Alfalfa Production on Acid, Humid-Region Soils

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Abstract

Because of its excellent nutritional value, alfalfa [Medicago sativa (L.) Pers.] is often called "Queen of the Forages." On the Coastal Plain of the southern U.S., sustainable production of alfalfa has been restricted by lack of attention to subsoil acidity and by a humid environment that delays alfalfa drying for hay. Production of alfalfa also has been restricted by the popularity and ease of growing bermudagrass [Cynodon dactylon (L.) Pers.] and the aggressiveness of bahiagrass (Paspalum notatum Flugge) grown for pasture and hay production, both of which are much lower quality than alfalfa. Development of grazing tolerant alfalfa varieties has placed renewed emphasis on alfalfa production under these conditions. Guidelines for alfalfa production on Coastal Plain soils were developed through research by Texas Agricultural Experiment Station scientists to identify and overcome factors that inhibit alfalfa growth on these soils. This work initially was based on a dual cropping system of alfalfa interseeded into Coastal bermudagrass meadows, but developed guidelines apply to monoculture alfalfa equally well. Site selection is critical for successful establishment and production of alfalfa. Good soil drainage and low soil acidity are essential. A pH of 6.8 to 7.0 in the surface 6-in. depth is needed. Toxic levels of aluminum (Al) and manganese (Mn) in the subsoil inhibit alfalfa root extension. Samples collected by 1-ft. depths to 4 ft. should be analyzed for pH. As soil acidity increases below pH 5.5, (1:2 soil:water) phytotoxic levels of Al and Mn can develop. Alfalfa growth is enhanced when 0.01 molar calcium chloride ($CaCl_2$) soluble Al concentration is less than 1.0 ppm in each depth of the soil profile. The larval stage of the alfalfa weevil [Hypera postica (Gyll.)] is the most harmful insect in alfalfa, but it is easily controlled. Other insect and weed pests also occasionally need to be controlled.

Introduction. The Coastal Plain of the southern and southeastern U.S. is dominated by highly leached, acid soils. Hybrid bermudagrasses developed on acid soils produce excellent forage yields in response to high rates of N. Alfalfa has not been a common forage in the Coastal Plain due to its intolerance to soil acidity and poor hay drying conditions caused by high humidity and frequent spring precipitation. The release of grazing-tolerant varieties has increased the potential for production of alfalfa on Coastal Plain soils. Research on interseeding and production of alfalfa concurrently with hybrid bermudagrasses is limited. Our interest in mixed stands of alfalfa and hybrid bermudagrass developed from the need to improve the forage quality in bermudagrass pastures without continued applications of N that increase soil acidity on sandy, low-buffer-capacity soils. The preliminary objective of this research was to evaluate production of 'Alfagraze' alfalfa with 'Coastal' bermudagrass to determine species competitiveness, yield, sustainability, and fertility requirements of this synchronous forage system on Coastal Plain soils. Guidelines resulting from this research on alfalfa production on Coastal Plain soils are presented here, and are similar for monoculture alfalfa.

Materials and Methods. Research on alfalfa interseeded into Coastal bermudagrass sod has been conducted by scientists with the Texas Agricultural Experiment Station at Overton and College Station during the last ten years. Experiments were established on soil previously limed to pHw 7.0 (1:2-soil:water). Bermudagrass was cut to a stubble height of 2 to 3 in. in early October. No-till planting of inoculated seed was accomplished in October or early November when sufficient moisture was available to sustain alfalfa seedlings. Alfalfa was planted using a small-plot drill with double-disk openers and packer wheels. Except for variable rates of nutrients studied, fertilization with plant nutrients at rates sufficient to sustain alfalfa was done on all sites. Studies included: (1) alfalfa row spacing and nitrogen (N); (2) limestone and boron (B); (3) soil series (Alfisols, Ultisols, and an Inceptisol) and phosphorus (P); (4) potassium (K), magnesium (Mg), and sulfur (S); (5) establishment weed control; (6) plant response to grazing; (7) N transfer from alfalfa to bermudagrass; (8) zinc (Zn), copper (Cu), and molybdenum (Mo); (9) depth of limestone incorporation with and without Mo; (10) use of gypsum to neutralize aluminum toxicity in subsoil; (11) susceptibility of grazing tolerant varieties to grazing pressures; (12) beef cattle weight gains on alfalfa versus bermuda grass; and (13) demonstration of alfalfa production on producer farms and ranches, using 5 to 8 acre sites.

