Cultivar Mulato II

(*Brachiaria* hybrid CIAT 36087)

High-quality forage grass, resistant to the spittlebug and adapted to well-drained acid tropical soils

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grupo papalotla

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Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

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GRUPO PAPALOTLA

PAPALOTLA HYBRIDS

The Grupo Papalotla conducts state-of-the-art agricultural research in the tropics and finances the study of new solutions to production problems. The strategic alliance with the International Center for Tropical Agriculture (CIAT) guarantees access to tomorrow's hybrids, under strict varietal protection norms.

- Cultivars Mulato (*Brachiaria* hybrid CIAT 36061) and Mulato II (*Brachiaria* hybrid CIAT 36087), as well as the hybrids to be developed over the next several years as part of the agreement with CIAT, are the result of 20 years of genetic research on *Brachiaria* carried out by the Center's Tropical Forages Program.

- These hybrids have been continuously evaluated and multiplied since 2000 under the umbrella of the Grupo Papalotla–CIAT Alliance.

- Evaluations are carried out in multiregional trials on different continents to ensure quality and adaptation to climate and soils.

Cultivar Mulato II
(*Brachiaria* hybrid CIAT 36087) A high quality forage grass, resistant to spittlebugs and adapted to well-drained, acid tropical soils

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Resumen

Brachiaria híbrido cultivar (cv.) Mulato II (CIAT 36087) es el resultado de tres generaciones de cruzamiento y selección realizadas por el Proyecto de Forrajes Tropicales del Centro Internacional de Agricultura Tropical (CIAT) a partir de cruces iniciados en 1989 entre *Brachiaria ruziziensis,* clon 44-6, tetraploide sexual y *B. decumbens* cv. Basilisk, tetraploide apomíctico. Estudios con marcadores moleculares mostraron que tiene alelos presentes en la madre sexual *B. ruziziensis,* en *B. decumbens* cv. Basilisk y en accesiones de *B. brizantha* incluyendo el cv. Marandu. El cv. Mulato II es un híbrido tetraploide (2n=4x=36 cromosomas), perenne, de crecimiento semierecto. Los tallos son cilíndricos, pubescentes y vigorosos; las hojas son lanceoladas y de color verde intenso; la inflorescencia es una panícula con 4 a 6 racimos con hilera doble de espiguillas, las cuales tienen estigmas de color blanco-crema. El cv. Mulato II produce alto número de panículas con alta sincronización floral y buena formación de cariópsides lo que se traduce en aceptables rendimientos de semilla de buena calidad, que pueden oscilar entre 150 y 420 kg/ha de semilla pura dependiendo del sitio, la edad, el manejo del cultivo y el método de cosecha. Resultados de varias pruebas de adaptación han mostrado buen crecimiento del cv. Mulato II desde el nivel del mar hasta 1800 m.s.n.m. en trópico húmedo con altas precipitaciones, y en condiciones subhúmedas con 5 a 6 meses secos y precipitaciones anuales mayores a 700 mm. El pasto tiene buena adaptación a suelos ácidos infértiles, bien drenados, aunque tolera suelos con deficiente drenaje sin que estos lleguen a tener encharcamiento en forma permanente. También presenta buen crecimiento en condiciones

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subtropicales como las presentes en el departamento de Canelones (Uruguay) donde ocurren heladas periódicas. Este cultivar tiene resistencia antibiótica a las especies de salivazo *Aeneolamia reducta, A. varia, Zulia carbonaria, Z. pubescens, Prosapia simulans, Mahanarva trifissa, Deois flavopicta, D. schach* y *Notozulia entreriana.* La resistencia de la gramínea a hongos foliares es moderada y mayor que la observada en los cvs. Marandu y Mulato. Dependiendo de las características de clima y de suelos, la producción de forraje del cv. Mulato II varía entre 10 y 27 t/ha de MS por año y el 20% de este rendimiento puede ser producido durante la época seca. La gramínea responde a la fertilización, particularmente al nitrógeno en aplicaciones anuales fraccionadas entre 100 a 150 kg/ha de N y 50 kg/ha de fósforo, de acuerdo con la fertilidad del suelo. La calidad forrajera del cv. Mulato II es alta en comparación con otras gramíneas tropicales, presentando valores de PC entre 8 y 16% y digestibilidad in vitro de MS entre 55% y 66% en rebrotes con 25 a 30 días de edad. El consumo por bovinos en pastoreo es alto, lo que se traduce en producciones significativamente mayores de leche en condiciones similares de uso con relación a otros cultivares de *Brachiaria* como cv. Toledo (*Brachiaria brizantha* CIAT 26110). En algunos estudios realizados en los Llanos Orientales de Colombia, ha mostrado buenas características para la elaboración de heno.

A partir de 2000 el CIAT cedió los derechos exclusivos de multiplicación y comercialización de semillas de este híbrido al Grupo Papalotla S. A. de México, manteniendo los derechos de obtentor del mismo.

