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# BULLETIN

THE TEXAS AGRICULTURAL EXPERIMENT STATION/ J. E. Miller, Director/ Texas A&M University/ College Station, Texas

B-1151
May 1975

# ECONOMIC OPTIMUM RATES AND RETURNS FROM NITROGEN FERTILIZATION OF COASTAL BERMUDAGRASS FOR HAY IN EAST TEXAS

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## SUMMARY

The price of nitrogen has risen considerably recently, and producers need to figure the most economic nitrogen rates for their own situation. Knowledge of the nature of response by Coastal bermudagrass to various rates and forms of nitrogen can be helpful in the close calculation of the most profitable rate of nitrogen fertilization.

Research comparing production of Coastal bermudagrass forage from different rates and five forms of nitrogen fertilizer began in 1969 at the Texas A&M University Agricultural Research and Extension Center at Overton. The 5-year study compared urea, ammonium nitrate, ammonium sulfate and two nitrogen experimental controlled-release materials (sulfur-coated ureas) on a relatively deep, sandy soil. The long-term experiment included two seasons when rainfall in East Texas was considerably below normal. However, data from all 5 years were used in making the economic evaluations. Nitrogen was the only variable in the research with phosphorus, potassium and sulfur applied according to soil test. Three split applications of nitrogen were used in the initial year while five applications were made in all other years with the exception of 1973 (four applications). The first application was made about April 1. Potassium was split, while all phosphorus and sulfur was added with the initial application of nitrogen.

By use of a computer, single variable production functions for each of the sources of nitrogen studied were developed, utilizing the 5 years of production data from the field.

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## NITROGEN RESPONSE

During the research period, forage production was variable among years. For example, with below normal rainfall in the summer of 1969 and 200 pounds of nitrogen applied per acre, Coastal bermudagrass produced 32 pounds of forage per pound of nitrogen, while in 1973, with adequate rainfall, 76 pounds of forage per pound of nitrogen were produced.

The research has shown that Coastal bermudagrass is generally highly responsive to nitrogen fertilization. The nitrogen response curve follows a near-linear pattern at rates of less than 200 pounds per acre but will assume a quadratic nature at higher rates. How fast the production efficiency from nitrogen drops with rate depends on many factors, one of which is rainfall. The most efficient production (pound forage per pound nitrogen) is usually found at the front portion of the nitrogen response curve, synonymous with the largest net return per dollar invested in nitrogen fertilizer. However, whether bermudagrass needs to be fertilized at the rate needed to be at this portion of the curve will depend primarily upon two factors: (1) the amount of hay needed and the number of acres of Coastal bermudagrass meadow available and (2) the protein level desired in the forage. Protein will not reach the choice 12-percent level unless at least 60 pounds of nitrogen per acre is applied following each cutting of hay.

## OPTIMUM RATE

Economic optimum rates of nitrogen fertilization were developed using the production functions. Since ammonium nitrate and urea are the most common sources of nitrogen fertilizer in the East Texas region, economic optimum rates and returns are presented for these two materials. Similar data for ammonium sulfate and experimental sulfur-coated ureas will be available but are not presented here.

In obtaining these calculations, costs of other essential fertilizer nutrients, such as phosphorus, potassium and sulfur, were included as well as harvesting costs. An average harvesting cost of 55 cents per bale (40 cents for baling and 15 cents for hauling) for 55-pound bales was subtracted from the selling price of the hay prior to calculation of the optimum economic rates. Other fixed costs, such as weed control, interest on capital and others that comprise a small fraction of the total expense, have not been included in these calculations.

Table 1 shows various nitrogen fertilizer rates and prices, as they relate to hay costs. For example, with urea at $225 per ton, or 25 cents per pound of nitrogen, and hay valued at $50 per ton, the optimum economic rate of fertilization would be 340 pounds of nitrogen per acre, which would provide a return of $1.61 for each dollar invested in fertilizer. In this example the total profit from fertilizer is $51.85 per acre.

Using ammonium nitrate at the same price per pound of nitrogen (25 cents or $168 per ton) and $50 per ton for hay, the optimum nitrogen rate is 357 pounds per acre, with a total profit of $70.50 per acre from fertilizer.[1]

## NITROGEN SOURCE DIFFERENCE

The difference in profit per acre attributable to nitrogen source is primarily a result of forage production differences. The 340 pounds of nitrogen per acre yielded 6.75 tons of forage when applied as urea and 7.25 tons when ammonium nitrate was used. Protein content of the forage at this rate averaged approximately 13 percent for the five cuttings of hay.