Results and Discussion. Guidelines for establishment and sustained production of alfalfa on Coastal Plain soils are presented. These guidelines include:1. Planning; 2. Site selection; 3. Soil sampling and analysis; 4. Liming and fertilization; 5. Site preparation and seeding; 6. Weed control, 7. Insect control; and 8. Harvesting.

1. PLANNING

1. Planning. Planning is essential for efficient and economic use of alfalfa in a livestock production system. Maximum benefit will be attained when alfalfa is consumed by livestock with high nutritional requirements such as stocker cattle and superior lactating cows.

Planning includes consideration of establishment costs and maintenance of alfalfa relative to the current forage system. Establishment cost will vary depending mainly on the amount of limestone needed to neutralize surface soil acidity to pH 6.8 to 7.0. The cost of limestone, even at 4 tons/acre to neutralize soil acidity to pH 7.0, when prorated over two years of alfalfa production, compares favorably to the cost of N fertilizer and limestone applied for production of hybrid bermudagrass over a similar time. When viewed in this manner, the one-time cost of limestone and alfalfa seed will probably be lower or equal to the cost of N applied to produce quality bermudagrass. Alfalfa needs B and additional P compared to hybrid bermudagrasses while the need for K is similar for both forages.

The harvest method to be used is important. Grazing will be the least expensive alternative. Potential for hay production is determined by humidity levels and length of rain-free periods. Harvesting alfalfa for silage or greenchop and bale silage production are alternative harvest methods.

2. Site selection. Site selection is critical to successful production of alfalfa. Characteristics of a good site for alfalfa include adequate soil drainage, low subsoil acidity, high fertility, and good soil aeration. The importance of good soil drainage and aeration cannot be overemphasized. Alfalfa cannot tolerate wet soil conditions for extended periods, particularly near the surface. However, we have successfully grown alfalfa on a Thenas fine sandy loam that had a perched water table at 20 inches below the surface in the spring.

Knowledge of the type of soil available on the farm or ranch is important for successful alfalfa production on acid soils. Distinguishing characteristics among soils mainly occur in the B (argillic-zone of accumulation) horizon. Our research on soil series shows that alfalfa produces well on Paleudult and Paleudalf soils. These old, well-developed soils have excellent drainage and aeration. Subsoil colors are reddish orange to yellow with very little gray color in the top 4 ft. Gray subsoils can be indicative of prolonged periods of excess water. Depth of surface sand varies, but can exceed 4 ft. Soils with deep, sandy A horizons will hold less plant available water and, because of lower clay content, lower amounts of Al will be solubilized when these soils have a pH below 5.5. By contrast, lower alfalfa yields were attained on the Hapludult and Hapludalf soils. These soils have a shallower depth of surface sand and minimum horizon development. They have more clay, are a darker red color in the subsoil horizons, and therefore will contain more soluble Al as the soil pH drops below 5.5.

The surface 6-in. depth should be neutralized by liming to pH 6.8 to 7.0. The amount of lime needed will vary depending on the level of acidity and the clay content. The amount of acidity in the subsoil is an important consideration. As soil pH drops below 5.5, Al increasingly solubilizes from the soil clay. Research indicates that 0.01 molar $CaCl_2$-soluble Al at levels above 1.0 ppm can be toxic to alfalfa. Toxic levels of Al inhibit root tip growth, thereby preventing extension deeper into the soil and limiting plant access to available soil water. The closer to the surface a toxic level of Al occurs, the greater is its impact on alfalfa yield. This is particularly important when alfalfa depletes available water in the surface soil during a drought. Aluminum toxicity in the lower subsoil depths is less serious when water can be provided by irrigation during dry periods. Gypsum, although not a liming material, can alleviate subsoil Al toxicity and provide calcium (Ca) that is beneficial to alfalfa. Gypsum is relatively soluble compared to limestone but requires time for leaching through the soil profile. As soil pH approaches 5.2 and below, phytotoxic levels of Mn can develop especially when soils are wet for prolonged periods.