Summary

Brachiaria hybrid cultivar (cv.) Mulato II (CIAT 36087) is the product of three generations of hybridization and selection initiated in 1989 by the Forage Project of the Centro Internacional de Agricultura Tropical (CIAT), in Cali, Colombia, from crosses between the sexual tetraploidized clone 44-6 of *Brachiaria ruziziensis* and the tetraploid apomictic *B. decumbens* cv. Basilisk. Molecular studies showed that Mulato II has alleles present in the sexual mother *B. ruziziensis,* in *B. decumbens* cv. Basilisk and in lines of *B. brizantha* including cv. Marandu. In the year 2000, CIAT granted to the Mexican seed company Papalotla S. A. exclusive rights to seed multiplication and commercialization of this hybrid, maintaining the intellectual property rights of the hybrid. Cultivar Mulato II is a semi-erect tetraploid (2n=4x=36 chromosomes), perennial apomictic grass. The stems are cylindrical, highly pubescent and vigorous; leaves are lanceolate and have intense green color; the inflorescence is a panicle with 4 to 6 racemes with double rows of spikelets, which, at anthesis, show cream-white stigmas. Agronomic studies carried out at different locations showed that cv. Mulato II grows well from sea level to 1800 m.a.s.l. in humid tropic environments, and in sub-humid sites with 5 to 6 dry months and annual rainfalls above 700 mm. Also, good

growth of the grass has been reported in subtropical environments such as in Canelones state (Uruguay) where periodic frosts occurs. Cultivar Mulato II performs well in acid, well drained soils, although the grass tolerates moderate (but not permanent) waterlogging conditions. The grass is readily established by seed, but vegetative propagation is also possible using rooted cuttings. Flowering is abundant and well synchronized with acceptable levels of caryopsis formation, which leads to relatively good seed yields that range from 150 to 420 kg/ha of good quality pure seed. Seed yield is related to production site, crop age, management and harvest method. Forage yield of cv. Mulato II depends on the characteristics of the site, and may range from 10 to 27 t DM/ha/year; 20% of this yield may be produced during the dry season. The grass responds well to fertilization, particularly to nitrogen. Hence, split annual fertilizations with 100 to 150 kg/ha of urea and 50 kg of phosphorous may be convenient depending on the native fertility of the soil. Cultivar Mulato II has antibiotic resistant to several spittlebug species such as *Aeneolamia reducta, A. varia, Zulia carbonaria, Z. pubescens, Prosapia simulans, Mahanarva trifissa, Deois flavopicta, D. schach* and *Notozulia entreriana.* The resistance of the grass to fungal foliar diseases is moderate and superior to that observed in cvs. Marandu and Mulato. Forage quality of cv. Mulato II is high compared to other tropical grasses. Percentages of CP ranging from 8 to 16%, and in vitro dry matter digestibility from 55 to 66% for forage samples with 25 to 30 days of re-growth during the wet period have been reported. Animal (bovine) intake of the grass is high, which results in significantly greater milk production compared with other *Brachiaria* cultivars such as cvs. Toledo and Mulato. It is also possible to produce good quality hay from cv. Mulato II.

Introduction

Although species of *Brachiaria* are the grasses most commonly found in extensive pasturelands of tropical Latin America, there are still areas with acid soils of low fertility and poor drainage or that suffer periodic flooding where the establishment of improved cultivars of this type is slow and their use is limited (Miles et al., 2004). These areas are also characterized by adverse topographic and climatic conditions and high pest and disease incidence with predominance of extensive management systems in degraded pastures. In view of the high negative impact of this condition on livestock productivity in the tropics, the Tropical Forages Program of the International Center for Tropical Agriculture (CIAT), headquartered in Cali, Colombia, launched a project to develop new *Brachiaria* cultivars with a broad range of adaptation, high nutritive quality and forage production, and good-quality seed. Cultivar (cv.) Mulato (*Brachiaria* hybrid CIAT 36061) was the first cultivar released as a result of this undertaking. Although it requires soils of medium to high fertility, Mulato presents tolerance to drought, fast recovery after grazing, high plant vigor, and very good forage quality (Argel et al., 2005).

Cv. Mulato II (*Brachiaria* hybrid CIAT 36087) is the second commercial hybrid released by the CIAT Tropical Forages Project, in collaboration with other research institutions. This cultivar, in addition to having the outstanding characteristics of Mulato, adapts well to a broad range of localities, including those with acid soils of low fertility and moderate moisture saturation. It has also showed resistance to several species of spittlebugs found in Colombia and Brazil, although it is moderately susceptible to leaf fungi such as *Rhizoctonia solani*.

This brochure presents the findings of ongoing or completed agronomic adaptation and animal production studies conducted with Mulato II in the tropical lowlands of China, Thailand, Mexico, Colombia, Venezuela, Bolivia, Uruguay, Brazil, and several Central American countries, particularly Panama.

Origin

Cultivar Mulato II is the result of three cycles of hybridization and screening carried out by CIAT's Tropical Forages Project. Crosses were initiated in 1989 between *B. ruziziensis* R. Germ. & Evrard clone 44-6 (sexual tetraploid) x *B. decumbens* Stapf cv. Basilisk[1] (apomictic tetraploid). Sexual progenies of this first cross were submitted to open pollination to generate a second generation of hybrids, from which a sexual genotype identified with code SX94NO/0612 was selected for its superior agronomic characteristics and crossed again, using the same open pollination procedure, with a series of *B. brizantha* accessions and apomictic and sexual hybrids. A progeny clone, FM9503/S046/024, was selected visually in 1996, for its vigor, productivity, and leafiness. Progenies of this clone confirmed its apomictic reproduction, and results with molecular markers (microsatellites) showed that it has alleles that are present in the sexual mother *B. ruziziensis*, in *B. decumbens* cv. Basilisk, and in *B. brizantha* accessions, including cv. Marandu.

