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Brachiaria hybrids: potential, forage use and seed yield

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Abstract

A brachiaria breeding program initiated in 1988 at CIAT (Centro Internacional de Agricultura Tropical, Cali, Colombia) combined desirable attributes found in accessions of *Brachiaria brizantha* and *B. decumbens*. Three apomictic hybrids have been released (cvv. Mulato, Mulato II and Cayman). Mulato showed agronomic potential but seed yields were low. Trials in Central America demonstrated the superiority of Mulato II, a vigorous grass with deep and branched roots, giving it excellent drought tolerance in the Brazilian Cerrado and Mexico, plus outstanding nutritional value. Following trials in Mexico and Thailand, evaluating 155 new hybrids for 7 years, cv. Cayman was released due to strong waterlogging tolerance. Research on production, quality and seed yields of brachiaria hybrids in Asia, the Americas and Africa from 2003 to 2013 is summarized in this paper.

Resumen

Un programa de mejoramiento de brachiaria iniciado en 1988 en el CIAT (Centro Internacional de Agricultura Tropical, Cali, Colombia) combinó los atributos deseables encontrados en accesiones de *Brachiaria brizantha* y *B. decumbens* y condujo a la liberación de 3 híbridos apomícticos (cvs. Mulato, Mulato II y Cayman). Mulato mostró potencial agronómico pero la producción de semilla fue baja. Ensayos conducidos en Centroamérica demostraron la superioridad de Mulato II, un pasto de crecimiento vigoroso y con raíces profundas y ramificadas que proporcionan excelente resistencia a la sequía en el Cerrado brasileño y México. Mulato II también tiene un valor nutritivo sobresaliente. Después de ensayos en México y Tailandia, evaluando 155 nuevos híbridos durante 7 años, cv. Cayman fue liberado debido a su alta tolerancia de inundación. En este trabajo se resume la investigación conducida en Asia, las Américas y África durante 2003−20013, sobre la producción, calidad y rendimiento de semilla de híbridos de brachiaria.

Introduction

The registration of Mulato hybrid brachiaria (*Brachiaria ruziziensis* x *B. brizantha*) by Grupo Papalotla in 2004 (Miles et al. 2004) and the granting of Plant Variety Rights (PVR) in 2002, marked a significant breakthrough for tropical perennial forage cultivars. Until 2001, *Brachiaria* spp. cultivars used commercially were derived without genetic modification directly from natural germplasm collected in Africa or selected fromgermplasm collections in Australia and tropical America. The development in Belgium of a tetraploidized sexual ruzi grass (*B. ruziziensis*) (Swenne et al. 1981) and further studies by Ndikumana (1985) and Valle et al. (1994), led to Embrapa (Empresa Brasileira de Pesquisa Agropecuária) providing tetraploid, sexual ruzi grass to CIAT in 1988. The breeding program at CIAT combined desirable attributes found in accessions of *B. brizantha* and *B. decumbens.*

In 2001, Grupo Papalotla, a Mexican seed company, was granted the exclusive rights worldwide, to produce, research and commercialize the first generation of brachiaria hybrids developed by CIAT from 2001 to 2010. Mulato showed considerable agronomic potential but seed yields were low (Hare et al. 2007a). Fortunately, trials in tropical America found Mulato II had excellent drought tolerance in the Brazilian Cerrado and Mexico and its seed yields in Thailand were between 60 and

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100% higher than the highest seed yields of Mulato (Hare et al. 2007b; 2007c). From 2003 to 2008, further detailed studies were conducted in Mexico and Thailand on 155 new hybrid brachiaria lines resulting in 4 lines, BRO2/1718, BRO2/1752, BRO2/1794 and BRO2/0465 being granted PVR. BRO2/1752 produced similar dry matter (DM) yields to Mulato II, and in trials in Mexico demonstrated good waterlogging tolerance.

This paper summarizes research on production, quality and seed yields of brachiaria hybrids in Asia, the Americas and Africa from 2003 to 2013.

Regional evaluations and research

Asia

Field studies at Ubon Ratchathani University, Thailand (15° N), between 2003 and 2007, showed that Toledo palisade grass (*Brachiaria brizantha*), Mulato and Mulato II produced more total DM and leaf DM, particularly during the dry season, than other brachiaria grasses (Hare et al. 2009), Mulato II also producing significantly more leaf than Toledo palisade grass and Mulato. It is the production of green leaves that makes Mulato II a particularly attractive forage for livestock (Mutimura and Everson 2012).

From 2005 to 2008, 15 hybrid brachiaria lines were evaluated at Ubon Ratchathani University for DM production, quality (in terms of leaf percentage) and seed production (Table 1). Only 3 lines, BRO2/0465 and MXO2/1263 in the wet season in Trial 1 and cv. Cayman in the wet season in Trial 2, produced more DM than Mulato II. BRO2/0768 was the only line that produced a higher percentage leaf DM than Mulato II, in the wet season of Trial 1 and in the dry season of Trial 2 (Table 1). BRO2/1794 produced significantly more seed than all other hybrids in both trials. Mulato II, Cayman, BRO2/0465, BRO2/0768 and BRO2/1718 produced similar seed yields, averaging 150 kg/ha.

