Phenotypic variation in waterlogging tolerance of *Brachiaria* genotypes

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Introduction

Brachiaria grasses are the most widely planted forages in the tropics. *Brachiaria* pastures during the rainy season occasionally face waterlogging conditions that severely limit pasture productivity and animal performance. Waterlogging drastically reduces oxygen diffusion into the soil causing hypoxia which is the main limitation that reduces root aerobic respiration and the absorption of minerals and water. Tolerance to waterlogging was evaluated in different *Brachiaria* grasses (Baruch, 1994; Dias-Filho and Carvalho, 2000; Dias-Filho, 2002; Rao et al., 2005). Dias-Filho et al. (2000) found that *B. brizantha* is intolerant, *B. decumbens* is moderately tolerant and *B. humidicola* (Bh) is tolerant to waterlogging. But Bh is of low forage quality. An on-going *Brachiaria* breeding program at CIAT is developing hybrids that combine the desirable attributes including spittlebug resistance, *Rhizoctonia* resistance, adaptation to major abiotic stress factors (acid soils, waterlogging, drought), forage quality and seed production. Reliable screening methods are needed to evaluate the *Brachiaria* hybrids. The main objective of this work was to evaluate phenotypic differences for waterlogging tolerance among two *Brachiaria* hybrid populations and to identify plant attributes that can be used as indicators for waterlogging tolerance.

Materials and Methods

Two experiments that evaluated differences to waterlogging tolerance among genotypes of two *Brachiaria* populations (one apomictic + sexual and one sexual) were conducted at the CIAT's forages patio area.

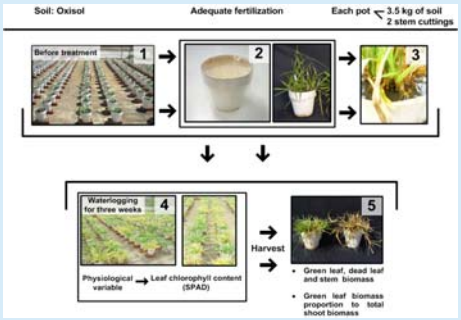

Figure 1. *Different phases for the induction of waterlogging treatment to evaluate tolerance of Brachiaria genotypes: (1) plants grown in pots for 50 days before establishing the waterlogging treatment; (2) pots lined with plastic bags; (3) waterlogging treatment established by applying excessive water to the pots (5 cm over soil surface); (4) Waterlogging treatment applied for three weeks; and (5) phenotypic differences in waterlogging tolerance.*

Table 1. *Genotypes, experimental design and condition of two Brachiaria populations.*

	Apomictic + sexual population	Sexual population
Genotypes	•48 apomitic hybrids •12 checks: CIAT 606, *B. ruz* 44-02, CIAT 6294, CIAT 679, CIAT 6133, CIAT 26110, CIAT 36061, CIAT 36087; BR02NO series/1372, 1485, 1752 and 1245.	•37 sexual hybrids •3 checks: CIAT 6294, CIAT 36061 and CIAT 26110.
Experimental design	•Randomized complete block •3 Replication	•Randomized complete block •5 Replication
Date	November 2006	August 2007
Temperature	Maximum 26.1 to 30.6 °C Minimum 16 to 20.2 °C	Maximum 27 to 31.4 °C Minimum 13.1 to 23.2 °C
Solar radiation	10.6 to 21.4 MJ m^{-2} d^{-1}	11.2 to 21.8 MJ m^{-2} d^{-1}

Results

For both *Brachiaria* hybrid populations, 7 days of waterlogging treatment induced chlorotic symptoms to most of the genotypes while 21 days of treatment caused mortality to several of them. Significant genotypic variability was observed in green leaf biomass production (Figure 2 and 3). Among genotypes tested, *B.dictyoneura* CIAT 6133 (check for apomictic + sexual population) and *B. brizantha* CIAT 26110 cv. Toledo (check for sexual population) were outstanding in waterlogging tolerance according to green leaf biomass production. The other two checks (used for both populations) *B. brizantha* CIAT 6294 and the hybrid cv. Mulato (CIAT 36061) showed lower level of waterlogging tolerance (Figure 3).

Three apomictic hybrids BR04/3069, BR04/3207 and BR04/2774 and three sexual hybrids SX05/1918, SX05/2043, SX05/2411 were superior in their production of green leaf biomass, green leaf biomass proportion to total shoot biomass and leaf chlorophyll content also than the others hybrids (Figure 2).

For all cases, genotypes that had greater amount of green leaf biomass and higher values of leaf chlorophyll content also showed less amount of dead leaf biomass (Figure 3). In general, the level of waterlogging tolerance in sexual population appeared to be lower than the apomictic + sexual population and this could be due to sensitivity of the sexual parent, Bruz 44-02 to waterlogging.

