Lolium multiflorum breeding

Andréa Mittelmann[1]

The *Lolium* genus originated in central Asia, around the Mediterranean and throughout northern Europe (Easton, 1983). Now it is widely distributed over the world's temperate and subtropical areas. The most important species are *Lolium perenne, Lolium multiflorum* and *Lolium rigidum*. *L. perenne* is more widespread in temperate Europe and Asia and *L. rigidum* is more frequent close to the Mediterranean and is a very short-lived type. *L. multiflorum* is intermediate in its distribution and growth cycle (Easton, 1983). The *Lolium* species are closely related to *Festuca*, a genus that contains other important temperate forage grasses, and some hybrids have been produced by ryegrass breeding programs (Borrill, 1976).

In Brazil, *L. multiflorum* is the species of choice. This species grows faster, with good production at the sowing year and better winter growth than *L. perenne* (Easton, 1983). It has good seed production in the first year and low need for vernalization to flower. The study of natural populations has shown that subtropical climates with high summer temperatures and a dry season are favorable to annual species, that allocate energy and reserves for seed production and not the maintenance of the original plant. This strategy is also valid for low fertility conditions (Campbell, 1990). Because of its high seed production, natural dehiscence and initially dormant seeds, ryegrass is perfectly adapted to Brazilian subtropics. As a naturalized species, it is adventitious at most geographic regions of Rio Grande do Sul State (Moraes, 1995). Its long history of adaptation in South America permitted another important trait to be selected: crown rust resistance. This is the most important winter grass disease in the region and a decisive barrier to the introduction of *L. perenne* cultivars.

Plant breeding strategies

L. multiflorum is alogamous, so plant breeding methods to be adopted are those for alogamous species, like mass selection and half-sib progeny selection. In addition, very simple strategies have made significant results in Brazilian ryegrass breeding efforts, because there is a number of locally adapted populations with high inter and intrapopulation variability that have never undergone selection before.

[1] Researcher at Embrapa Dairy Cattle / Embrapa Temperate Agriculture, BR 392, km 78, C.P. 403, 96001-970, Pelotas - RS

The strategy that gave rise to Embrapa´s new cultivar BRS Ponteio was simply collecting and evaluating under mechanical cuts a number of local populations. Populations were collected at the three States of the South Region of Brazil and conserved as Embrapa´s Active Germplasm Bank, with 215 accessions. An evaluation over seven locations allowed the identification of productive and stable populations. BRS Ponteio has a better distribution of forage production along the growing season. It establishes faster and flowers later than most of the other evaluated accessions.

Another simple strategy with good results is population selection. It was used when breeding for late flowering. A late harvest of the population we were interested in selecting has led to the multiplication of only the late flowering plants. Early plants had shed their seeds before, because of natural dehiscence. Not many cycles of selection are needed because flowering is a trait with moderate to high heritability in cereals and grasses. A similar strategy can be adopted on farm, to select natural populations growing in an area. It consists in maintaining animals feeding on ryegrass for a longer period, avoiding earlier plants to set seeds.

The efficiency of mass selection in ryegrass breeding was clearly demonstrated in the development of EMPASC 304 – Serrana cultivar, from Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (Epagri). One cycle of mass selection was sufficient to obtain a population 9% superior in total forage production and 13% in fall-winter forage production, compared to common types (Dall'Agnol et al., 1989).

Some cultivar introductions were also evaluated in Embrapa's Ryegrass Breeding Program. Amongst them, there were some tetraploid cultivars developed in Europe and North America and commercially available in Brazil and other countries of South America. In spite of having wider leaves and vigorous appearance they did not differ in forage production from the best local accessions. Tetraploid cultivars tended to be slow-establishing and extremely late in flowering. A smaller seed production was observed, probably due to meiotic instability and the incidence of water shortage periods at the seed development stage. This is a problem when trying to maintain a pasture by natural reseeding, one of the advantages of ryegrass pastures. However, this behavior is more a reflex of the environment where these cultivars were selected than a result of poliploidization. In colder regions, plants are selected to have a spring-growth behavior. Base-temperature estimates for different diploid and tetraploid cultivars support this hypothesis (Müller, 2009). One of Embrapa's Ryegrass Breeding Program goals is to obtain tetraploids from local populations.

Important traits

Plant breeding assumes the need of modifying a variety with known deficiencies and qualities and its objective is to augment productivity and improve quality and adaptation (Pereira, et al., 2001). South Brazilian cattlemen have always demanded for a rapidly establishing winter pasture because fall and early winter are the most critical periods of native grasslands forage production. On the other hand, late flowering cultivars that feed animals for a long time with better quality are desired. Gains have been made in both traits, but there is still more to improve.

Ryegrass seed producers have to be heard because the expression of some traits is detected only when seed harvesting is to be done. One of these traits is lodging resistance. Like in cereals as wheat and oats, lodging resistance may be attained by selecting plants for an association of short height and thick culms. In the same way, diseases which do not affect plant production under grazing may became a problem in seed production fields. Seed yield evaluations are also going to be incorporated to breeding trials.

The adaptation of ryegrass populations to a wider range of environments and production systems is under study. The expansion towards a more tropical zone, at Southwest Region of Brazil is possible and can contribute to intensify cattle production in the winter, but irrigation is needed. Lack of flowering in these conditions has been observed for a small number of populations (Pereira et al., 2008). Causes like vernalization needs or photoperiod sensitivity are to be investigated.

In most aspects, plant breeding and plant management studies have to be carried out together. For instance, proper fertilization enhances plant establishment. And facing new challenges such as plant adaptation to climatic changes and the need for greater efficiency in the use of agricultural inputs such as fertilizers and water, amplifies the need for interdisciplinary research.

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