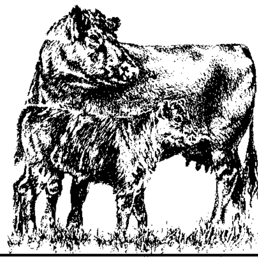

Western Beef Resource Committee ***Fourth Edition***

Cattle Producer's Handbook

Range and Pasture Section 594

Pasture Fertilization

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Healthy, productive pastures are financially important to the livestock industry. Proper fertility management, in combination with good pasture management, is required to maintain a sustainable forage resource, reduce production costs, and optimize livestock productivity.

Pastures are fertilized to replace nutrients needed for plant growth and to provide high quality feed for livestock. A pasture fertilization program is guided by current pasture conditions, potential productivity, and economics. This report is a fertilizer guide for irrigated pastures and/or areas with 20 inches annual rainfall or more.

Soil Analysis

A pasture fertilization program depends on the laboratory analysis of a representative soil sample. The soil analysis measures the current soil mineral components such as phosphorus (P), potassium (K), and sulfur (S). Using the soil analysis results, an appropriate fertilization program can be designed for maximum return on investment. Research-based fertilizer guides will help determine amount of fertilizer needed in your geographic region.

Soil analysis for pastures should be conducted annually until soil fertility is within recommended levels. Once fertility is at recommended levels, samples should be taken every 3 years to monitor any changes. If pastures are worked up on a rotation and planted to annual crops before perennial pasture establishment, annual soil analysis would also be beneficial.

In pasture systems, nutrients are in constant flux as they are moving among the atmosphere, soil, plants, and animals. As a result, nutrient levels do not remain constant throughout the year. Both fall and early spring are good times to take soil samples. To compare the soil nutrient profile from year to year, samples should be collected at a similar time each year. Field representatives from local fertilizer companies may offer assistance with soil sampling.

An accurate soil sample is a composite of samples taken from at least 15 to 20 locations within the pasture. A special soil testing probe is inserted into the soil at a depth of 6 or 12 inches and a core sample of soil is obtained. The sampling depth depends on the geographic location. Areas of pasture should be sampled separately if there are differences in yield, soil type, or topography (e.g., slopes, wet areas, etc.).

Each core sample should be collected in a clean plastic bucket, mixed together, and placed in a soil sample bag or 1-gallon zip-loc type bag (Robotham and Hart 1995). Some analytical laboratories will have special sample bags and may also provide specific instructions on sample collection and handling. The lab will often provide fertilizer recommendations based on yield goals and specific plants being grown. Pasture fertilizer recommendations as well as laboratory lists may also be available from your local county extension office or fertilizer supplier (Hart 1998 and 2008). In order to maintain and improve forage production, soils must be fertilized to recommended rates (Hart 1998; Hart et al. 2000).

Determine a Pasture Fertilization Plan

For pastures to be productive, the plants must be properly fed, watered, and receive adequate sunlight. If any one of these requirements is missing, forage production will suffer. Generally, pastures will require less applied fertilizer than field crops. Grazing livestock recycle as much as 85 to 95 percent of the N, P, and K consumed in grazed forages through urine and manure deposits. The distribution of recycled nutrients, however, is not always uniform across the pasture. Nutrients tend to accumulate more heavily where livestock linger the most—around water sources, bedding areas, and trails. Proper grazing management and livestock distribution can aid in depositing recycled nutrients more uniformly.

Timing of fertilizer applications varies by nutrient and stage of the growing season. Nitrogen is commonly applied in multiple, split applications over the course of the growing season. Some forms of N fertilizer are easily volatilized (i.e., change from a solid or liquid to a vapor). Nitrogen is also easily leached beyond the plants' effective root zone with rain and irrigation. Phosphorus movement in soil is limited, so it should be applied and incorporated at the rooting depth during seedbed preparation for new pasture seedings.

For existing stands, P should be applied during the dormant season, which is typically fall in most western regions. Potassium has somewhat limited soil movement as well and should be applied at the same time as P. Sulfur is typically applied in late winter or spring (Hart et. al. 2000).

Certain grasses have higher needs for N, P, K, and S than others. For example, perennial ryegrass has high nutrient requirements. Orchardgrass and fescue grasses respond positively to fertilizer applications as well but are known to survive low fertility followed by a decrease in forage production.

Soil pH

The pH of soil is a measure of soil acidity and alkalinity. The pH scale ranges from 0-14, with a neutral soil having a pH of 7. Soils with a pH below 7 would be considered acidic and above pH 7 are basic (alkaline). Plants generally grow best when soil pH is closer to neutral, in a range of 6-8.

Many factors affect soil pH such as soil parent material, rainfall, and temperature. Typically, soils found in lower rainfall areas tend to be more alkaline and, conversely, soils in high rainfall regions tend to be more acidic. Soil pH has an effect on the plant nutrient availability and biology of beneficial soil organisms. Fertilizer sources and soil amendments can also affect soil pH. When used strategically, they can aid in adjusting pH to a desired level.

