PUBLICATIONS

1995

Ryegrass Symposium Proceedings

1995

CHAPTER 5

MANAGEMENT OF RYEGRASS AND RYEGRASS MIXTURES

G. W. Evers and G. R. Smith
Pasture Management and Legume Breeding
Texas A&M University Agricultural Research and Extension Center - Overton, Texas

Annual ryegrass (*Lolium multiflorum* Lam.) can be used for grazing from November through May in the eastern half of Texas with peak forage production in March and April (Ward et al., 1992, 1993, and 1994). Total forage production and its distribution during the growing season depends on location, climate, and management practices such as type of seedbed (prepared or overseeded), planting date, and fertilization. Cultural and proper management practices in turn are based on whether ryegrass is grown in a pure stand, mixed with small grains, or with clovers. Ryegrass management will be discussed under these three headings.

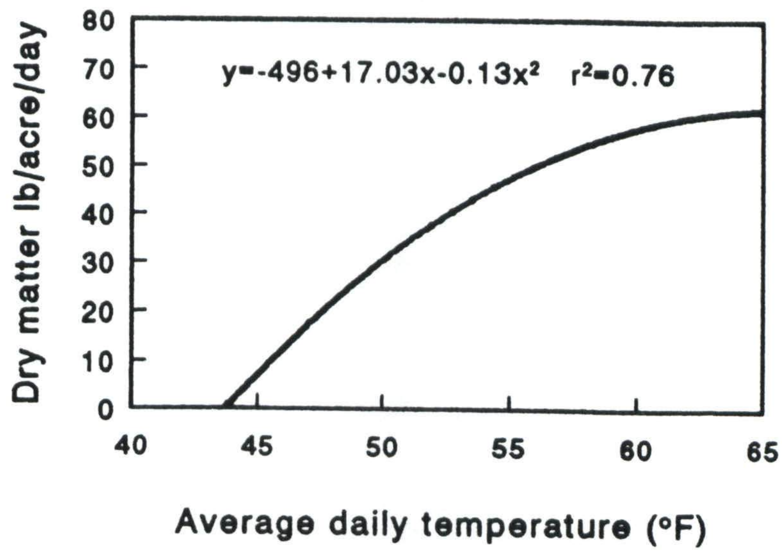
Pure Ryegrass Stands

Climate and Location

Ryegrass growth is influenced by moisture, light, temperature, and availability of plant nutrients. Supplemental moisture from irrigation is seldom used except in low rainfall areas such as the southwestern USA and Mexico. Light is essential for all plant growth since it is the energy source that drives photosynthesis. This photochemical process produces chemical energy (e.g., ATP [adenosine triphosphate]) as well as sugars and amino acids which are the building blocks of plant cell growth. Under favorable temperatures, Hull and Mooney (1990) have shown that the photosynthetic rate in annual ryegrass is related to the nitrogen (N) content of the leaf. As the leaf N concentration increases, the photosynthetic rate, and therefore growth rate and dry matter production, increase.

Weihing (1963) described the relationship between average daily temperature and growth rate (lb dry matter/acre/day) of annual ryegrass when planted on a prepared seedbed. Annual ryegrass growth ceased when the average daily temperature decreased to 44°F (Fig. 1). As average daily temperature increased above that level, growth rate increased with a peak at about 65°F. To demonstrate the difference in forage production due to location, the relationship developed by Weihing was used to predict ryegrass growth rates at Angleton (southeast Texas) and Overton (northeast Texas) from long term temperature records. Forage production was substantially less during the winter months at Overton because of lower average daily temperature (Fig. 2). Spring growth rates were similar for both locations. These data explain why total ryegrass yields are highest along the Gulf Coast and decrease as one moves north. Work by Keatinge et al. (1980) has also shown that leaf growth rate of annual ryegrass increased as average daily temperature increased from 41° to 59°F.

Figure 1. Annual ryegrass response to average daily temperature (Weihing,Agron.J.55:519-521.).