Table 1. Average wet season (May−October) and dry season (November−April) dry matter yields, leaf percentage and pure seed yields of hybrid brachiaria lines from 2005 to 2008 in Ubon Ratchathani, Thailand.

Hybrid line	Dry matter yields				Leaf percentage				Pure seed yields	
	Trial 1		Trial 2		Trial 1		Trial 2		Trial 1	Trial 2
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry		
	(kg/ha)				(%)				(kg/ha)	
Mulato II	8674	2886	10566	2801	74	91	72	83	129	141
Cayman	9252	2837	12597	3059	62	84	55	79	136	108
BRO2/0465	11477	3050	11594	2861	68	86	66	78	166	144
BRO2/1794	9420	2655	11149	2901	58	81	55	77	277	244
BRO2/1718	8569	2517	10394	3318	69	87	67	76	172	197
BRO2/1747	8728	2950	10539	2752	61	83	56	77	88	107
BRO2/1245	8889	3348	10399	2773	68	79	64	79	76	37
BRO2/0771	9032	3447	10866	2955	74	82	71	82	52	76
BRO2/0799	9282	2646	10734	2492	66	86	63	83	114	90
BRO2/1372	7602	2966	8722	3212	70	83	66	77	36	22
BRO2/1728	9515	2966	10558	2834	61	83	56	80	99	79
BRO2/0768	8542	3219	10653	3078	80	90	74	88	142	123
BRO2/1485	8901	3287	11790	2984	71	80	65	80	39	55
BRO2/1452	7451	2343	7667	2126	67	79	67	80	85	113
MXO2/1423	8809	3090	11076	2624	62	78	56	75	61	24
MXO2/1263	10853	3178	10859	2670	66	83	66	80	84	83
LSD (P<0.05)	2060	751	1349	569	4.9	4.8	3.8	4.4	69	64

From 2008 to 2011, a further 28 hybrid brachiaria BRO6 lines were evaluated alongside Mulato II, *B. brizantha* cvv. Marandu and Toledo, and the promising BRO2 lines, 1794, 0465, 1718 and 1372. None of the BRO6 lines produced significantly more DM than Mulato II. Mulato II produced significantly higher percentage of leaf DM than all other lines in both wet and dry seasons, except for BRO6/1922 in the dry season. Mulato II and BRO2/1718 produced significantly more seed than all the BRO6 lines. In this trial, BRO2/1794 produced less seed than Mulato II, BRO2/1718 and BRO2/0465.

Field trials conducted by the Thailand Department of Livestock Development (DLD) from 2004 to 2006 in

northern Thailand (18° N; 319 m asl), showed that Mulato and Mulato II produced significantly higher DM yields than ruzi grass, but ruzi grass produced 3−4 times the seed yields of Mulato and Mulato II (Phunphiphat et al. 2007). In the dry season, Mulato and Mulato II produced 60% more DM than ruzi grass. In seed production trials conducted by DLD from 2007 to 2008 in northern Thailand at the same location, Mulato II produced significantly more seed (500 kg/ha) than Cayman (290 kg/ha), BRO2/1718 (250 kg/ha), BRO2/1794 (390 kg/ha), BRO2/0465 (145 kg/ha), Mulato (220 kg/ha), 10 MX02 lines (180 kg/ha), 8 BRO4 lines (157 kg/ha) and 20 BRO5 lines (40 kg/ha).

Further trials conducted in Thailand by DLD showed that leaf DM digestibility of Mulato II and 3 hybrid brachiaria lines averaged 75% and stem DM digestibility averaged 60%.

Research during 2005−2007 at the Tropical Pasture Research Center, Chinese Academy of Tropical Agricultural Sciences (CATAS) in Hainan, China (19° N), on acid soils (pH 4.9−5.5), with annual rainfall of 1600 mm, found that Mulato and *B. brizantha* cv. Reyan 6 produced significantly more DM than Mulato II, *B. decumbens* and *B. humidicola*, even though Mulato II had a higher leaf:stem ratio. In Guangxi, China (25° N), Mulato II was found to be very susceptible to winter cold, with only 5% plant survival in May, following 2 days below 0 °C in December. This was similar to results from Florida, USA, where Mulato II pastures are considerably weakened by winter temperatures below 0 °C and recover slowly in spring (Vendramini et al. 2012).

The Americas

Seed production trials were conducted at Warnes, Bolivia (19° S; 423 m asl), from 2007 to 2010 on hybrid brachiaria lines BRO5, MXO2 and BRO4. Over 4 years, only 1 new line, MXO2/2552, produced more seed than Mulato II, due to a high seed yield in 2010. In 2009, seed yields were low overall, due to dry conditions during anthesis and seed set. Further trials from 2008 to 2010 at the same location, found that none of the BRO6 lines produced significantly more seed than Mulato II.

