Nitrogen and Phosphorus Applications Increase Yields and Profits from Irrigated Ryegrass in Southwest Texas

By Hagen Lippke

In southwest Texas, the 400,000-acre base of ryegrass and small grains is expanding as irrigation water supplies are restricted. These cool-season grasses require a third to half as much supplemental irrigation water as do traditional row crops, making them attractive economic alternatives, particularly when they are grazed by stocker cattle. Current and impending legal restrictions on pumping from the Edwards Aquifer and from various river basins in the region provide added pressure to convert to cool-season crops on much of the irrigated acreage in this region. Furthermore, the development of a water market by the City of San Antonio makes high profits imperative if intensive agriculture and its service industries are to compete for the water resource and continue to support the rural communities in the area. Cool-season grasses have the potential to meet this challenge.

The experiment reported in this article was undertaken to provide the basic response curve data for the effects of nitrogen (N) and phosphorus (P) fertilizer on forage yield and composition of annual ryegrass on calcareous soils of southwest Texas.

Much of the irrigated acreage along the southern edge of the Edwards Aquifer is on clay soils that are characterized by high levels of calcium (Ca), potassium (K), and high pH. There is little information available from controlled experiments testing appropriate levels of N and P applications for forage production from irrigated cool-season annual grasses. Soil test recommendations usually indicate application of less than 30 lb P_2O_5/A.

The Study

The study area was established on a Knippa Clay site that had been used for grazing winter annual grasses for more than 10 years and, according to tests on preliminary soil samples, was very low in N and moderate in available P. Using four replications of a factorial arrangement of 20 treatments, N (as ammonium nitrate, NH_4NO_3) was applied at annual rates of 0, 120, 240, 360 (all in three applications), or

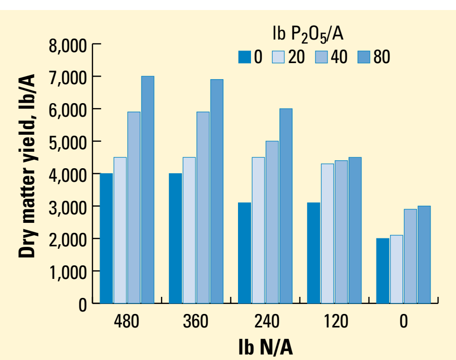

Figure 1. Effect of N and P fertilization on ryegrass yield in year one (1995-1996).

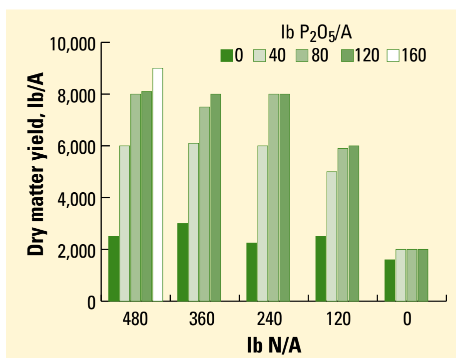

Figure 2. Effect of N and P fertilization on ryegrass yield in year two (1996-1997).

480 lb N/A (in four applications). Phosphorus (as triple superphosphate, TSP) was applied at 0, 20, 40, or 80 lb P_2O_5/A in year one and 0, 40, 80, or 120 lb P_2O_5/A in years two and three. An additional treatment in years two and three combined 480 lb N/A with 160 lb P_2O_5/A. All of the P and a fourth to a third of the N were incorporated preplant. Remaining N was top-dressed after the first (December) and second (February) of six harvests, as well as after the third harvest (March) for plots receiving 480 lb N/A. Ryegrass (TAM-90) was planted at the rate of 30 lb/A during the first week in October each year and irrigated within a few days unless rainfall provided sufficient moisture for seedling emergence.

Plots were harvested at a 3-inch stubble height whenever the anticipated yield of the most productive plots exceeded 1,200 lb/A and at the end of the growing season. Each clipping was weighed, and a sample was taken for determination of dry matter (DM), crude protein (CP), and acid detergent fiber (ADF).

The software program, FORAGVAL, was used with data from CP and ADF determinations to estimate average daily gain (ADG) and dry matter intake (DMI) by stocker steers for each clipping. These estimates, together with the yield data, were used to calculate total body weight gain per acre (EGA). Income per acre was then calculated from EGA (adjusted downward an assumed 40 percent for trampling loss under grazing), and from a sliding-scale pasture lease rate (based on ADG) ranging from \$0.30 to \$0.37/lb EGA.

Cost per acre was calculated assuming \$0.25/lb for N (adjusted downward for an assumed 30 percent N recycling under grazing), \$0.20/lb for P_2O_5, and \$40/A for all other costs.

Yield and Quality Response

Total forage dry matter yields for the first year of the experiment are shown in **Figure 1**. Ryegrass yields responded to the highest level of P application (80 lb P_2O_5), but only if N application was at least 240 lb/A. Conversely, yields responded to the highest levels of N application only with the highest level of P. The yield advantage for high levels of balanced fertilization was most pronounced during the coolest months. Forage quality is normally higher in cooler weather. Consequently, the higher production during these months is partially responsible for the better overall quality of fertilized grass (data not shown).