Management

Planting on a prepared seedbed allows an earlier planting date which enhances early forage production because of the mild early autumn temperatures. Substantial ryegrass growth can occur in November if planted on a prepared seedbed and supplied with adequate fertility (Ward et al., 1992). At Overton, average production of 'Gulf' and 'TAM 90' on prepared seedbed was 6756 and 7477 lb DM/acre, respectively (Ward et al., 1994). When overseeding, ryegrass planting is often delayed until mid-October or later because of the warm-season grass competition. Cold winter temperatures slow ryegrass establishment and seedling growth so that grazing is seldom available before February. More detailed information on establishment is presented in Chapter 3.

Numerous studies have been conducted on cutting height and frequency of annual ryegrass (Binnie and Harrington, 1972; Craigmiles and Weihing, 1971). Optimum cutting height on annual ryegrass is 2- to 3-in. Defoliation heights less than 2-in. resulted in loss of stand and regrowth potential. Craigmiles and Weihing (1971) harvested ryegrass every 1, 2, 3, or 4 weeks at a 2- and 5-in. cutting height beginning in January. Highest yields were obtained harvesting every 4 weeks at a 2-in. cutting height. Data from these small plot studies suggested that annual ryegrass should not be grazed shorter than 2- to 3-in. and that a 3 to 4 week rest period in a rotational grazing system would permit a higher stocking rate.

Fertilization

Application of plant nutrients as fertilizer is the primary management tool producers use to influence ryegrass growth. Ryegrass is very responsive to N under favorable moisture and temperature conditions. Fertilization should always be based on a soil test since the initial soil nutrient level will depend on previous fertilization practices, soil texture, and annual rainfall. Phosphorus and potassium should be applied at or shortly after planting. If more than 75 to 80 lb/acre of potassium are needed on sandy soils in East Texas, it is recommended to split it into an autumn and late winter application because of potential leaching.