Based on CIAT germplasm classification standards, this clone was subsequently identified as *Brachiaria* hybrid accession CIAT 36087. In the year 2000, CIAT granted the Mexican company Semillas Papalotla S. A. de C. V. the exclusive rights to multiply and market this hybrid, which was released in 2005 as cv. Mulato II.

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[1] Cv. Basilisk is also known as cv. Chontalpo in Mexico, cv. Señal in Australia, cv. Pasto Peludo in Costa Rica, cv. Barrera in Venezuela, and cv. Pasto Amargo in Colombia.

Morphological Description

Mulato II is a perennial, tetraploid hybrid (2n=4x=36 chromosomes), with a semi-erect growth habit, reaching heights up to 1 m. Its stems are strong, cylindrical, and pubescent; some present semi-decumbent growth habit and are capable of rooting when they come into close contact with the soil, either because of the effect of animal trampling or because of mechanical compaction. In general, however, Mulato II is less decumbent and shorter than the comparable Mulato. For example, in the subhumid tropics of Costa Rica, average plant height 4 months after establishment was significantly greater ($P < 0.05$) in Mulato (73.5 cm) than in Mulato II (44.9 cm). Nevertheless, soil cover was similar for the two cultivars (CIAT, 2004). Similar results have been reported in the humid tropical conditions of Huimanguillo (State of Tabasco, Mexico) in grazed paddocks that have been fertilized with nitrogen and phosphorus (Guiot, 2005a) (Photo 1). The dark green leaves of Mulato II are linear-triangular (lanceolate) in shape and approximately 3.8 cm wide. Although both sides of the leaf blade present abundant pubescence, this pubescence is shorter and less dense than that observed in Mulato. Leaf sheath pubescence, however, is similar for both cultivars. The ligule is short and membranous.

Photo 1. Initial tillered growth of *Brachiaria* hybrid cv. Mulato II (insert) and total soil coverage in grazed paddocks fertilized with nitrogen and phosphorus in Huimanguillo, Mexico.
SOURCE: Jorge Guiot.

The inflorescence of Mulato II consists of a panicle with 4-6 racemes with a double row of spikelets, which are around 5 mm long and 2 mm wide. Stigmas are cream-white in contrast with Mulato (and all other cultivars of *Brachiaria*) that presents dark red stigmas, as illustrated in Photo 2 (Loch and Miles, 2002).

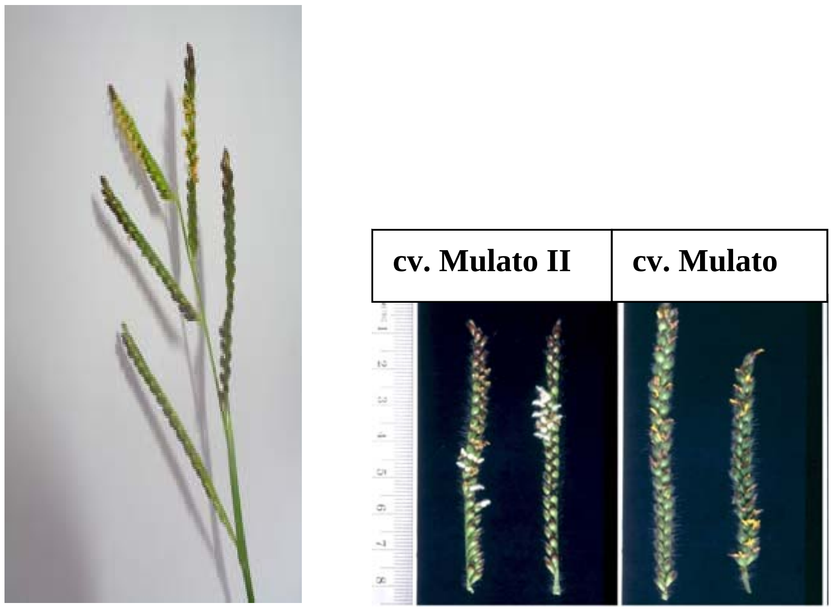

Photo 2. Panicle of *Brachiaria* hybrid cv. Mulato II, with inserts detailing racemes with cream-white stigmas (Mulato II) and dark red stigmas (Mulato).
SOURCE: CIAT

Forage Adaptation and Production

The range of adaptation of Mulato II is similar to that reported for Mulato, which grows well from sea level up to 1800 m above sea level in the humid tropics with high precipitation, and in subhumid conditions with 5-6 dry months and an annual precipitation over 700 mm.

This cultivar adapts well to poor, acid soils with high aluminum (Al) content, such as the Oxisols found in the Eastern Plains of Colombia, an area with dry periods lasting 3-4 months, where Mulato II has presented forage yields similar to those reported for *B. brizantha* (cv. Marandu) and *B. decumbens* (cv. Basilisk), and much higher than those of Mulato in conditions of both high and low soil fertilization (CIAT, 2004). The absorption of nutrients (N, P, K, Ca, Mg) by aerial parts was similar for cultivars Mulato II and Marandú and much higher than that observed for cv. Basilisk.