3. Soil Sampling and Analysis. Low buffer-capacity, sandy soils will have a lower pH in fall than in spring. Fall is the recommended seeding time for alfalfa on Coastal Plain soils. The lime requirement of fall-sampled soils should best approximate the lime needs of these soils for alfalfa seedling growth. The surface 6-in. depth of Coastal Plain soils intended for alfalfa production should be analyzed for P, K, Ca, Mg, S, B, and pH. Request a test for lime requirement to raise pH to 6.8 to 7.0. Sample the subsoil at depths of 6 to 12 in. and 1 to 2, 2 to 3, and 3 to 4 ft. for pH analysis. A pH above 5.5 in all depths is desired. If the pH is much below this level, alfalfa yields can be limited by Al and possibly Mn toxicities. Under rainfed conditions a phytotoxic level of Al in the 3- to

4-ft. depth will allow alfalfa roots to have access to more soil water than will a similar level of Al in the 1- to 2-ft.-soil depth. If the pH is below 5.5 in subsoil depths, request tests for 0.01 molar CaCl2-soluble Al and extractable Mn on these samples. If soluble Al is above 1.0 ppm in the subsoil, an alternative site for alfalfa production should be located and tested.

4. Liming and Fertilization. Time is needed for limestone to neutralize soil acidity. Apply limestone at the recommended rate the winter preceding fall planting. In regions of the Coastal Plain affected by summer drought, disk the limestone into the 0- to 6-in. depth from late February to May, even where alfalfa will be overseeded into bermudagrass. To conserve soil moisture, pack the soil with a roller immediately after disking. With adequate moisture, the bermudagrass will quickly reestablish. Where soil test levels are low, incorporate needed P, K, and B with the limestone. Fertilize reestablished bermudagrass as normally done for grazing. In late summer, stop N treatment to reduce grass competition with emerging alfalfa seedlings. Resample the 6-in. depth in late summer to verify that pH is approximately 6.8 to 7.0 and determine additional fertilizer and limestone needs. Add additional lime if the pH is below 6.8. On tilled soils, limestone can be incorporated in late winter or early spring before seeding a warm-season crop for hay or grazing.

When the soil tests very low in P, 120 lb. of P_2O_5/acre may be needed to maximize alfalfa yield the seedling year. In succeeding years, the P rate needed to maintain alfalfa production on very low P soils can be lowered to 80 lb. of P_2O_5/acre. The N in fertilizer blends containing diammonium phosphate may benefit establishment of alfalfa seedlings, but if applied to a grass pasture to be overseeded to alfalfa, the N can increase grass growth that may compete with alfalfa seedling growth. Apply K, S, and other plant nutrients as recommended by soil test. Alfalfa removes approximately 50 lb. of K (60 lb. of K_2O)/ton of forage produced. Liming low-buffer-capacity soils to pH 6.8 to 7.0 decreases plant-available soil B. On deficient soils, those that contain hot-water-soluble B levels less than 0.35 mg/kg (ppm), apply B at the rate of 3.75 lb./acre. Analyze the 0- to 6-in. soil depth each fall and apply fertilizer and limestone at recommended rates. Soil tests for plant-available B should be made on the 2-to 6-in. depth to eliminate the organic matter layer. This requires collection of a separate sample for B analysis. Alfalfa readily responds to elevated levels of soil B.

5. Site Preparation and Seeding. In October, when nighttime temperatures begin to drop below 60^{o}F, harvest grass to a stubble height of 2 to 3 in. if overseeding alfalfa into a bermudagrass sod. Short stubble allows sunlight to reach alfalfa seedlings and protects them from harsh winter and spring conditions. Lightly till the soil with a disk harrow. On tilled soils to be planted to alfalfa, pack the soil sufficiently so that the heel print of a boot made by walking on the packed soil leaves an indention no deeper than one-fourth inch (0.6cm). When adequate soil moisture is available, drill pre-inoculated, or freshly re-inoculated, viable alfalfa seed to a depth no greater than ¼ in. in clay soils and ½ in. in sandy soils. Use a drill with packer wheels or a cultipack seeder. On drills equipped with packer wheels that cover the seed row with excess soil, remove the packer wheels and pack the soil with a roller immediately after seeding. At a 7- to 10-in. row spacing, plant