In Mexico, evaluations on the hybrid brachiaria collections commenced in 2005 at Santa Elena, Oaxaca (16° N; 4−8 m asl; 800−1200 mm annual rainfall; 6−8 months dry season) on very sandy soils, with low organic matter, N and P and a pH of 5.6. To date, studies have been conducted on 15 BRO2 lines, 38 BRO5 lines, 28 BRO6 lines and 74 BRO9 lines.

Within the BRO2 lines, 4 lines (1718, 0465, 1752 and 1794) were selected from the Mexico and Thailand studies and granted PVR. Further trials with BRO2/1752 showed that it displayed superior waterlogging tolerance compared with Mulato II and 38 BRO6 lines. It was subsequently released as cultivar Cayman.

The 3 released cultivars (Mulato II, Cayman and BRO2/0465) produced 30 tonnes, 21 tonnes and 18 tonnes DM/ha respectively, 120 days after cutting. After 30 days subsequent regrowth, Cayman and BRO2/0465 produced significantly more DM (700−740 kg DM/ha) than Mulato II (100 kg DM/ha).

In the USA, forage production and nutritive value of Mulato II and Cayman under grazing were studied at the University of Florida, Beef Research Unit (29° N; 45 m asl) from 2010 to 2011 (João Vendramini pers. comm.). Under intensive grazing every 2 weeks, both hybrids had significantly higher percentage of leaf (70−80%), crude protein (19−21% in leaves, 10−12% in stems) and in vitro organic matter digestibility (73−75% leaf, 59−61% stem) than under grazing every 4 and 6 weeks, similar to the high quality achieved under cutting in Thailand.

Africa

Improved hybrid brachiaria grasses were evaluated in Rwanda (2° S) at a lower rainfall site (1400 mm/year) and a higher rainfall site (1800 mm/year) that had high soil Al levels (47 meq/100g of soil), against local signal grass (*B. decumbens*) and a naturalized buffel grass (*Cenchrus ciliaris*). At the lower rainfall site, BRO2/1485 and the local signal grass produced more DM than buffel grass and the brachiaria hybrids BRO2/0465 and BRO2/1452. When asked to rank the grasses, farmers selected Mulato II as the preferred cultivar at both sites, because of its year-round production of green forage without any input of fertilizer, high DM production, palatability, drought tolerance, quick regrowth, persistence, perenniality, and being easy to cut and carry (Mutimura and Everson 2012).

Commercial pasture development

In Vietnam, Mulato II is used as cut-and-carry forage by dairy farmers because of its high protein levels, palatability and digestibility (Raf Somers pers. comm.). In Thailand, Laos and Malaysia, expansion of planting of Mulato II has been slow, due to the strong competition from far cheaper ruzi grass seed produced in Thailand.

In the Pacific region, since 2007 over 10,000 hectares of Mulato II pastures have been established in Vanuatu, where it is primarily used for beef cattle grazing. In

Africa, Mulato II pastures have been established on nearly 1000 smallholder farms in Kenya, Tanzania and Ethiopia and on larger farms in Congo and Uganda. In Rwanda, 50 hectares of Mulato II have been planted to provide vegetative planting material for famers. In Burundi, Mulato II is currently being evaluated on research stations.

In the Americas, nearly 200,000 hectares of Mulato II pastures have been established since 2005 for both dairy and beef cattle grazing.

Commercial seed production

Mulato II and Cayman seed produced in Thailand and Laos is harvested by hand. In Thailand, the seed is ground-swept and in Laos it is harvested by knocking the seed from seedheads. The seed is hand-cleaned by the farmers and then acid-scarified in Thailand to reach 98% purity, 90% viability and 80% germination.

In tropical America, seed is produced only in Mexico (Mulato II and Cayman) and Brazil (Mulato II), with all seed being ground-swept using machinery (Pizarro et al. 2010). The seeds are cleaned and acid-scarified at a central location in each country.

Conclusion

In many trials in Asia, Africa and the Americas, the hybrid brachiaria cultivars have consistently produced significantly more dry-season forage than other tropical grasses and other brachiaria grasses. Because of its excellent drought tolerance, year-round production of green forage, leafiness, high digestibility and higher crude protein levels than most other tropical grasses, cv. Mulato II is a valuable grass for improved beef and dairy production. Cultivar Cayman also exhibits many of the qualities of Mulato II, and its outstanding waterlogging tolerance adds a new dimension to the hybrid brachiaria collection. Research is now continuing to evaluate the new BRO9 collection to select lines with high seed yields and high forage quality, as well as persistence and tolerance to grazing, or outstanding drought tolerance, or upright form with high DM yields for cut-and-carry forage systems, or good shade tolerance.

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