In 2004, Mulato II produced 19 t DM/ha (3.7 t/ha during the dry season and 15.6 t/ha during the 8-month rainy season) in a sandy clay loam Inceptisol (pH = 4.6, OM = 4%, P = 2 ppm, Ca = 0.3 meq/100 g, Mg = 0.1 meq/100 ml) in Gualaca, Panama, located at 70 m.a.s.l. In 2005, however, yields decreased to 5.2 t/ha because of the excessive precipitation (> 3000 mm) at the site. Mulato yielded slightly less than Mulato II (IDIAP, 2006).

Mulato II, cut every 4 or 6 weeks over a 2-year period, presented DM yields (2.3 t/ha) that were slightly higher than those of cv. Toledo (2.2 t/ha) or Mulato (2.1 t/ha) on a well-drained Inceptisol of medium fertility (pH 5.4) in Guápiles, Costa Rica, located at 250 m.a.s.l. with very moist tropical conditions (4620 mm/year) and 24.6 °C mean annual temperature. The incidence of pests and leaf diseases in Mulato II was also less than that observed in other hybrids assessed (Hernández et al., 2006).

The adaptation and forage yield of Mulato and Mulato II were evaluated on sandy clay loam soils (pH = 5.2, low OM = 1.5%-2.1%, low P = 3.4-5.1 ppm) in Sahagún (Córdoba) and Sincelejo (Sucre), located at 160 m.a.s.l. on Colombia's Caribbean Coast. At 90 days after establishment, better soil cover was observed at both sites for Mulato than for Mulato II, which can be attributed to the more tillered initial growth of the latter (Hugo Cuadrado, per. com.). Forage yields have been slightly superior in Sincelejo.

In the humid tropics of Huimanguillo, Mexico, Mulato II yielded 3.9 t DM/ha per harvest with an annual fertilization of 150 kg N and 50 kg P/ha. This yield was similar to that of Mulato under the same conditions (Guiot, 2005a).

On terraced land and in hillside areas of Colombia's Amazon piedmont region, which are characterized by acid soils (pH 4.6), low P (1.7 ppm) and high Al contents (3.2 ppm), Mulato II yielded, on average, 2.6 t DM/ha every 90 days. Mulato II in association with *Arachis pintoi* cv. Mani Forrajero presented a higher forage yield (3.5 t DM/ha) than the grass alone (Velásquez and Muñoz, 2006). In this case, plots were fertilized at planting with 50 kg diammonium phosphate and 46 kg N/ha.

Forage production of Mulato and Mulato II was assessed in subhumid tropical conditions in Atenas, Costa Rica (420 m.a.s.l., 9º 57' N latitude and 84º 24' W longitude), over an 18-month period. Plots were cut at 5-week intervals during the rainy season and at 8-week intervals during the dry season. The soil was an Inceptisol of medium fertility (pH = 5.9, OM = 7.6%, P = 3.6 ppm). Mulato II produced more forage DM than Mulato in both the dry (0.97 versus 0.75 t/ha) and the rainy seasons (1.9 versus 1.8 t/ha) (Figure 1). In this trial, the leaf:stem ratio of Mulato II (2.78) was higher than that of Mulato (2.03) ($P < 0.05$).

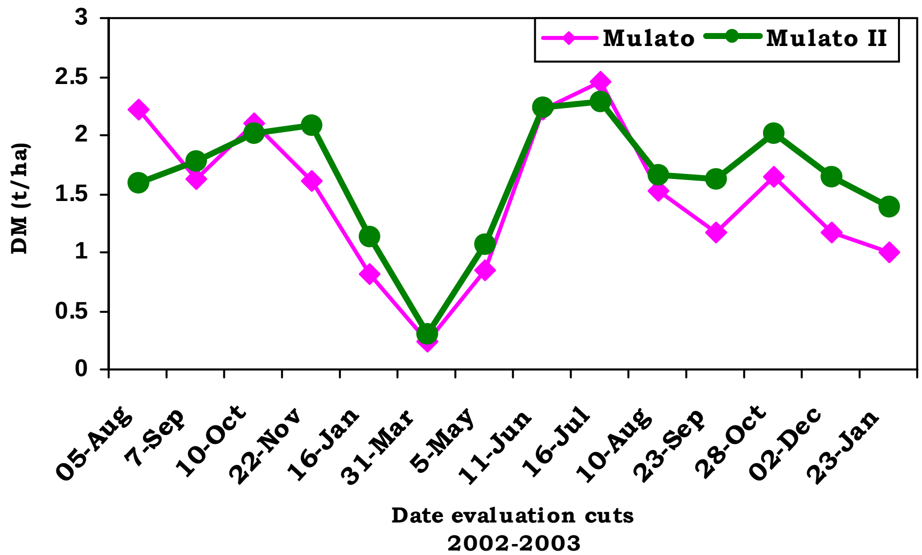

Figure 1. Forage yield (t DM/ha per cut) of *Brachiaria* hybrids cvs. Mulato and Mulato II during the rainy (May—November) or the dry (December—April) seasons on an Inceptisol of Atenas, Costa Rica

SOURCE: CIAT, 2004.