15 - 20 lb. of treated alfalfa seed per acre. Coated seed may contain only 66% pure seed. When planting coated seed, adjust the seeding rate to plant no less than 15 lb. of actual pure live seed per acre. Reduce the seeding rate by one-half when extending the width between rows to 15 to 20 inches. On low fertility soils, narrow-row alfalfa can severely reduce a stand of hybrid bermudagrass. Under these conditions, common bermudagrass can invade the site as the alfalfa stand density declines. Hybrid bermudagrass can compete effectively with alfalfa on a high fertility soil. Increasing the alfalfa row spacing from 9 to 27 in. in a hybrid bermudagrass pasture can lower alfalfa production approximately one ton/acre. Regardless of alfalfa row spacing in a hybrid bermudagrass sod, total forage produced will remain relatively constant but the proportions contributed by alfalfa and bermudagrass will change. Alfalfa overseeded into a common bermudagrass pasture is not expected to compete well because common bermudagrass stands are more dense than those of the hybrid bermudagrasses.

Because of unpredictable rains and competition from weeds, broadcast and winter or spring seeding of alfalfa is discouraged on Coastal Plain soils, particularly when seeding into grass sod. Planting in fall allows germinated seedlings to develop a root system that can effectively compete for soil water in the spring. Manage mixed stands of alfalfa and grass to benefit alfalfa. Applying N to a bermudagrass-alfalfa mixture will not benefit the alfalfa, but can increase competition from the grass and will not be economical.

6. Weed Control. Broadleaf weeds can be controlled with 2,4-DB or Pursuit™ if sprayed when weeds are less than 2 in. tall. Pursuit™ may be used for broadleaf weed control after seedling alfalfa has reached the second true-leaf growth stage. When alfalfa is seeded in clean-tilled soil, most young annual grasses can be controlled by Poast Plus™. There is no herbicide labeled for selective control of grasses when alfalfa is planted into a grass sod except that Poast Plus™ may be used for control of annual ryegrass in alfalfa when hybrid bermudagrass is dormant. Balan™ or Eptam™ may be incorporated into a prepared seedbed before planting alfalfa. Treflan™ and Zorial™ can be applied as a pre-emergent for control of germinating grass and broadleaf weeds in established alfalfa. Read and follow all label restrictions for haying and grazing and to avoid damage to alfalfa and the environment.

7. Insect Control. In mid-February, begin monitoring alfalfa for chewing damage by the larval stage of the alfalfa weevil. Aphids (Family Aphidae) in alfalfa have been effectively controlled by lady beetle (Family Coccinellidae). The three-cornered alfalfa hopper has been a minor problem in alfalfa in Coastal Plain regions in the summer. Check for blister beetle (Family Meloidae) during summer months. Blister beetle can be fatal if consumed by horses and can cause illness in cattle. Several insecticides are available for effective insect control in alfalfa. Read and follow label directions for safe use of insecticides and for haying and grazing restrictions.

8. Harvesting. Alfalfa may be harvested by grazing, green chopping, as silage, or cut and baled for hay. Curing first and second growth alfalfa for hay in Coastal Plain regions can be difficult due to unpredictable drying conditions. A cutter-conditioner encourages drying, but can squash blister beetles if present, preventing them from leaving the cut

hay. Tedders and hay preservatives are helpful aids for hay production. Slight dew helps prevent leaf loss from dry alfalfa during baling. When alfalfa is grazed, bloat can be a problem. Preventive measures include allowing cattle their fill of hay, pre-grazing on grass, feeding poloxalene free choice, and allowing cattle to limit-graze for 1 to 2 hours a day to become accustomed to alfalfa before full-time grazing. Bloat potential in cattle is lowered when grass is grown with alfalfa. The first harvest can be cut for hay or grazed at early bloom. Depending on weather, grazing can begin three weeks after the first harvest when the alfalfa has 10 to 12 inches of regrowth. When continuous grazing is practiced, the recommendation is to leave 7 to 8 inches of growth during the grazing season. For an intensive rotational grazing system, fence the alfalfa into eight or more paddocks. Use a sufficient number of animals to graze the alfalfa to a 3- to 4-inch stubble in 3 to 4 days or less, then move them to the next paddock. Trampling can damage new growth buds at the crown of the alfalfa plant when grazers are allowed to remain on a paddock longer than 4 days. Allow the grazers to go off the alfalfa for water to prevent severe trampling around the water supply. Allow alfalfa 4 to 5 weeks regrowth, or more, depending on soil moisture and precipitation, before returning cattle to a previously grazed paddock.