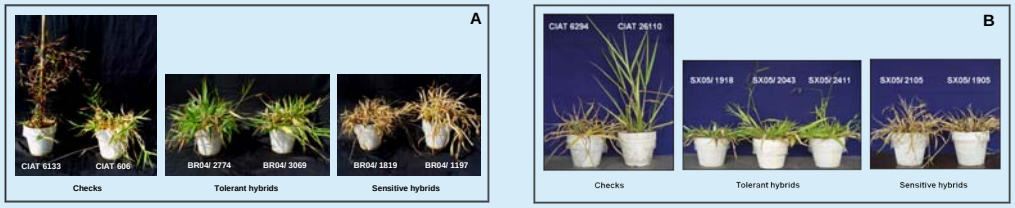

Figure 2 . *Influence of waterlogging on shoot growth at harvest time (21 days of waterlogging treatment). 2 checks, tolerant hybrids and sensitive hybrids. A = Apomictic + sexual population; B = Sexual population.*

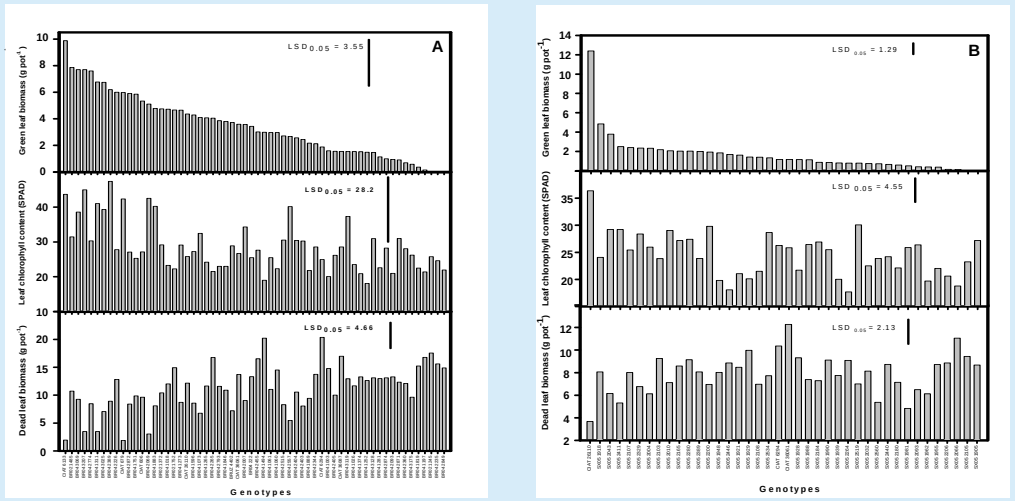

Figure 3. *Influence of waterlogging on phenotypic variation in green leaf biomass production (g pot $^{-1}$), leaf chlorophyll content (SPAD) and dead leaf biomass (g pot^{-1}). Plant attributes were measured at 21 days after waterlogging. LSD values are at the 0.05 probability level. A = Apomictic + sexual population; B = Sexual population.*

Table 2 *. Correlation coefficients (r) between green leaf biomass (g pot^{-1}) and other shoot traits of two Brachiaria populations grown under waterlogging in an oxisol from Santander de Quilichao, Colombia. A = Apomictic + sexual population; B = Sexual population.*

A

Plant traits	Waterlogging
Total chlorophyll content (SPAD)	0.649**
Dead leaf biomass (g pot^{-1})	-0.576**
Green leaf biomass proportion (%)	0.87***
Stem biomass (g pot^{-1})	0.028

B

Plant traits	Waterlogging
Total chlorophyll content (SPAD)	0.49***
Dead leaf biomass (g pot^{-1})	-0.33***
Green leaf biomass proportion (%)	0.94***
Stem biomass (g pot^{-1})	0.49***

*, **, *** Significant at the 0.05, 0.01 and 0.001 probability levels, respectively.

Conclusions

- We implemented a screening method to evaluate phenotypic differences in waterlogging tolerance in two *Brachiaria* hybrid populations.
- Three apomictic hybrids ((BR04/3069, BR04/3207 and BR04/2774) and three sexual (SX05/1918, SX05/2043 and SX05/2411) hybrids were identified as superior in waterlogging tolerance based on their greater values of green leaf biomass production, green leaf biomass proportion to total shoot biomass, leaf chlorophyll content and lower values of dead leaf biomass.
- The above four plant attributes could serve as criteria for evaluating waterlogging tolerance in *Brachiaria*.

References

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Acknowledgements

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