An important characteristic of Mulato II is its tolerance to prolonged periods of drought (up to 6 months), as demonstrated by the results of agronomic studies conducted over a period of 4.5 years in the Eastern Plains of Colombia. During a 4-month dry season, *B. brizantha* cv. Toledo (CIAT 26110) and Mulato II were the grasses that consistently maintained a large amount of green leaves, with both low and high fertilizer application rates. Mulato II performed better than Mulato and *B. decumbens* cv. Basilisk (CIAT, 2006). Similarly, the performance of this cultivar was outstanding in the Brazilian *cerrados* owing to its tolerance to drought (Esteban Pizarro, per. comm.).

The company Estero S.A. is currently evaluating cultivars of *Panicum maximum*, *Digitaria eriantha*, *Paspalum*, and the new *Brachiaria* hybrids cvs. Mulato and Mulato II under the temperate conditions of Uruguay. Work is still in an initial stage but the potential of these tropical forages is evident in regions different from those of their natural habitat and their typical area of influence. Cultivars of *P. maximum* and hybrids of *Brachiaria* have notably surpassed the forage production of species adapted to subtropical conditions, such as *Digitaria eriantha, Chloris gayana* cv. Finecut, *Paspalum notatum* cv. Tifton 9, *P. dilatatum, P. notatum* cv. Pensacola, or *Festuca arundinacea.*

Mulato II has been observed to recover acceptably after frosts at the El Pedregal Experiment Station in the department of Gargoyles, Uruguay (Photo 3) (Esteban Pizarro, per. com.).

Likewise, Mulato II shows good adaptation to soils, pest and disease tolerance, and recovery after burning in localities such as Yapacaní, Bolivia. The latter characteristic is important because the persistence of this grass can be guaranteed in areas where burning is a common pasture management practice or where burnings occur accidentally (Photo 4).

Other important characteristics of Mulato II are its tolerance to moderate shade, its superior growth along living fences and, although it does not tolerate permanent water logging, it does adapt better to areas with deficient or poor drainage than cv. Mulato or cv. Marandu.

Photo 3. *Brachiaria* hybrid cv. Mulato II after a frost at the El Pedregal Experiment Station (Gargoyles, Uruguay).
SOURCE: Esteban Pizarro.

Photo 4. *Brachiaria* hybrid cv. Mulato II after burning in Yapacaní, Bolivia.
SOURCE: Esteban Pizarro.

Establishment

Mulato II is readily established by seed, and the emerging seedlings present vigorous growth. Pastures can be ready for grazing between 90 and 120 days after planting, with over 80% cover. The grass can also be established using vegetative material, but in this case it is recommended to select rooted stock to improve establishment success. Vegetative planting is usually more expensive than sowing botanical seed, although this depends on the local cost of labor and the price of commercial seed. Botanical seed can be broadcast, hill-plot planted (using a long stick tapered at one end or the tip of a machete), or drilled in rows spaced 0.50-0.70 m apart, on land either prepared conventionally with plow and harrow or following control of existing vegetation using a machete or non-selective herbicide.

Seeding rate varies according to seed quality, especially regarding percentages of purity and germination. Broadcast planting requires higher seeding rates because many seeds are left in the open and are easily attacked by predators such as birds or ants, or simply do not have the moisture conditions required for germination. In these cases, a rate of 5-6 kg/ha of seed with a minimum cultural value of 60% is recommended, which means seed with, e.g., 80% purity and 75% germination. Hill-plot planting or drilling requires smaller amounts of seed than broadcast plantings.

The current trend is to offer pelleted commercial seed of *Brachiaria* cultivars, which consists in coating the seed, generally following scarification with sulfuric acid, with finely ground materials that improve seed flow, increase weight, provide several nutrients, and protect the seed against predators. The substances used in the pelleting process are usually hygroscopic and, as such, favor an adequate supply of moisture to the germinating seed. As a direct result of this practice, livestock producers can obtain better quality commercial seed. For example, 88% germination and 100% purity have been obtained with pelleted seed of Mulato II, increasing its cultural value.

The number of seeds per kilogram is lower when seed is pelleted—1 kg contains 130,000 non-pelleted seeds of Mulato II but only 52,000 pelleted seeds. Under adequate soil moisture conditions, it is not necessary, however, to increase the seeding rate per unit area to have a well-established pasture because of the better seedling emergence of pelleted seeds.

Response to Fertilization

Mulato II shows good response to fertilization, particularly to the application of nitrogen. Depending on the level of soil fertility, one or more maintenance applications may be required per year to maintain high yields of good quality forage. In Atenas, Costa Rica, the forage yield of Mulato II was significantly higher ($P < 0.05$) than that of Mulato (2.6 versus 1.9 t DM/ha per harvest) with an application of 30 kg N/ha every 30 days for a total of four applications, during the rainy season for a total of 120 kg N/ha per year.

The best results have been obtained with three applications of N, particularly in the case of Mulato II, which has increased DM yields from 2.2 t/ha per cut with one application of N to 3.1 t/ha per cut with three applications of N ($P < 0.05$) (CIAT, 2007). In addition to the application of N, in soils of low and medium fertility it is necessary to regularly apply other nutrients such as P, K, Ca, and Mg.