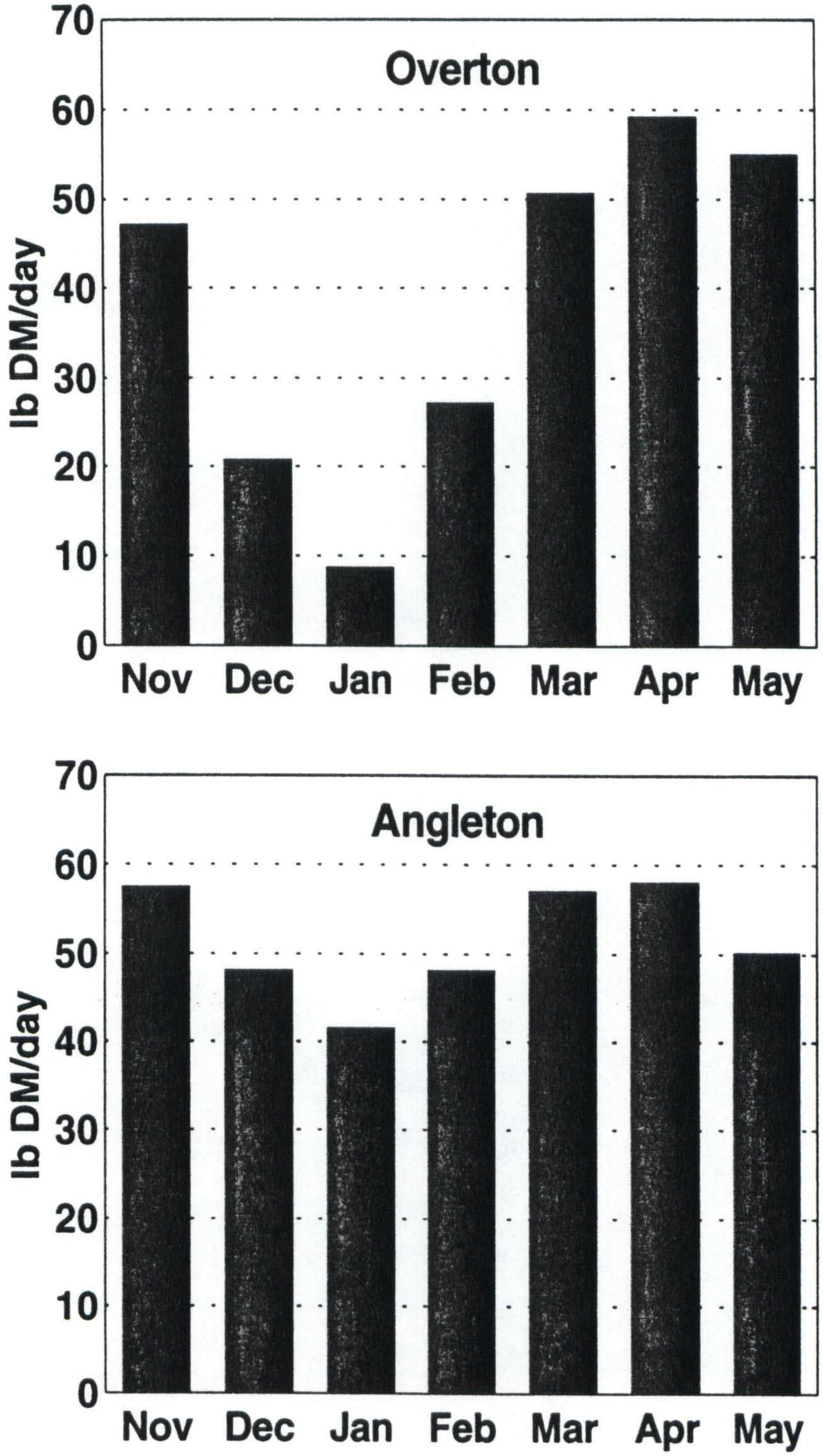
Because N is subject to leaching, the recommendation is to apply it in split applications during the growing season (Cummins et al., 1965). When planted on a prepared seedbed, N fertilizer applications of 50 to 70 lb/acre are applied two to four times during the growing season. Three applications are the most common with N being applied at planting, December, and March (Matocha, 1972). In Central Texas, N is limited to two applications applied at planting and winter because of heavier textured soil and lower rainfall (Holt et al., 1969). On deep, sandy soils in East Texas, N may be applied every 6 weeks because of the low nutrient holding capacity of the soil and high rainfall. Fertilization recommendations for ryegrass planted in a lightly disked sod is the same as prepared seedbed.

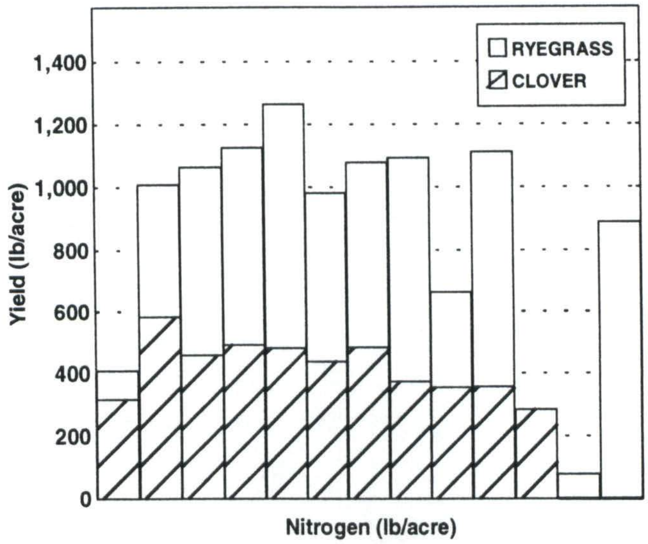
Nitrogen fertilization of ryegrass overseeded on warm-season perennial grasses is different. The later planting date and slower establishment rate reduces early ryegrass growth. The initial N application is delayed until after the first frost to prevent the warm-season grass from taking up the N. One or two additional N applications are applied from late February to early April. Additional information on fertilization of ryegrass is reported in Chapter 4.

