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Sulphur-coated urea: a slow-release nitrogen source for grass

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Summary

The Tennessee Valley Authority has developed an effective slow-release nitrogen fertilizer by coating granular urea with elemental sulphur and microcrystalline wax.

Sulphur-coated urea was compared with ammonium nitrate and uncoated urea at Muscle Shoals, Alabama, for production of tall fescue (*Festuca arundinacea*) and Coastal bermuda grass (*Cynodon dactylon*).

When these N sources were compared on tall fescue, spring forage production was less but summer and fall production was higher from sulphur-coated urea than from the soluble N sources.

In trials on Coastal bermuda grass, the coated product was superior in total yield and uniformity of seasonal production when all sources were applied in a single spring application, but not with 4 split applications.

Introduction

Excessive N uptake soon after application followed by N deficiency a few weeks later is one of the more troublesome problems associated with N fertilization of forage and turf grasses. With forages the problem is usually solved by use of frequent small applications of some quickly soluble N fertilizer. Fine turf grasses are often fertilized with sewage sludge, oil seed meals, or urea ureaformaldehyde (Allen *et al.*, 1968; Lunt, 1968) all of which release N over an extended period of time, but at high cost.

In recent years several research workers have tried various coatings on soluble fertilizers in an effort to develop slow-release N fertilizer at a reasonable cost. Such coatings include plastic (Allen *et al.*, 1968; Beaton *et al.*, 1967), asphalt, waxes, and plasticized sulphur (Lunt, 1968). The Applied Research Branch of the Tennessee Valley Authority has developed a coated urea product (Brown *et al.*, 1966) using elemental sulphur, and wax which promises to combine satisfactory slow-release characteristics with reasonable cost.

The purpose of this paper is to present data on yields and N uptake by Kentucky 31 tall fescue (*Festuca arundinacea*) and Coastal bermuda grass (*Cynodon dactylon*) following fertilization with ammonium nitrate (AN), urea, and sulphur-coated urea (SCU).

Experimental methods

Sulphur-coated urea is produced experimentally at TVA by placing pre-heated granular urea in a pan granulator and spraying it with molten S. The coating weight is determined by the length of time the granules remain in the granulator. After coating with S, the granules are sealed with a microcrystalline petroleum wax containing about 10% oil. The SCU used in these experiments contained 26.1% N, 40% S, and 4% wax sealant. The AN and urea were commercial products containing 33.5 and 45.9% N, respectively.

Field experiments were conducted at Muscle Shoals, Alabama, an area with an average annual rainfall of 125 cm, 32–35°C midsummer temperatures, and some freezing weather between 15 November and 15 March. Work was carried out on an established sod of Kentucky 31 tall fescue in 1966 and 1967. All N sources or mixtures of N sources were applied at rates of 84 or 168 kg/ha of N in single annual applications on one of the following dates: 15 December, 15 January, 15 February, or 15 March. In one experiment AN was also applied in 3 split applications. The forage was harvested 3 times annually. Approximate cutting dates were 1 May, 1 July, and 5 October.

The Coastal bermuda grass experiments were conducted in 1966, 1967, and 1968. N was applied on an old sod at rates of 224 and 448

kg/ha in 1, 2, or 4 applications annually. Approximate cutting dates were 5 June, 10 July, 15 August, and 20 September.

Both fescue and bermuda grass experiments were carried out on silt loam soils high in P and medium to high in K. The fescue site had a pH of 6.4. The bermuda grass site had an initial pH of 5.0 and was surface limed at the rate of 6.7 MT/ha.

The experimental plots were 1.5 to 1.8 m wide and 7.0 m long. Yield samples were obtained by cutting a 76 cm swath through the centre of each plot. The cut forage was raked, weighed, and subsampled for dry matter determination. N content of forage was determined by a micro-Kjeldahl technique. Data were analysed statistically by analysis of variance and multiple regression.

Results

Tall fescue experiments

The responses of fescue to applications of AN, urea, or SCU at different dates from December through March were similar. Data from plots fertilized on 15 February (Fig. 1) show that all N sources produced similar total yields; however, there were tremendous differences in seasonal growth distribution. Following application of AN or urea, almost half of the total seasonal production was obtained at the first cutting, fall yields being little better than check plot yields. SCU-fertilized plots produced little more forage than check plots in the spring, but midsummer and fall growth was excellent. Release of N from SCU appeared to be strongly temperature-dependent, as no response was noted on SCU-fertilized plots regardless of application date until late May, when air temperatures were high.

N content of forage was highest at the first cutting following AN or urea application, highest at the second cutting with SCU, and similar for all N sources at the third cutting. Total N uptake was highest from AN and similar from urea and SCU.

Figure 2 shows that seasonal distribution and total yield from a mixture which supplied one-third of the N from AN and two-thirds from SCU were identical with yield and distribution from the same amount of total N applied as AN in 3 split applications. Several other AN-SCU mixtures gave similar results.