Tolerance to Pests and Diseases

Both controlled greenhouse tests and field observations have demonstrated that Mulato II presents antibiotic resistance[1] to the spittlebug species *Aeneolamia reducta, A. varia, Zulia carbonaria, Z. pubescens, Prosapia simulans*, and *Mahanarva trifissa* (CIAT, 2005). It has also showed in Brasil, through tests made by EPAMIG[2] and UFV[3] in Viçosa/MG, using the same methodology from CIAT, resistance to several species found, including *Deois flavopicta,*

[1]Which is to say, the host plant exerts a negative effect on the development and fertility of the insect feeding on it.
[2]Empresa de Pesquisa Agropecuária do Estado de Minas Gerais, Brazil
[3]Universidade Federal de Viçosa, Brazil

D. schach, and *Notozulia entreriana* (Franco, 2006). This type of resistance is one of the most desirable characteristics of Mulato II because spittlebugs are the most common and most damaging pests of *Brachiaria* species and other tropical forage species.

Similarly, Mulato II has been observed to be moderately susceptible to damage by *Rhizoctonia solani,* a foliar fungus that causes significant damage to Mulato, particularly during those times of the year with high relative humidity and high temperatures (Argel et al., 2006).

Seed Production and Quality

In the northern hemisphere, Mulato II initiates flowering at the beginning of October, i.e., the end of the rainy season, which is similar to *B. brizantha* cv. Toledo but later than other *Brachiaria* cultivars such as *B. brizantha* cv. Marandu, *B. decumbens* cv. Basilisk, and *B. humidicola* (cv. Brunca in Costa Rica, cv. Gualaca in Panama, and cv. Llanero in Colombia). Cultivars of *B. humidicola* flower at the beginning or middle of the rainy season, lowering the quality of the forage on offer due to the low leaf:stem ratio and the proliferation of floral stems. The growth of Mulato II is completely vegatative during this period of the year and, as a result, it offers cattle more stable grazing during the rainy season.

Mulato II produces numerous panicles with good synchronization of flowering and acceptable seed fill (caryopsis formation), which results in its seed yields being higher than those of Mulato (CIAT, 2007). Table 1 presents the results of evaluations of Mulato II, 1 year after establishment, in Atenas, Costa Rica. The date of closing cut had a significant effect ($P < 0.05$) on seed yield, plant height at harvest, and panicle size. At this site, where rains start in May, the July cut produced the highest yields (330 kg seed/ha) as compared with the first cut in June (179 kg/ha). Although the date of cut did not affect seed purity or seed weight, the latest cut (July) delayed the initiation of flowering by 10 days, to 17 October, whereas the pastures cut in June flowered by 7 October. Seed harvest was performed manually on 1 November for the first uniformity cut and on 7 November for the second.

The effect on seed yield of level of N (0, 50, 100, 150, or 200 kg/ha), applied on 1 September, was also evaluated. A trend toward higher yields was observed with increasing N rate, although the differences were not significant ($P > 0.05$). The interaction of the date of closing cut with N levels was not significant in terms of seed yield or number of floral stems (293/ m^2, on average). However, stem lodging was notable for the June cut, hindering manual harvest and forcing greater manipulation of spikes. This,undoubtedly increased the loss of spikelets, which could explain the lower seed yields obtained for that date of cut. The shorter plants, which did not present problems of lodging, favored manual harvest of seeds in July.

Table 1. Effect of time of uniformity cut on average seed yield, plant height, panicle length, and seed quality of *Brachiaria* hybrid cv. Mulato II in Atenas, Costa Rica (CIAT, 2007).

Date of cut	Pure seed (kg/ha)	Plant height (cm)	Panicle length (cm)	Seed purity (%)	100-seed weight (g)
15 June	179 a*	95 a	32 a	46 a	0.8 a
	(163–187)[a]	(91–98)	(31–32)	(41–53)	(0.7-0.8)
15 July	330 b	87 b	37 b	51 a	0.8 a
	(299–365)	(77–94)	(36–38)	(38–55)	(0.7-0.8)

* Average in the same column followed by different letters differ significantly (P < 0.05).
a. Range of average values within parentheses.

Forage Quality

The feeding value of a grass, particularly if related to percentages of crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF), as well as in vitro dry matter digestibility (IVDMD), depends on the age and the plant part that is analyzed, the time of year, and soil fertility conditions. At the CIAT Experiment Station in Santander de Quilichao, Colombia, characterized by poor, acid Ultisols (pH = 5.1, 64% aluminum saturation, P = 1.8 ppm), Mulato II presented significantly higher percentages (P < 0.05) of CP than cv. Toledo or Mulato in both the rainy and the dry seasons (Table 2). In this case paddocks were fertilized with 50 kg/ha N and submitted to a stocking rate of 3 cows/ha (CIAT, 2006). The forage on offer did not differ among *Brachiaria* cultivars, but Mulato II

Table 2. Forage availability and quality (crude protein and in vitro digestibility) of *Brachiaria* cultivars grazed by dairy cows in two contrasting periods of the year in Santander de Quilichao, Colmbia (CIAT, 2006).