Ryegrass - Small Grain Mixtures

Ryegrass is higher yielding than rye (*Secale cereale* L.), wheat (*Triticum aestivum* L. emend. Thell.), or oats (*Avena sativa* L.) in the eastern half of Texas in part because it is later maturing (Table 1). Small grains are mixed with ryegrass to improve early forage production over planting ryegrass alone. Oats are planted with ryegrass in the southern part of the state where they are very productive because winters are mild. In the northern half of the state, wheat and rye are usually grown with ryegrass because they are more cold tolerant and therefore produce more forage than ryegrass during the winter months. Rye is used most frequently on the sandy soils in East Texas because it is higher yielding than wheat (Table 1). Wheat has traditionally been used on the loam to clay soils in north central Texas.

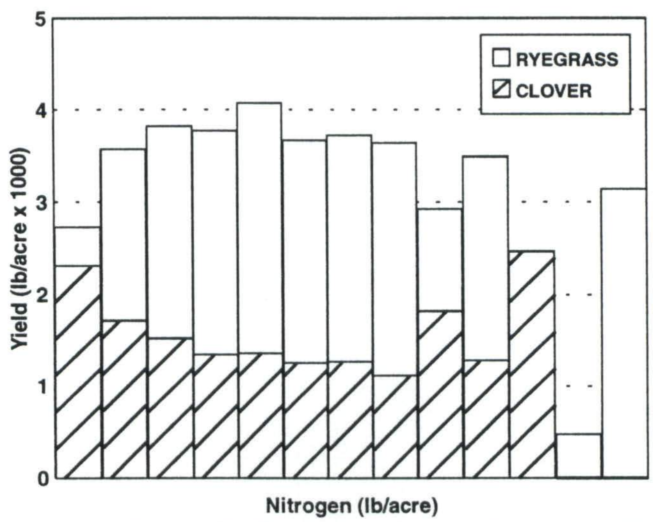
Figure 2. Predicted monthly ryegrass production at Overton and Angleton, Texas from equation in Fig. 1.





October	0	0	30	60	90	0	0	0	0	0	0	0	60
November	0	0	0	0	0	30	60	90	60	60	0	0	0
January	0	60	60	60	60	60	60	60	0	60	0	0	60

Fig 3. Influence on N rate and application time on early forage production of crimson clover-ryegrass mixture harvested in March (2yr avg, Overton).



October	0	0	30	60	90	0	0	0	0	0	0	0	60
November	0	0	0	0	0	30	60	90	60	60	0	0	0
January	0	60	60	60	60	60	60	60	0	60	0	0	60
March	0	60	60	60	60	60	60	60	0	0	0	0	60

Fig 4. Influence of N rate and application time on forage production of a crimson clover-ryegrass mixture (2 yr avg, Overton).

Table 1. Comparison of small grains and annual ryegrass.

Species	Maturity	Cold tolerance	Overton[1]	College Station[2]	Beaumont[3]
			--------------------lb/acre------------------		
Rye	1	1	4600	6800	2699
Wheat	2	2	3300	5200	3589
Oats	3	4	5500	5800	3861
Ryegrass	4	3	8300	7100	7157

[1]Three year average, L. R. Nelson.
[2]Three to four year average, D. H. Bade, S. Simecek and M. Hussey.
[3]Two year average, G. W. Evers.

Management

Seeding rates and planting methods for ryegrass-small grain mixtures are reported in Chapter 3. Ryegrass-small grain mixtures provide the earliest and the most forage production if planted early on a well prepared seedbed. However, they are also the most expensive and are best utilized by lactating dairy cows, stocker calves, replacement heifers, or limit grazed (2 hr per day or 4 hr every other day) by beef cows nursing fall calves. Grazing can usually begin from late November to December depending on location and autumn rainfall. Initial stocking rate should be about 600 lb animal weight per acre in late autumn and winter. During the spring flush of growth the stocking rate can be increased from 1200 to 1800 lb of animal weight per acre.

Fertilization

Fertilization of ryegrass-small grain mixtures is the same as ryegrass planted on a prepared seedbed reported in the previous section.

