Harvest methods and seed yield potential in *Brachiaria* hybrids

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Abstract

Until 2000, *Brachiaria* spp. cultivars were derived without genetic modification directly from natural germplasm collected in Africa. A breeding program was initiated at CIAT in 1988. Trials demonstrated the superiority of Mulato II, a vigorous, semi-erect grass with very deep and branched roots giving it excellent drought resistance. Mulato II has excellent nutritional value: CP is in the range of 14 to 22% and IVDMD from 55 to 65%. These values, similar to temperate grasses, are unusual in warm-season grasses. Seeds yields are encouraging and are related with management, harvest methods, and geographical locations.

Introduction

Until 2000, *Brachiaria* spp. cultivars were derived without genetic modification directly from natural germplasm collected in Africa.

A breeding program, based on sexual germplasm kindly provided by C.B. do Valle (EMBRAPA-CNPGC), was initiated at CIAT in 1988, to combine desirable attributes found in accessions of *B. brizantha* and *B. decumbens*. (Miles *et al*., 2004).

Since the release of cv. Mulato II, a series of agronomic experiments have been conducted. Trials, demonstrated the superiority of Mulato II, a vigorous, semi-erect grass with very deep and branched roots giving it excellent drought resistance, confirmed by results in the Brazilian Cerrado, Central America, Mexico, Asia, as well as in the Argentine Chaco (Pizarro *et al*., 2008). Mulato II is the most innovative alternative to improve ruminant livestock productivity in the tropics (Pizarro *et al*., 2008).

Mulato II has the potential to produce in excess of 500 kg ha^{-1} of pure seed, as evidenced by experiments where an effort is made to recover all pure seed produced, either by bagging inflorescences or by opportune recovery of fallen seed (Hare *et al*., 2007c; Chávez Chena *et al*., Personal communication). How much of this potential is realized in practice will depend on many factors, including harvest method.

Choosing an appropriate method for seed harvest depends firstly on the particular species, especially its growth habit and seed structure, the synchrony of crop development and relative amounts of standing and fallen seed. Secondly, it depends on the availability of machinery or hand labor and finally, on previous experience.

Several methods are commonly used for harvesting forage grass seed. For the genus *Brachiaria* both manual and mechanized harvest has been employed. Mechanized harvest is further divided into direct heading and recovery of fallen seed.

Seed harvesting procedures used in *Brachiaria* hybrids: Manual harvesting

Thailand: (Field trials were conducted in Ubon Ratchathani province, Thailand (15^{o} N Lat., 130 masl, AAR 1538 mm).

Effect of time of planting on seed production of Mulato II (Hare *et. al*., 2007a)

Seven tiller planting dates were compared in a five replicate, randomized complete block field trial. Tillers with roots were divided from 1-yr-old Mulato II plants.

Table 1. Effect of time of planting Mulato II on seed yields and seed yield components

Time of planting	Inflorescences m^2	Racemes inflorescence	Spikelets raceme	Seed yield kg ha^{-1}
May 16	163	4.7	35.0	138
June 1	138	5.2	34.6	109
June 16	122	5.3	34.0	80
July 1	104	5.0	32.7	54
July 15	59	2.8	25.5	20
August 1	23	2.7	21.9	6
August 16	-	-	-	
LSD(P<0.05)	28	0.7	6.4	28

Planting earlier in the season produced higher seed yield as well as a greater numbers of inflorescences and seeds than subsequent plantings. Planting in August produced either very low seed yield (5 kg ha^{-1}) with low thousand seed weight, or no seed at all. Raceme and spikelet numbers were reduced when tillers were planted from mid-July onwards.

Effect of harvesting method on seed yield and seed quality of Mulato II (Hare *et al*., 2007c)

Four harvest methods were compared in a four-replicate, field experiment. In the first three methods, inflorescences were tied up into "living sheaves" and seed knocked into large cloth bags daily, twice daily, or on alternate days. For the fourth method, inflorescences were enclosed in mesh bags. In the fifth treatment, fallen seed was swept up from the ground.

Table 2. Effect of harvesting method on Mulato II seed yields and seed viability

Harvest method	Seed yield kg ha^{-1}	TSW g^{-1}	Seed viability %
Knocking daily	230	8.79	92
Knocking twice daily	271	8.68	92
Knocking 2 days	255	8.94	89
Nylon net bag	509	9.03	91
Ground sweeping	87	8.20	84
LSD P<0.05	73.2	0.38	5.8

The method of tying nylon net bags over the seed heads to collect seed produced the highest Mulato II seed yield, which was twice the yield than from the 3 methods of knocking seed heads. Sweeping Mulato II seed from the ground produced a much lower seed yield, lighter seed and seed with lower viability than other harvesting methods possibly owing to ant predation or seed rotting on the ground.