Cultivar	Forage on offer (kg DM/ha)	CP (%)	IVDMD (%)
Rainy season			
Toledo (check)	2905 (58)[a]	9.1 b*	66.6
Mulato	2666 (60)	9.7 b	67.2
Mulato II	3042 (58)	11.4 a	66.3
Significance	ns	P < 0.05	ns
Dry season			
Toledo (check)	3082 (78)*	7.4 b	57.9
Mulato	2815 (48)	7.5 b	61.1
Mulato II	3269 (52)	8.4 a	61.0
Significance	ns	P < 0.05	ns

* Means within season and column followed by different letters differ significantly (P<0.05).
a. In parentheses, the proportion of green leaf in the forage on offer.

showed a trend toward greater production compared with the other cultivars, regardless of the time of year. Similarly, no difference among cultivars in forage digestibility was observed and, as expected, digestibility of all cultivars decreased in the dry season.

At this same experiment station in Quilichao, Mulato II has also shown adequate mineral contents when fertilized with N (Table 3). Year-round, this cultivar presents calcium (Ca) contents that are higher than those of cv. Toledo or Mulato and, during the period of minimum precipitation, it surpasses cv. Toledo in phosphorus (P) content (CIAT, 2006). The contents of other minerals, such as sulfur (S), potassium (K), and magnesium (Mg), are similar among the evaluated cultivars, except in the case of Mg, which is higher ($P < 0.05$) in Mulato II during the rainy season.

Table 3. Leaf tissue mineral composition of *Brachiaria* cultivars grazed by dairy cows in contrasting seasons in Santander de Quilichao, Colombia (CIAT, 2006).

Cultivar	Ca (%)	P (%)	S (%)	K (%)	Mg (%)
Rainy season					
Toledo (check)	0.33 b*	0.22	0.14	1.68	0.34 b
Mulato	0.49 a	0.19	0.11	1.82	0.37 b
Mulato II	0.54 a	0.24	0.14	1.56	0.44 a
Significance	P < 0.05	ns	ns	ns	P < 0.05
Dry season					
Toledo (check)	0.39 c	0.17 b	0.11	1.57	0.32
Mulato	0.47 b	0.20 ab	0.10	2.24	0.35
Mulato II	0.52 a	0.25 a	0.13	1.62	0.43
Significance	P < 0.05	P < 0.05	ns	ns	ns

* Means within season and in the same column followed by different letters differ significantly ($P < 0.05$).

IVDMD values between 55% and 62% and CP values between 12% and 16% have been reported in 25- to 35-day regrowth of Mulato II in Mexico (Guiot, 2005a). Tissue mineral contents (in parenthesis) were as follows: P (0.19%), Ca (0.26%), Mg (0.39%), and S (0.07%) (Guiot, 2005a). In the Colombian localities of Sahagún (Córdoba) and Sincelejo (Sucre), DM values of 25% and 29% were reported, respectively, for Mulato and Mulato II at 30 days regrowth. CP contents, however, were similar for the two cultivars (8.6%) (Hugo Cuadrado, per. com.).

Animal Production

Milk

The good forage quality of Mulato II and its high animal intake result in higher milk production of crossbred cows grazing this hybrid as compared with other *Brachiaria* cultivars (Table 4). Results obtained by CIAT's Tropical Forages Project in Santander de Quilichao, Colombia, show that cows grazing Mulato II produced 11% more milk during the dry season and 23% more during the rainy season as compared with pastures of *B. decumbens* cv. Basilisk and *B. brizantha* cv. Toledo (CIAT, 2004).

Table 4. Milk production of crossbred cows grazing different *Brachiaria* cultivars in Santander de Quilichao, Colombia (CIAT, 2004).

Cultivar	Milk production (kg/cow per day)	
	Dry season	Rainy season
Basilisk	5.4 b*	5.1 b
Toledo	5.5 b	5.5 b
Mulato II	6.0 a	6.5 a

* Values with different letters are statistically different (Tukey, P < 0.05).

Subsequent evaluations at the same site showed that supplementing cows with hay of the legume *Lablab purpureus* did not affect daily milk production but the type of pasture did have a significant effect (P < 0.05). Once again the superior quality of Mulato II was reflected in higher milk yields (Table 5). The effect of the legume supplement or pasture type did not affect the other milk components measured (fat and non-fatty solids) (CIAT, 2005).

Table 5. Effect of supplementation with hay of the legume *Lablab purpureus* and type of pasture (cultivar) on milk production and composition of crossbred cows in Santander de Quilichao, Colombia (CIAT, 2005).

Treatment	Milk (kg/cow per day)	Fat (%)	Not-fatty solids (%)
Suplementation			
Without *L. purpureus*	7.7 ns	4.3	9.1
Without *L. purpureus*	8.0 ns	4.0	8.7
Cultivar			
Toledo	7.9 b*	3.9	8.8
Mulato	7.5 b	4.2	8.9
Mulato II	8.3 a	4.3	8.9

* Values with different letters are statistically different (Tukey, P < 0.05).

In Tabasco, Mexico, Brown Swiss cows grazing Mulato II produced 12% more milk than those grazing Mulato, in a rotational grazing system of 1 day grazing and 23 days rest (10.9 versus 9.7 kg milk/day, respectively). The stocking rate was 4 cows/ha, and paddocks received an annual fertilization of 150 kg N and 50 kg P/ha. Evaluations were conducted for 3 consecutive years and CP contents ranged between 16% and 20% for Mulato and 19% to 21% for Mulato II (Guiot, 2005a).