Ryegrass-Clover Mixtures

Both annual ryegrass and annual clovers are important forage crops in Texas. Both crops are cool-season plants and are often grown as mixtures overseeded on warm-season perennial grass sods. Management of ryegrass-clover mixtures is complex because of the difference in N requirements between grass and clover. Ryegrass must be constantly supplied with a source of N and its forage production is directly dependent on rate of N fertilization. In comparison, clovers can form a symbiosis with *Rhizobium* bacteria that infect the roots of legume plants. As a result of this symbiosis, the bacteria use atmospheric N and provide it to the legume plant. Therefore, N fertilization is not necessary for annual clover production. Mixtures of ryegrass and clover are planted for a variety of reasons.

Ryegrass-Clover Mixture Advantages

Like ryegrass, clovers provide high quality forage during the cool season when the warm season perennial grasses are dormant with peak forage production in March and April. However, ryegrass, unlike clovers, can be productive during winter months if N is not limiting. Clover forage production can extend into June using perennials like white (*Trifolium repens* L.) and red clover (*Trifolium pratense* L.) which act as annuals because they seldom persist through the summer. Average forage production ranged from 3000 to 3800 lbs DM/acre/yr for annual clovers overseeded in Coastal bermudagrass sod at Overton, TX (Gilbert et al., 1992).

Less N fertilizer is required for a ryegrass-clover mixture than a pure ryegrass stand because of the N_2-fixation ability of the clover. When ryegrass or a ryegrass-clover mixture is overseeded on a warm-season perennial grass sod, forage yields are lower than for a pure stand of ryegrass grown in prepared seedbed conditions (Evers et al., 1992 and 1993). Forage yields of overseeded ryegrass - clover mixtures were generally in the range of 3500 to 4500 lb DM/acre/yr for two years when these mixtures were evaluated at Overton. Ryegrass - clover mixtures fertilized with nitrogen in early winter were significantly more productive (double or triple) by early March than with no nitrogen fertilization.

Fall establishment of clovers in warm-season perennial grass sods is often unreliable due to grass competition, poor nodulation or erratic soil moisture. Clovers require nodulation with *Rhizobium* bacteria so that symbiotic nitrogen fixation can take place. Specific strains of *Rhizobium* are required by different clover species for symbiotic nitrogen fixation to occur. For example, the bacteria strain required by white clover will not function normally with arrowleaf clover (*Trifolium vesiculosum* Savi). For a first-time establishment, clover seed are inoculated with a specific strain of *Rhizobium* inoculant before planting. *Rhizobium* inoculants die under hot, dry conditions but flourish in mild, moist environments. Therefore, the initial establishment of a healthy clover pasture means keeping both a small seedling and *Rhizobium* bacteria alive. Including ryegrass with clover in overseeded mixtures helps reduce risk of little or no forage production if clover stands are thin because of poor moisture conditions.

Nitrogen fixation by clovers

On sandy, infertile soils, ryegrass forage production is dependent on N fertilization. However, clovers can obtain all their required N through symbiotic nitrogen fixation. Estimates of clover nitrogen fixation range from 50 to 140 lb N/acre/yr (Silver and Hardy, 1976; Morris et al., 1986). The N available through this fixation process is used directly by the clover for growth and production of high protein forage. The N fixed by the clover - *Rhizobium* symbiosis is not directly available to companion plants. A two year study at Overton, TX using ryegrass-arrowleaf clover mixtures and labeled ammonium nitrate, evaluated N transfer in mixtures. Very low amounts (<4 lb/acre) of N were actively transferred between the clover and annual ryegrass without the influence of recycling through livestock (Morris et al., 1990). Under grazing, recycling of animal waste will allow an indirect transfer of N from clover to grass with the animal as the intermediate user. In general, symbiotic nitrogen fixation supplies clovers with all the N that they need for productive growth and this fixed N is available to associated grasses primarily by recycling through grazing livestock.