Yapakani – Bolivia (J. H. Antezana Rojas)

In Yapakani, (17º 4´ S – 53º 83´ W, 500 masl, AAR 1800 mm), Santa Cruz Province, Bolivia, farmers with limited capital have hand-harvested seed of cv. Mulato II, using sickles to sever seed heads above the leaf canopy. These are bound in sheaves and stacked in the field to "sweat". About two weeks later, the stokes are collected and threshed, normally by beating the seed out on a sheet with sticks.

Seed quality can be low (up to 80% dead seed with sweating and hand threshing, compared with only 30% with mechanized harvest). The dead seed is mainly due to overheating during sweating.

Recovery of fallen seed: Chiapas – Mexico: A. Chávez Chena, R. R. Ramón, A. Balbuena and I. G. Miranda

Field trials were conducted in Chiapas (15°27’ N - 92°16’ W, 2800 masl, AAR 2000 mm) for two consecutive years with four replications.

The recovery of fallen seeds can potentially collect a greater proportion of total seed yield than methods previously described which target the standing crop.

Moreover, the viability of seed recovered from the ground is normally high, because seeds are mostly mature when shattering occurs.

Table 3. Effect of the length of harvesting period on seed yield

Length of harvesting period days	Harvested pure seed kg ha $^{-1}$	
	Paraíso*	**Jacaranda II***
0	533a**	619a**
7	508a	713a
14	242b	581b
21	239b	542b
28	173b	593b
35	188b	422b
42	100c	344c
49	92c	281c
56	119c	212c
63	88c	110d

*Paraíso= 3 years crop; Jacaranda II=2 years crop. ** Values with different letter differ significantly ($P < 0.05$)

Seed fields are invariably rolled immediately after sowing to facilitate harvesting by the ground-sweeping methods. In some years, late crops are attacked by "honey dew" (an ergot caused by *Claviceps* spp.) thereby reducing yields and seed quality.

Although there are good seed yields in both areas, the field seed losses are significantly very high in a 60 days harvesting cycle. Mechanical sweeping need to be carried out within two to three weeks in order to recover at least 50% of the seed (Table 3).

Ground sweeping was not successful in Thailand in research trials. However, farmers in one village only use ground sweeping. Yields of over 500 kg ha^{-1} are common. In Brazil and Mexico, this method has been the predominant seed harvesting method of *Brachiaria* species for the past two decades, producing up to 700 kg/ha from either manual or machine sweeping.

We think that due to the length of the harvesting period, a lot of the seed is eaten by ants and perhaps a smaller amount rots on the ground. Brachiariagrass hybrid seeds are relatively soft when they shed and can be easily eaten by ants.

Moist conditions during harvest, from either rain or heavy dews, could contribute to brachiariagrass hybrid seed rotting on the ground.

Combine harvesting (J. H. Antezana Rojas)

Due to the fact that mechanical seed sweeping equipment is costly and the harvest season is very long and a significant amount of seed inevitably is left in the field, or carried away by ants, and perhaps a smaller amount rots on the ground, there is a renewed interest in combine harvesting brachiaria seed.

Direct headed seed is especially at risk because of its high initial moisture content (up to 50 - 60%), and rapid deterioration can occur if freshly harvested seed is left in moist unventilated bulk for more than a few hours, especially with small dense seeds that pack tightly.

In Bolivia, the trials carried out in Montero (17º 20´S - 63º 10´W, 300masl, AAR 1300 mm), the final yield was 100 kilogram pure seed per hectare. Further improvement can be achieved, since seed swept samples collected by hand from the ground after mechanical harvesting reached more than 350 kg pure seed ha^{-1}. New experiments are in the pipeline.

Discussion and perspectives

When the components of seed yield are examined it appeared that the number of inflorescences and seeds m^2 were the most critical components of yield. Planting early in the wet season, May or June (Northern Hemisphere), produced the most brachiariagrass hybrid seed in the current study.

Planting early enables farmers to cut forage from their seed crops before closing. The forage of the brachiariagrass hybrids cut before closing was of a very high quality in all trials, with a high proportion of leaf (55-60%) and a high leaf crude protein concentration that averaged over 15%.

The time of final closing date defoliation was found to be extremely important for seed production of brachiariagrass hybrids in Thailand (Hare *et al.*, 2007b) and Bolivia (J. H. Antezana Rojas, personal communication) as well as the length of the harvesting period as was evaluated in Mexico.

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