Figure 2 shows that the monthly milk production of cows grazing Mulato II at this site was consistently higher than that of cows grazing Mulato throughout 2005, except in April. Differences in production due to the effect of the pasture were significant in January, March, May, July, and September.

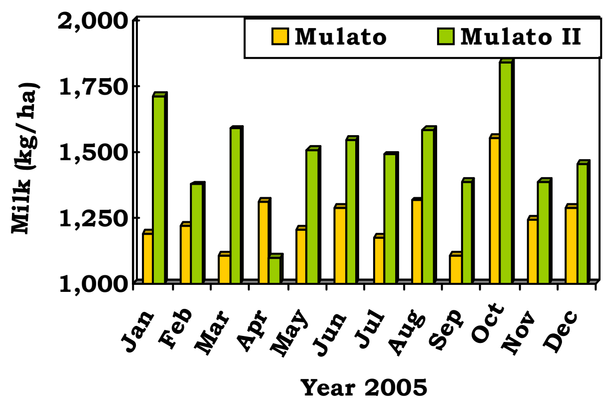

Figure 2. Monthly milk yields of Brown Swiss cows grazing fertilized pastures of *Brachiaria* hybrid cv. Mulato or Mulato II in Huimanguillo (Tabasco, Mexico).
SOURCE: Guiot, 2005b.

Meat

Few studies have been designed to measure the meat production of cattle grazing pastures of Mulato II. One such study is underway at the Carlos Ortega Experiment Station of the Instituto Panameño de Investigación Agropecuaria (IDIAP) in Gualaca, Panama. The liveweight gain of animals was measured in two rotational systems: 3 days occupation/21 days rest and 7 days occupation/21 days rest (IDIAP, 2006). Initial results show a higher daily liveweight gain (g/animal per day) and a slightly higher stocking rate with the first system (611 g and 3.5 AU/ha) as compared with the second (534 g and 3.2 AU/ha).

Use and Management

As with other *Brachiaria* cultivars, Mulato II is mainly used for grazing beef cattle or crossbred dairy cows in dual-purpose systems. Nevertheless, because of its high forage quality and production capacity, it's a good alternative for preparing silage and hay. On one farm in the Eastern Plains of Colombia, hay was made from Mulato II sown in a field where maize had been planted for 3 consecutive years, with a high level of fertilization. In this case, the vigor of the grass was excellent indicating a good use of the residual fertilizer applied to the crops. Hay yield, 70 days after establishment, was 72 bales, each weighing 500 kg, per ha (Photo 5) (Camilo Plazas, per. com.).

These initial results indicate that grass-crop (or crop-grass) rotation systems have high production potential in this region, where commercial maize and soybean cultivars adapted to acid soils and forage species such as the new *Brachiaria* hybrids, very efficient in the use of residual fertilizer applied to annual crops, are already being grown.

Photo 5. Bales of hay, each weighing 500 kg, made with *Brachiaria* hybrid cv. Mulato II established after annual crops of maize in the Eastern Plains of Colombia.
SOURCE: Pedro J. Argel.

The initial upright growth habit of Mulato II favors association with stoloniferous legumes such as *Arachis pintoi* cv. Mani Forrajero. Photo 6 shows this association in one pasture in Olanchito, Honduras, grazed by cows in a rotational system consisting of 1 day occupation and 21 days rest (Conrado Burgos, per. com.). In Inceptisols of Turipaná (Córdoba, Colombia), an excellent association was observed between Mulato II and native legumes of the genera *Teramnus, Centrosema*, and *Desmodium* (Hugo Cuadrado, per. com.).

Photo 6. Mulato II in association with forage peanut in a dual-purpose farm in Olanchito, Honduras.
SOURCE: Pedro J. Argel.

Attributes of Mulato II in comparison with Mulato and Other *Brachiaria* Cultivars

Brachiaria hybrid cv. Mulato II has several characteristics that make it superior to Mulato and other commercial cultivars of *Brachiaria*. However, it also has several limitations that seed producers and sales companies should be aware of before deciding to adopt this cultivar or when making decisions about sowing and management practices, depending on the type of farm. Table 6 summarizes the main characteristics of both *Brachiaria* hybrids as well as cv. Marandu—currently the best-selling grass in the tropical America.

Table 6. Comparative characteristics of *Brachiaria* hybrids cvs. Mulato and Mulato II and cv. Marandu.

Characteristic	Cultivar		
	Mulato	Mulato II	Marandu
Tolerance to drought	Very good	Very good	Good
Tolerance to water logging	Very poor	Poor	Poor
Tolerance to shade	Good	Good	Good
Tolerance to burning	Good	Good	Good
Tolerance to Rhizoctonia leaf blight	Poor	Intermediate	Poor
Tolerance to the spittlebug	Tolerant	Resistant	Resistant
Recovery following defoliation	Fast	Fast	Moderate
Forage quality	Very good	Very good	Good
Synchronization of flowering	High	High	Low
Seed quality	Good	Good	Good
Establishment by seed	Easy	Easy	Easy
Seedling vigor	High	High	Intermediate
Compatibility with forage legumes	Good	Good	Good
Soil requirements	Medium-high fertility	Medium-high fertility	Medium fertility

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