

Research at the Hopland Field Station, where nitrogen was applied monthly from September through January in a 36-inch rainfall zone, showed that the earlier N was applied in the fall the greater the winter forage growth. Total forage as measured at the end of the growing season was not affected by the time of application unless the application was made after February. Nitrogen is generally not recommended where rainfall is greater than 30 inches since leaching losses are high. Denitrification can contribute to N losses, especially on poorly drained soils that are saturated for extended periods.

Winter temperatures averaging much below 50°F severely limit responses to nitrogen fertilization. Daily mean temperatures below this limit are common in northern California and Oregon during the months of December, January, and February. Therefore, nitrogen should be applied before the first autumn rains when mean temperatures are 50° or more. Lack of response in cold weather is mainly a simple restriction of plant growth, but N fertilized grass often is less damaged by frost and appears to recover faster than N deficient grass.

How Much to Apply

Generally, a good forage response is gained from applying between 40 and 80 lb/A of nitrogen. The variation in recommendations between counties is a reflection of year and range site differences, especially annual variation in amount and distribution of precipitation. How much nitrogen to apply has been a continuing question and the subject of numerous fertilizer trials. Rates of N up to 200 lb/A have been applied and forage or animal yield measured.

Production functions for nitrogen fertilization follow the law of diminishing returns. Therefore, beyond a certain level, each additional increment of fertilizer will give less production than the previous increment. The point of diminishing returns is where the return equals the cost of the added increment. On California annual rangelands, this point is commonly in the range of 40 to 80 lb/A of N, and it will vary within this range due to seasonal and yearly variations in weather. Lower rates seldom yield adequate forage production to justify the expense. Individuals should seek local advice from county Extension personnel for recommended rates for their soils.

How Often to Apply

Traditionally, nitrogen applications have been made in the fall near the time of the first fall rains. In regions of high rainfall and where heavy winter grazing has occurred, the forage may become extremely nitrogen-deficient in the spring even though N was applied the previous fall. Under these circumstances spring applications of nitrogen fertilizer may be beneficial, but this practice has not been adequately evaluated in our annual grasslands.

Where rainfall is not great enough to leach all of the fertilizer nitrogen out of the soil, and plant nitrogen uptake is insufficient to use all of the fertilizer nitrogen, there may be a carry-over response to nitrogen fertilization during the next growing season. In the 1950s many grazing trials were conducted to demonstrate the response of range livestock gains to range nitrogen fertilization. Carry-over effects were assessed in 13 of the tests. In all but one test there was an appreciable carry-over effect from fertilization, the additional gain being equivalent to about 50 percent of the first year effects on the average. Part of the gains in these studies should be credited to the P and S also applied, but the amount of credit to be given cannot be determined with the data at hand. Without applied N or a good stand of legumes, there is usually no response to P or S on annual grasslands of California.

How to Apply

Fertilizer can be applied from the ground or by aircraft. Large, inaccessible, rough and rocky ranges are usually fertilized by aircraft. Fertilizer application equipment and tractors are usually restricted to use on rangeland where slopes are less than 20 to 30 percent and the surface is relatively free of rocks or other obstructions to the equipment. The analysis of range sites on a given ranch during a range management planning process will help to identify those areas that can be treated from the ground and those that must be treated from the air.

Forage Quality

Fall nitrogen fertilization generally increases the protein percentage in annual grasses and broad leaved forbs early in the growing season. However, an increase in protein in winter is not beneficial since there is typically adequate protein for animal needs in unfertilized pasture at that time of year. The primary benefit from nitrogen

In the early part of the season is an increase in dry matter production. As the season advances, the protein levels may decrease more rapidly in plants fertilized at moderate nitrogen levels than in those not fertilized. As a result, at the end of the growing season fertilized plants are often lower in protein than are unfertilized plants. Exceptions may occur in very dry spring seasons when moisture becomes limiting and plants are unable to grow to their full potential, thus drying up before growth dilutes the nitrogen (protein) to a low level.

Yearly application of nitrogen generally increases the percentage of grasses and forbs. The particular grasses or forbs which increase will depend upon the grazing or clipping management of the pasture in question. For example, slender wild oats or ripgut brome often become dominant where nitrogen fertilizer is applied to ungrazed plots. In similarly treated plots that are heavily grazed, soft chess may become dominant. This is due to the greater tillering ability of soft chess when grazed as compared to wild oats or ripgut which tiller poorly. Moderate to heavy grazing pressure tends to reduce the impact of fertilizer on botanical composition.