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CHAPTER 2

RYEGRASS IMPROVEMENT AND IMPORTANT CULTIVARS

L. R. Nelson, Ryegrass Breeder, TAES
Texas A&M University Agricultural
Research and Extension Center at Overton

Annual ryegrass (*Lolium multiflorum* Lam.), is a member of the grass family that is indigenous to Europe and most areas near the Mediterranean Sea region including Africa and Asia. It is native to most of those regions wherever rainfall is sufficient to allow it to grow. Ryegrass is a highly important grass specie that can survive under many types of soils, climates, and grazing regimes.

Terrell (1968) reports that annual ryegrass is a cross-pollinating specie and is normally thought to be self-incompatible as is perennial ryegrass (*L. perenne* and *L. regidum*). These three closely related *Lolium* species will readily cross with each other as well as fescue (*Festuca* sp.). All ryegrass taxa are normally diploid with 2n chromosome numbers equaling 14. A number of tetraploid varieties have been released in attempting to improve yield and quality of the specie. A large research effort to hybridize ryegrass and fescue (2n = 42) was undertaken at the University of Kentucky several years ago (Webster, 1974). Large numbers of crosses were made which resulted in amphiploids. An amphiploid is a polyploid whose chromosome compliment is made up of the entire somatic compliment of both species. Amphiploids were then backcrossed either to tall fescue or to ryegrass and progeny of these crosses were then tested. Chromosome numbers in the first few generations were often aneuploid (not an even number of either specie), but generally chromosome numbers became stable and new lines were selected out of this breeding program for testing. Results evidently were that these progeny were not significantly improved over original ryegrass parents because no important festoleums are being marketed in the South.

There is a large genetic variability within annual ryegrass populations and in fact because of ryegrass being cross pollinating, there is much variation even within a variety of ryegrass. Because of this variability, ryegrass has the ability to adapt to a wide range of environmental conditions and may be found growing wild around the world. In many regions, it is considered a weed particularly in association with most cool season crops such as wheat. Ryegrass has the ability to escape heat, drought, and floods by going dormant in some cases. It normally persits in areas with hot dry summers as dormant seed.

Annual ryegrass has several common names throughout the world, but for the most part has been called "Italian" ryegrass or "common annual" ryegrass. In Texas, the name "Gulf" or even "Gulf rye" is often used and misused by producers to denote Italian annual ryegrass. These names originated from the variety 'Gulf', the first improved variety which was released by the Texas Agricultural Experiment Station in 1958 (Weihing, 1963) and has remained popular for the past 37 years. Gulf ryegrass is a direct increase of "La Estanzuela 284", an improved variety from Uruguay. The seed were introduced in 1950, by the Crops Research Division, ARS, USDA, as P. I. 193145 (Holt, 1976). Gulf was first tested in 1952 by the Texas Agricultural Experiment Station and because of its consistent superiority for yield and crown rust (*Puccinia coronata*) resistance, it was later released. In some parts of the world, ryegrass may be called "Westerwold" ryegrass. This is from a variety or varieties which originated in the Westerwolde area, Province of Groningen, Netherlands. Haan (1955) reported that the Westerwold types were actually Italian ryegrass which had been selected for earliness. There is no indication that the Westerwold ryegrass differs botanically from Italian (annual) ryegrass. The first reported annual ryegrass which was cultivated was grown in northern Italy (Piper, 1935). It was reported in France in 1818 and in Switzerland in 1820. Piper indicates it was imported to England in 1831; however, it may have been present as a weed prior to that date. The actual date annual ryegrass was imported into the USA is not known. Ryegrass was brought to America in early colonial days (Schoth and Weihing, 1962) and has become an important grass.

Annual, common (variety not stated) ryegrass was successfully grown in the Gulf Coast region of the US in the 1940's and 1950's. However, crown rust was often a serious disease problem and reduced forage yields and quality. Plant breeding efforts in Texas, Mississippi, and Florida resulted in the release of crown rust resistant varieties. Texas released Gulf, and Mississippi released 'Magnolia' ryegrass. Both varieties have remained moderately resistant to crown rust and are still available today.

Another major problem with annual ryegrass has been its susceptibility to winterkilling or freeze damage from extreme cold periods during the winter in the southern US. This was to be expected since annual ryegrass had been developed or originated as a spring grass in temperate climates but was being utilized as a winter grass in warmer climates. Plant breeders have selected annual ryegrass as a non-dormant type in the winter. Therefore, tillers must be able to tolerate freezing temperatures while producing rapid vegetative growth when average daily temperatures rise above 50^0F. Cultivars differ in winter hardiness and for length of time for cold hardening to occur (Eagles, 1984). When annual ryegrass has two weeks of temperature near freezing most varieties will be very winter hardy.