The response to N where no P was applied in the first year was not apparent in the second year (**Figure 2**), indicating that the pool of available P had been mined to low levels by the first year's crop in plots that received no P fertilizer. In year two the yield response curve to N application increased up to 240 lb/A and then flattened for all levels of P (except 0). In the second and third years of the experiment, 120 lb P_2O_5/A was applied to those plots assigned to 20 lb P_2O_5 during the first year. This change was made in order to learn whether forage yields were at their peak with 80 lb of P_2O_5. **Figure 2** shows that response to P reached a plateau at 80 lb P_2O_5/A in the second year.

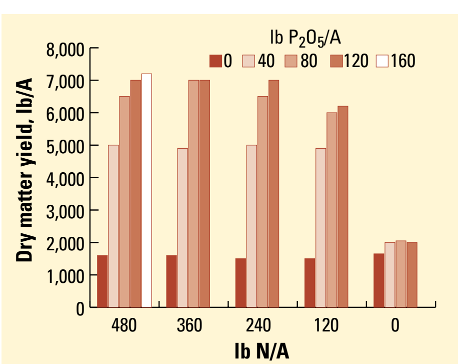

Figure 3. Effect of N and P fertilization on ryegrass yield in year three (1997-1998).

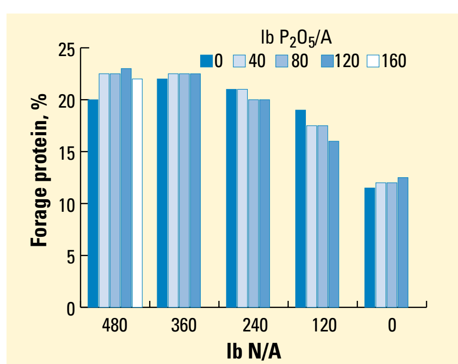

Figure 4. Average ryegrass protein for year two (1996-1997).

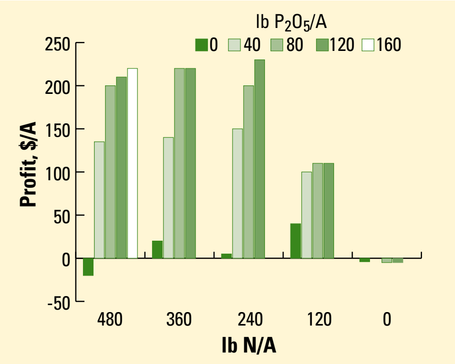

Figure 5. Estimated profit from stocker steer gain on ryegrass due to N and P fertilization (1996-1997).

In the third year, winter temperatures were colder, and spring temperatures were warmer than in years one and two, shortening the growing season and reducing yields (**Figure 3**). Forage yields from plots that received no P were proportionately much lower in the third year than yields from those plots in the first and second years. Plots that were fertilized with N but not P had yields in the third year that were less than half the yields in the first year. The uniformly low yields in the third year from plots receiving no P indicate that the pool of available soil P may have reached minimum levels. As in year two, N fertilizer rates above 240 lb N/A gave no response at any level of P, and at 40 lb P_2O_5/A N fertilizer showed no response above 120 lb/A. Also, as in year two, response to P reached a plateau at 80 lb P_2O_5/A.

Figure 4 shows a typical response of forage CP content to N and P applications. Increases in CP are primarily a response to N fertilizer. As with DM yield, the CP response appears to reach a plateau at 240 lb/A of N. Crude protein response to P application was small in this experiment and consistent with expectations, although the decline in CP with increasing P application at 120 lb N/A (**Figure 4**) is contrary to the usual trend. Acid detergent fiber tended to decrease with increasing N application and also decreased slightly with increasing P when no N was applied (data not shown). These trends are a reflection of the proportionately higher yields during late season in plots with no or unbalanced fertilizer application.

Economics

Estimated profit per acre from year two is depicted in **Figure 5**. Profit increased dramatically with the first increments of both N and P applications. Another major increase in profit was calculated for plots where both N and P were increased another step (240-80-0). At 240 lb/A, applied N reached a peak in profits where P was supplied. Profits for added P above 80 lb P_2O_5/A seemed to reach a plateau. The large increase in profit with the application of at least 120-40-0 was due to increased forage protein and ADG as well as to increased DM yield.

Calculated profits for the first year of the experiment (not shown) were much lower than in the second year (**Figure 5**) and peaked at 360-80-0. Higher overall profits in the second year were primarily due to higher yields. With the flattening of the yield curve at 240 lb N/A in year two, profits would be expected to decline with additional increments of applied N.

This experiment has clearly shown the advantage of higher rates of P application than have been recommended in the past for stocker cattle grazing winter annual grasses on irrigated calcareous soils in southwest Texas. Recommendations for N application may also need to be adjusted, but rates of applied N are highly dependent on uniformity of feces and urine deposition and on rate of N recycling within a season. Forage tissue testing and application of small increments of N to hold CP at 20 to 22 percent during vegetative stages of growth may be the best route to most profitable levels of N fertilization. BC

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