Fertilization

Fertilization of ryegrass-clover mixtures with nutrients other than nitrogen should be based on a soil test and applied at planting. The amount and timing of N fertilization is critical to maintaining the clover component in the mixture. Ryegrass must receive sufficient N fertilizer to produce forage in late autumn and winter but not be so competitive that it crowds the clover out. A 2-year study at Overton demonstrated how N fertilizer can influence early and total production of a ryegrass-crimson clover (*Trifolium incarnatum* L.) mixture on a sandy soil low in N (Evers and Haby, 1995).

From 0 to 90 lb/acre of N were applied at planting (October) or a month later (Fig. 3). Most treatments included an additional 60 lb/acre of N in January. The dependence of ryegrass on N fertilizer was demonstrated by the fact that less than 100 lb/acre of ryegrass was produced by March when no N was applied to a clover-ryegrass mixture or a pure ryegrass stand. The most efficient N fertilizer response was obtained by applying 60 lb N in January only. There was some response to the N applied at planting or a month after planting. The pure stand of ryegrass fertilized with 60 lb/acre of N at planting and in January was less productive than any ryegrass-clover mixture that was fertilized with N in January.

Forage production for the total season is shown in Figure 4. Crimson clover production was greatest when no N was applied to a pure clover stand or clover-ryegrass mixture. There was a general trend for clover production to decrease as the quantity of N applied increased. Production of clover-ryegrass without N was only about 400 lb/acre less dry matter than that from a pure stand of ryegrass receiving 180 lb N/acre. However, without applying N fertilizer in early winter there was not sufficient forage for grazing until March 1.

Without N fertilizer, ryegrass is more productive on a loam or clay soil that has a higher nutrient holding capacity (Table 2). Ryegrass did respond to N regardless if it was put on at planting, January, or February. However, as N rate increased within application date, percent clover decreased (Table 3). This competitive effect from the N fertilized ryegrass continued through the growing season. However, without additional N fertilizer applications, clover percentage of the harvested forage within treatment increased throughout the spring.

Since clover production is limited to the spring, the most efficient use of N fertilizer to a ryegrass-clover mixture is in early winter. This enhances ryegrass production during winter months when clover is not productive. Applying N fertilizer at planting or soon after planting to a ryegrass-clover mixture overseeded on a warm-season perennial grass is a debatable management practice. If moisture is adequate and temperature mild, the warm-season grass will take up some of the N and be more competitive to the emerging cool-season forages. If moisture is limited or temperatures are low, seedling growth of the ryegrass and clover will be slow and therefore take up little of the applied N. If planted early on prepared seedbed, applied N fertilizer would be utilized by the ryegrass-clover mixture.

Table 2. Influence of a single nitrogen application on the forage production of a ryegrass-Abon Persian clover (*Trifolium resupinatum* L.) mixture on a Lake Charles clay (Evers, Angleton).

	Harvest Date				
N rate and date	18 Jan	24 Feb	29 Mar	4 May	Total
	----------lb/acre----------				
Planting					
0	951 a†	348 d	1140 b-d	2292 a	4731 ab
50	1228 b	468 cd	819 de	1629 c	4144 b
100	1882 c	541 c	719 e	1083 d	4225 b
18 Jan					
50	951	1183 b	1169 a-d	1675 c	4978 a
75	951	1287 ab	1245 a-c	1604 c	5087 a
100	951	1366 a	1039 c-e	1597 c	4953 a
24 Feb					
50	951	348	1434 ab	1845 bc	4578 ab
100	951	348	1533 a	2199 ab	5031 a

†Yields within harvest date are not significantly different at the .05 level if followed by the same letter.

Table 3. Influence of a single nitrogen application on the clover percentage of a ryegrass-Abon Persian clover (*Trifolium resupinatum* L.) mixture (Evers, Angleton).

N rate and date	Harvest Date			
	18 Jan	24 Feb	29 Mar	4 May
	----------clover %----------			
Planting				
0	2.3 a†	36.2 a	56.0 a	77.3 a
50	0.2 a	21.1 bc	36.8 b	65.0 ab
100	0.3 a	1.0 d	9.8 e	31.3 d
18 Jan				
50		30.8 ab	26.8 bc	50.5 bc
75		10.2 cd	18.0 c-e	41.3 cd
100		18.6 bc	13.0 de	35.8 cd
24 Feb				
50			33.3 b	46.0 cd
100			25.5 b-d	45.5 cd

†Percent clover within harvest date are not significantly different at .05 level when followed by the same letter.