In the mid 1970's, Mr. B. L. Arnold a researcher at the North Mississippi Branch Station at Holly Springs, Mississippi, noticed a stand of volunteer, annual ryegrass which was thought to be the result of 29 years of natural selection. This selection appeared to be more productive than commercial varieties of ryegrass planted in the autumn. 'Marshall' ryegrass was developed from this population and released in 1981 (Arnold et al., 1981). Marshall was significantly improved for winter hardiness and has extended the range of ryegrass 200 to 300 miles northward in the US and reduced the threat of winter freeze damage.

To improve winter hardiness in the East Texas ryegrass breeding program, breeding populations were planted on the High Plains near Amarillo, Texas where winter temperatures can be near 0^0F. Germplasm which survived that environment eventually was released in 1991 as 'TAM 90' (Nelson, et al., 1992) and is a winter hardy variety that has cold tolerance similar to Marshall. Since the release of these two varieties as well as others, annual ryegrass acreage has significantly expanded in northeast Texas, Oklahoma, Arkansas, and Tennessee. Varieties of annual ryegrass released in the United States, their origin, and other pertinent information are listed in Table 1 (Balasko, et al., 1995).

New ryegrass breeding objectives:

In the ryegrass breeding program at the Texas A&M University Agricultural Research & Extension Center at Overton, we have initiated three new areas of research. They are (1) improving tolerance to acid soil and aluminum toxicity, (2) reseeding potential, and (3) understanding the value of the fungal endophyte in annual ryegrass. In East Texas and across much of the South, many soils are slightly acid to very acid. Acid tolerant ryegrass would require less liming of soils which would reduce input costs for producers. Likewise, all producers would prefer a variety of ryegrass that has the ability to reseed itself annually to eliminate the annual cost of seed and planting. Research has indicated that these attributes appear to be beneficial but may have some disadvantages.

We have selected for Al tolerance in the seedling stage utilizing the hematoxylin staining procedure (Polle, et al., 1978). In a study comparing the Al tolerant line TX-91-A7 with TAM 90, TX-91-A7 produced a competitive forage yield under acid soil conditions but was not competitive for yield in a limed soil with high nitrogen fertilization (Fig. 1 and 2). Therefore, we either lost some high yielding component in the selection process or we need to go back and select again for high yielding vigor in the Al tolerant population.

Improved reseeding has been incorporated into several of our advanced breeding populations. The screening procedure (Prine, 1982) is relatively easy to conduct and is easily incorporated into ryegrass populations. Seed which germinate at temperatures between 80 and 100^0F are discarded. The seed which do not germinate have a high temperature dormancy gene which delays germination until cooler soil temperatures occur. This prevents ryegrass seed from germinating and dying during the summer months. Our research data indicate that the dormancy character tends to delay early fall growth because much of the seed will not germinate in September or early October. Naturally reseeding ryegrass tends to germinate more slowly (as a population) than present varieties and therefore early forage production is reduced. Even though this character may have an advantage and make naturally reseeding types attractive in grazing systems it will be difficult to release new varieties because fall yields and total forage production may be reduced.

Table 1. Annual ryegrass cultivars released in the United States.

Cultivar	Originator	Release year	Maturity	Cold tolerance	Crown rust resistance
Gulf	USDA, TX-AES	1958	intermediate	average	good
Florida Rust Resistant	FL-AES	1965	early	average	good
Magnolia	USDA, MS-AES	1965	intermediate	good	average
Marshall	MS-AES	1980	late	excellent	poor
Florida 80	FL-AES	1982	early	good	good
Rustmaster	DLF Trifolium Seed Co.	1985	early	average	good
King's Alamo[a]	Douglass King Seed Co.	1987	late	average	good
Beefbuilder[a]	Forbes Seed Co.	1988	late	average	good
Jackson	MS-AES	1989	intermediate	good	good
Surrey	FL-AES	1989	intermediate	good	good
TAM-90	TX-AES	1991	intermediate	good	good
Rio	Olsen-Fennell Seed Inc.	1991	intermediate	average	good
Southern Star	Williamette Valley Plant Breeders	1991	intermediate	good	good
Grazer	USDA, ARS Tifton, Ga	1994	early	good	poor

[a]tetraploid

Sources: Personal communication: L. R. Nelson, G. M. Prine, and C. E. Watson.