Agricultural lime is an amendment used to aid in increasing soil pH. Both grasses and legumes can benefit from lime to increase soil pH when soil test results indicate a need. However, legumes are generally more sensitive to low pH than grasses. Lime would be indicated for grass pastures when the soil pH is less than 5.4; for legumes, lime is indicated at pH less than 5.8.

Lime is most efficient at increasing soil pH when it can be incorporated into the soil before seeding. Applying lime to an existing pasture will aid in keeping the soil from reaching a lower pH but generally has little effect on increasing soil pH (Rogers and Hart 1996; Angima 2009; Downing et al. 2006).

Alkaline soils can also negatively affect pasture growing conditions. In areas where soil pH exceeds 8.2, soil tests should be used to evaluate the presence of salts and sodium. Leaching through sprinkler irrigation and drainage as well as the addition of organic matter can be used to help reclaim high salinity soils. For soils affected by sodium, drainage is important to help remove sodium from the root zone.

"Gypsum (calcium sulfate) is the most common material used to supply calcium for sodic soil reclamation." (Horneck et al. 2007). Elemental S should be incorporated into soil to speed reclamation.

Nitrogen Fertilizer

Symptoms of N deficiency in grasses include slow or stunted growth and yellow or pale green color. However, even if no deficiency symptoms are obvious, grass pastures generally respond well to N fertilization. As more N is applied, the rate of yield increase slows until the maximum rate has been applied and zero additional yields are achieved. The point at which this occurs is dependent on soil-available N from other sources.

Depending on past fertilizer/manure applications and grazing history, pasture soils can have a range of 40 to 120 pounds of N that is mineralized and available for plants to utilize each year due to organic material breaking down in the soil. If clovers or other legumes are present in the pasture, they may be able to fix N and make it available in the soil for grass plants to use.

Legumes in a pasture can contribute a significant amount of N. Rhizobium bacteria produce nodules on the roots of legumes, if properly inoculated, which allow the legume plants to fix N from the atmosphere. The fixed N is then available in the surrounding soil. Properly functioning clover nodules have been known to produce from 75 to 150 pounds of N per acre per year. Amount of N needed by plants depends on the production potential of the pasture. Production potential varies by length of growing season, precipitation, grass species present, percent legumes in the stand, and number of grazing periods.

Making multiple small applications of N over the growing season helps eliminate N losses through volatilization or leaching and allows plants to efficiently utilize the available N. Thirty pounds of N per acre is the minimum amount that should be applied each time a pasture is fertilized. Grass pastures need approximately 50 to 65 pounds N per ton of grazed pasture, including the N supplied by grazing animals (urine and manure), any legume plants, and available soil mineral N (Hart 1998).

T-Sum 200

T-Sum 200 is a method used to determine when N can first be applied after January 1. It is based on air temperature that is related to when pasture plants can start using N fertilizer. Initiation of plant growth in late winter/early spring is regulated by temperature and light. A method to estimate N demand is to monitor air temperature, then change air temperature into heat units. A heat unit is the average of the high and low temperature for the day and is a way to measure heat accumulation over time. The process includes: (1) beginning January 1, add together each day's maximum temperature and minimum temperature, and divide by two (day's average temperature), and (2) determine heat units beginning January 1 by adding together the heat units for each day. Apply N when 360 heat units (degrees Fahrenheit) are accumulated, indicating plant readiness to grow.

Application of N based on heat units can produce feed 1 to 3 weeks earlier than traditional applications made in March or April in moderate climatic regions. In colder, drier climates such as the Great Basin, a consistent economic increase in early forage production has not been realized from T-Sum application methods (Peters and Hart 2007; Pirelli et al. 2004).

Phosphorus Fertilizer

Phosphorus deficiency symptoms may include reduced growth rates, stunted plants, delayed maturity, or poor seed development. Generally, legumes have a greater requirement for P than grasses. However, high producing grass pastures can often benefit from P fertilization, particularly when legumes are a component of the pasture mix.

Soil pH has an effect on the availability of P. A pH between 6.0 and 7.5 will allow for the most available soil and fertilizer P than a soil pH range above or below this level. To obtain a valid soil P result, ensure the correct P testing method for your geographical region is chosen. The Olsen Extraction Method is best to characterize P levels in alkaline soils and, conversely, the Bray Extraction Method is best suited to evaluate acidic soils. For the Olsen method, no additional P is needed if the soil level is 15 ppm (parts per million) or higher. For the Bray method, a soil P level of 40 ppm or higher requires no additional P (Hart et al. 2000; Hart 1998).

Phosphorus, unlike N, does not move much in the soil profile. Only apply the amount of P needed for the next growing season since it is usually not cost-effective to stockpile P. Phosphorus needed for spring forage production, for example, should be applied in the fall. Phosphorus and N applied together can sometimes have a synergistic effect on plant growth, producing more forage than individual applications (Hart 2000).