Literature Cited

Binnie, R. C., and F. J. Harrington. 1972. The effect of cutting height and cutting frequency on the productivity of an Italian ryegrass sward. J. Br. Grassld. Soc. 27:177-182.

Craigmiles, J. P., and R. M. Weihing. 1971. Temporary winter pasture studies in the Gulf Coast Rice Belt. Texas Agric. Exp. Stn. MP-990.

Cummins, D. G., J. P. Craigmiles, and J. P. Newton. 1965. Seasonal response of temporary winter grazing mixtures to split applications of nitrogen. Agron. J. 57:451-453.

Evers, G. W. and V. A. Haby. 1995. Response of crimson clovers-ryegrass mixture to N fertilizer. In Agronomy Abstracts. ASA, Madison, WI (In Press).

Evers, G. W., V. A. Haby, J. L. Gabrysch, J. M. Moran, J. V. Davis, and A. T. Leonard. 1992. Nitrogen fertilization of arrowleaf-ryegrass mixtures. p. 59-60. Overton Research Center Technical Report No. 92-1.

Evers, G. W., V. A. Haby, J. L. Gabrysch, J. M. Moran, J. V. Davis, and A. T. Leonard. 1993. Nitrogen fertilization of arrowleaf-ryegrass mixtures. p. 61-62. Overton Research Center Technical Report 93-1.

Gilbert, C. L., G. R. Smith, and I. J. Pemberton. 1992. Forage legume production at Overton p. 41-42. Overton Research Center Technical Report No. 92-1.

Holt, E. C., M. J. Norris, and J. A. Lancaster. 1969. Production and management for small grains for forage. Texas Agric. Exp. Stn. B-1082.

Hull, J. C., and H. A. Mooney. 1990. Effects of nitrogen on photosynthesis and growth rates of four California annual grasses. Acta Ecologica 11:453-468.

Keatinge, J.D.H., M. K. Garrett, and R. H. Stewart. 1980. Response of perennial and Italian ryegrass cultivars to temperature and soil water potential. J. Agric. Sci. 94:171-176.

Matocha, J. E. 1972. Production of wheat-ryegrass and Coastal bermudagrass grown in association as affected by rates and sources of nitrogen. Texas Agric. Exp. Stn. PR-3015.

Morris, D. R., R. W. Weaver, G. R. Smith, and F. M. Rouquette. 1990. Nitrogen transfer from arrowleaf clover to ryegrass in field plantings. Plant and Soil 128:293-297.

Morris, D. R., R. W. Weaver, G. R. Smith, and F. M. Rouquette. 1986. Competition for nitrogen-15-depleted ammonium nitrate between arrowleaf clover and annual ryegrass sown into bermudagrass sod. Agron. J. 78:1023-1030.

Silver, W. S. and R.W.F. Hardy. 1976. Newer developments in biological dinitrogen fixation of possible relevance to forage production. p. 1-34. In. C. S. Hoveland (ed.) Biological N fixation in forage-livestock systems. ASA Spec. Publ. 28. ASA, CSSA, and SSSA, Madison, WI.

Ward, S., J. Crowder, and L. R. Nelson. 1992. Ryegrass forage yields at Overton for 1990-91 and 4-year means. p. 31-32. Overton Research Center Technical Report No. 92-1.

Ward, S., J. Crowder, and L. R. Nelson. 1993. Ryegrass forage yields at Overton for 1991-92 and 5-year means. p. 35-36. Overton Research Center Technical Report No. 93-1.

Ward, S., J. Crowder, and L. R. Nelson. 1994. Ryegrass forage yields at Overton for 1992-93 and 4-year means. p. 29-30. Overton Research Center Technical Report 94-1.

Weihing, R. M. 1963. Growth of ryegrass as influenced by temperature and solar radiation. Agron. J. 55:519-521.