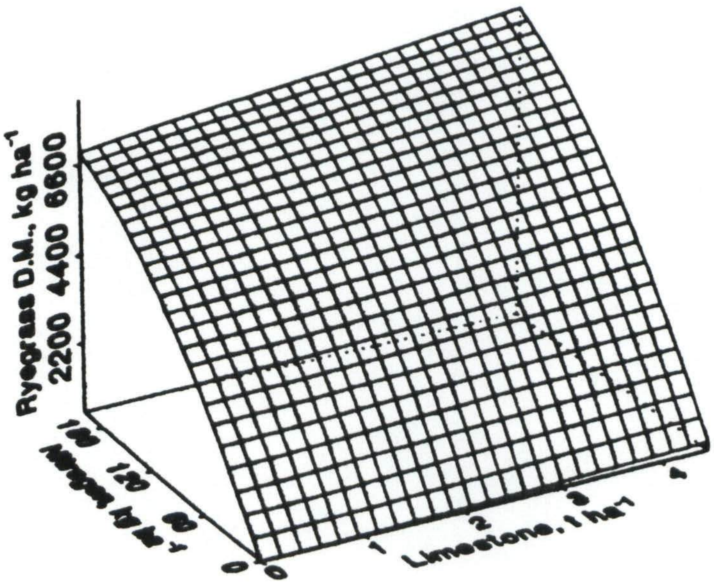

Figure 1. Two year mean yield response of TAM 90 ryegrass to limestone and nitrogen treatments.

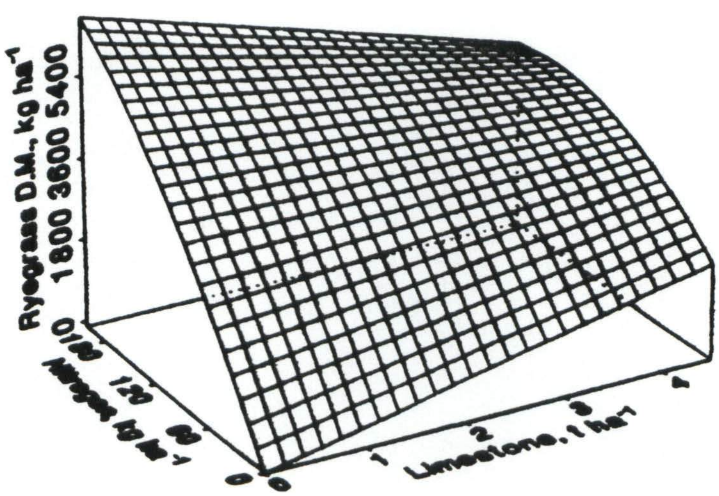

Figure 2. Two year mean yield response of TX-91-A7 ryegrass to limestone and nitrogen treatments.

Some level of fungal endophyte (*Acremonium lolii*) in annual ryegrass is common in most varieties. For example, our research (Nelson and Ward, 1990 and 1991) indicated that TAM 90, Marshall, Jackson, and Surrey had between 20 and 50% seed infection (Table 2).

Percentage of infected plants from the same seed lot under field conditions was reduced. This indicated that either slow growth of the fungus during the cold season was occurring or poor efficiency of the fungus in passage from the seed to the plant. Presence of the endophyte in ryegrass may improve tillering and perhaps some tolerance of plants to greenbug infection (Nelson et al., 1993). At this date, there are no reports in the literature of any detrimental effect of the endophyte in annual ryegrass on animal performance. However, this is not the case with perennial ryegrass or tall fescue as many studies have indicated that endophyte infected forage will result in toxicosis of animals consuming that forage. We are in the process of conducting grazing studies with endophyte infected annual ryegrass to determine what effects on the animal, if any could arise when grazing this forage. Preliminary data indicate that we found no detrimental effects when grazing annual ryegrass which was infected with the endophyte.

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Table 2. Italian annual ryegrass genotypes screened for presence of fungal endophyte mycelium in seed or plant tissue.

Variety	% Infected Seed	Infected Plants		
		January	March	May
FLA 80	0	0	0	0
Surrey	25	0	0	0
Penploid V	a	0	0	0
Jackson	36	0	0	0
TAM 90	50	0	17	10
Gulf	a	0	0	0
Marshall	21	0	0	0
NF-32	a	0	0	0
Tetila	0	0	0	0
TX-R-86-2-L	19	0	0	0
NF-149	a	0	0	0
TX-R-89-B	a	0	0	0
Alamo	0	0	0	0
Tetragold	a	0	0	0
Concord	94	0	50	20
WVPB-LM-AR-2	a	0	0	0
WVPB-LM-B7T	a	0	0	0
ETCO-90-88	0	0	0	0
WVPB-LM-AR-42	a	0	17	50
WVPB-LM-601	a	0	0	0
WVPB-LM-AR-22	a	0	0	0
WVPB-LM-F-41	a	0	0	0
WVPB-LM-F-4	a	0	0	0
Equipe	0	0	0	0
Mondora	0	0	0	0
Planter's Choice	0	0	0	0
Major	0	0	0	0
Magnum	13	0	0	0

[a]Seed were not available for testing for endophyte presence.