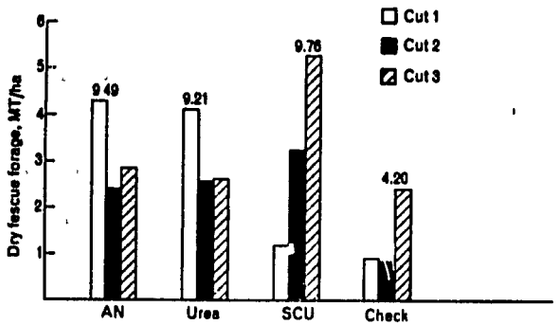

Fig. 1. Seasonal growth distribution of tall fescue, 168 kg N/ha in single spring application, 2-year average.

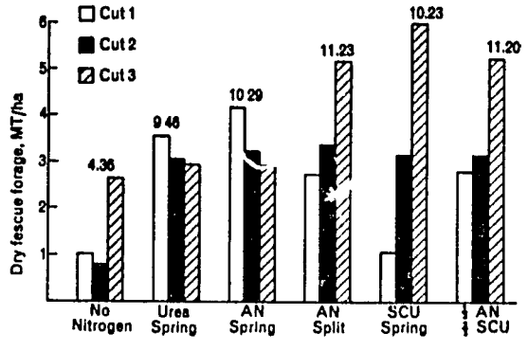

Fig. 2. Seasonal growth distribution and total yield of tall fescue forage, 168 kg N/ha, comparing split application of AN with mixture of AN and SCU and spring-applied AN, urea, and SCU.

Coastal bermuda grass experiment

Coastal bermuda grass response to these N sources varied somewhat among years. Three-year average yields (Fig. 3) show more forage with SCU than with other sources when all were applied in a single spring application, but yield differences with other application schedules were not significant. AN and urea tended to produce more forage with multiple applications, while a single spring application of SCU resulted in the highest yield. First year production was low following split application of SCU: however, early season growth from this treatment was good in subsequent years.

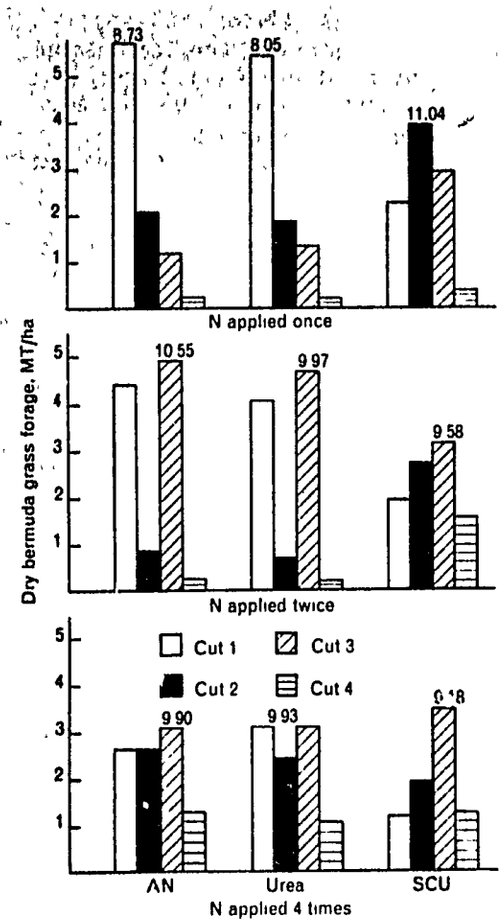

Fig. 3. Seasonal yield and growth distribution of Coastal bermuda grass forage from different N sources and frequencies of application, 224 kg N/ha, 3-year average.

This indicated significant carry-over of applied N in the soil, since SCU from the same batch was used each year and presumably had the same N release rate.

N uptake by bermuda grass forage was highest following application of AN and lowest on urea-fertilized plots. Uptake from SCU equalled uptake from AN with a single application but was inferior to uptake from multiple applications of AN. Uptake differences among N sources were greater at the high N rate.

As with fescue, seasonal distribution of bermuda grass forage was strongly influenced by N source. With 1 or 2 annual applications yield distribution was much more uniform with SCU than with soluble sources, but with 4 applications AN and urea gave the more uniform distributions.

Analysis of soil samples taken after the third growing season showed little effect of SCU on soil pH at the highest application rate (685 kg S/ha annually). Soil S contents ranged from 35 p.p.m. on plots fertilized with AN or urea to 140 p.p.m. on plots receiving the high rate of SCU.

Discussion

The foregoing data clearly show that seasonal growth distribution of both cool and warm season grasses can be greatly altered, while still maintaining similar total yields, by the use of sulphur-coated urea rather than some soluble N source. The most desirable fescue yield curves were obtained when mixtures of SCU and soluble N were applied together. Mixtures seem less important, however, for use on bermuda grass, since maximum growth occurs in hot weather when dissolution of SCU is more rapid.

Other potential advantages of SCU include reduced application costs because single annual applications are possible, less possibility of luxury uptake which is often associated with heavy applications of soluble N, elimination of foliage burn following heavy applications, and the ability to supply significant amounts of sulphur to the soil.

Refined production techniques have made it possible to produce more desirable grades of SCU than the one used in these experiments. The SCU which TVA now makes has an N content of 37% with a total coating weight of less than 20%. Research is continuing on both production and use of SCU.

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