If the price of hay is increased by $10 per ton (to $60 per ton), the optimum economic rate of nitrogen increases to 475 and 468 pounds per acre, respectively, for urea and ammonium nitrate. Likewise, the returns per dollar invested in fertilizer increases significantly over 25 cents.

Differences in the optimum rate of nitrogen and returns due to nitrogen source appear to widen slightly as hay prices increase.

## OTHER FACTORS

Harvesting costs of hay are a major factor in the net value of the hay and, consequently, play a large role in the computed economic optimum rates of nitrogen fertilization. If harvesting equipment is owned or readily available, these costs then may be reduced and the nitrogen rates for economic production of Coastal bermudagrass will increase. On the other hand, if harvesting costs are higher than the calculated cost of $19.80 per ton of hay, the nitrogen rates and fertilizer returns are over-estimated.

One of the most important factors determining the nitrogen fertilization rate is the expected selling price of the hay. Although it may be difficult to predict hay prices several months in advance, it is important to establish some estimated selling price to determine an economic rate for optimum nitrogen fertilization. A differential hay price of $10 per ton, or slightly more than 25 cents per bale, will have a substantial effect on the amount of nitrogen fertilizer that is profitable to use. For example, it can mean the difference between not being able to fertilize the hay meadow profitably ($30 per ton of hay) and fertilizing for some profit ($40 per ton of hay).

[1] Example formula for figuring profit per acre:
lb. N per acre X cost per lb. N X dollar return per dollar fertilizer = profit per acre
For $225 per ton urea and $50 per ton hay: 340 X .25 X ($1.61 – $1.00) = $51.85
For $168 per ton ammonium nitrate and $50 per ton hay: 357 X .25 X ($1.79 – $1.00) = $70.50

## Optimum Economic Nitrogen Rates and Returns for Coastal Bermudagrass Hay in East Texas *

### Price of Urea ($ per ton, cents per lb N)

| Price of hay | $80 per ton ¢8.9 per lb N | | $150 16.7 | | $175 19.4 | | $200 22.2 | | $225 25.0 | | $250 27.8 | | $275 30.6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ per ton | lb N/A | $ | lb N/A | $ | lb N/A | $ | lb N/A | $ | lb N/A | $ | lb N/A | $ | lb N/A | $ |
| 30 | not profitable → | | | | | | | | | | | | | |
| 40 | 536 | 1.77 | 303 | 1.53 | 230 | 1.54 | 190 | 1.50 | 66 | 2.44 | not profitable → | | | |
| 50 | 652 | 3.21 | 498 | 1.83 | 445 | 1.74 | 393 | 1.66 | 340 | 1.61 | 290 | 1.60 | 245 | 1.60 |
| 60 | 704 | 4.09 | 590 | 2.48 | 553 | 2.29 | 515 | 2.07 | 475 | 1.87 | 437 | 1.78 | 399 | 1.72 |
| 70 | 733 | 4.90 | 644 | 2.96 | 615 | 2.69 | 583 | 2.39 | 554 | 2.14 | 523 | 2.05 | 492 | 1.95 |
| 80 | - | - | 678 | 3.10 | 654 | 2.83 | 629 | 2.60 | 603 | 2.42 | 576 | 2.30 | 548 | 2.20 |

### Price of Ammonium Nitrate ($ per ton, cents per lb N)

| Price of hay | $60 per ton ¢8.9 per lb N | | $112 16.7 | | $130 19.4 | | $149 22.2 | | $168 25.0 | | $186 27.8 | | $205 30.6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 237 | 1.39 | not profitable → | | | | | | | | | | | |
| 40 | 524 | 2.07 | 337 | 1.64 | 266 | 1.64 | 209 | 1.64 | 148 | 1.71 | 98 | 1.87 | 38 | 3.00 |
| 50 | 621 | 2.83 | 487 | 2.10 | 446 | 1.97 | 401 | 1.85 | 357 | 1.79 | 316 | 1.73 | 276 | 1.69 |
| 60 | 665 | 3.58 | 564 | 2.59 | 532 | 2.39 | 500 | 2.23 | 468 | 2.09 | 434 | 1.98 | 385 | 1.93 |
| 70 | 690 | 4.36 | 611 | 3.08 | 587 | 2.81 | 559 | 2.61 | 534 | 2.44 | 506 | 2.30 | 481 | 2.19 |
| 80 | 707 | 5.14 | 642 | 3.57 | 620 | 3.26 | 597 | 3.01 | 576 | 2.79 | 553 | 2.62 | 533 | 2.48 |

*Costs of required fertilizer nutrients other than nitrogen (P, K, S) and harvesting have been included in these computations but fixed costs such as land, interest on capital, etc. have not been included.

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