Potassium Fertilizer

Symptoms of potassium deficiency are tip burn on mature leaves, weak stalks, small seed heads, and slow growth. The level of K needed for grasses is generally lower than for legumes. However, both grasses and legumes will uptake more K than what is actually needed for sufficient plant growth.

Potassium is adequate in many areas of the West. However, K levels deplete more rapidly in pastures that are harvested for hay. If pastures are only grazed (and not hayed), livestock will cycle a significant portion of K back to the soil in urine and manure. For every ton of hay that is harvested, 60 pounds of K are removed. Therefore, the amount of fertilizer needed to maintain desired levels of production are much higher than grazed forage requirements. The required level of K is 100 ppm for grasses and 150 ppm for legumes.

Similar to P, K movement through the soil profile is somewhat limited and is ideally incorporated at the time of seedbed preparation for a new seeding. Fall applications of K are typical for existing pastures. The most common forms of K fertilizer are potassium chloride (0-0-60) and potassium sulfate (0-0-50). Select a potassium source based on local availability, ease of application, and cost per unit of K_2O.

Minor Elemental Fertilizers

Sulfur (S) is one of two minor but essential plant nutrients that should be considered in fertilization plans. Legumes require more S than grasses. Sulfur is essential for root nodulation in legumes such as clover and alfalfa.

Soil S levels vary based on soil texture, rainfall, irrigation levels, and water source. Volcanic ash-derived soils can have an effect on the amount of S available to plants. A significant level of S can also be supplied naturally in irrigation water in some geographic regions. In high rainfall areas, S can be leached from the soil. Symptoms of S deficiency are similar to those of N and P deficiency: young leaves are light green or yellowish, plants are small and spindly, and they exhibit a retarded growth rate and delayed maturity.

Plants absorb S as sulfate. Thus, the sulfate sulfur sources (ammonium sulfate, gypsum, potassium sulfate, and potassium-magnesium sulfate) are more readily available and work best to address an immediate sulfur deficiency. Late winter or spring applications are typical, unless there is a severe deficiency, in which case, additional fall or spring applications may be needed. Elemental S can be used as a source of S. However, soil microbes must convert elemental S to the sulfate form before the microbes can be used by plants. Time needed for this conversion to a usable form depends on soil and environmental conditions. When using elemental S, allow an additional 3 to 4 months or longer for it to become available for plant use.

If soil test results show S levels less than 10 ppm (SO_4-S), a 30-pound S per acre application would be recommended. In high rainfall areas, it is common to apply S every year. At least 5 pounds of S can be applied per acre per year or 15 pounds every 3 years, where needed.

Micronutrients

Boron (B) is a micronutrient that is needed but can also be toxic to plants. Soil test levels of B below 0.25 ppm will indicate a need for 1 to 3 pounds B per acre. If higher rates are applied, toxicity may result.

Magnesium (Mg) is essential for photosynthesis, which is the conversion of sunlight into plant growth.

Magnesium is also essential for adequate production of plant enzymes essential for plant growth. Many western soils have adequate levels of Mg. Signs of a deficiency include yellowing of leaves, leaves curling upward along margins, and marginal yellowing along the mid-rib of the leaf.

Nutrient deficiencies not only affect plant growth but can also affect animals. One example is grass tetany. Grass tetany is a metabolic deficiency of Mg and calcium (Ca). It is a syndrome primarily involving mature cattle grazing on succulent forages. Pastures heavily fertilized with high levels of N or pastures with high soil K are more likely to produce tetany-prone pastures. Cool, rainy weather generally accelerates the occurrence (Maas and Kvasnicka 2002.) Magnesium applications may be desirable if grass tetany is a problem.

Selenium (Se) is a micronutrient that is not required for plant growth but is essential for animal production. Deficiencies in livestock dietary Se can have detrimental effects on the animals. White muscle disease is the most commonly recognized, but other problems such as reproductive and production losses, as well as immune system dysfunction, can all impact efficient livestock production. In the West where the soil is formed on volcanic parent material, forages will commonly have low levels of Se.

Selenium is most commonly supplemented to livestock through mineral mixes, boluses, and injections. These strategies may not provide adequate or sustained blood Se levels, however, and can be relatively expensive. Pastures can be fertilized with Se. Studies have shown that this method of supplementation is safe and effective. Selenium fertilization increases forage Se levels for up to 2 years, providing a cost-effective method of supplying Se for grazing livestock (Filley et al. 2007).

Summary

Adequate soil fertility is required to grow quality forages. Analyzing soil on a regular basis and fertilizing according to recommendations will provide the best growing conditions. In addition to developing a fertilizer plan, a harvest program should also be planned (Bruce 1996; Mosley 1992). Maintenance of adequate pasture stubble height (generally 3 inches) after harvesting should be included in the plan to maintain plant health and vigor. Focusing on soil needs will pay off in quantity and quality of feed grown.

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