ADVANCES IN BREEDING APOMICTIC BRACHIARIA IN TROPICAL AMERICA

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ABSTRACT

Prior to 1988 *Brachiaria* improvement was based exclusively on the collection, introduction, and evaluation of natural germplasm from Africa. Breeding programs in *Brachiaria* have been possible only in the past 10 years with the creation of a sexual, tetraploid *B. ruziziensis* cross-compatible with *B. decumbens* and *B. brizantha*. Applied *Brachiaria* breeding projects are underway both in Colombia (International Center for Tropical Agriculture, CIAT) and Brazil (National Centre for Beef Cattle Research - Brazilian Corporation for Agricultural Research, CNPGC/EMBRAPA). These seek to combine the broad edaphic adaptation and other desirable agronomic attributes of *B. decumbens* cv. Basilisk with spittlebug resistance. An accumulation of basic biological knowledge of the plant has facilitated genetic manipulation. Significant genetic progress has been achieved. Major constraints to further progress in breeding *Brachiaria* include the cost and imprecision of evaluation methodologies.

KEYWORDS

Brachiaria, plant breeding, insect resistance, apomixis

INTRODUCTION

Widely sown commercial cultivars of *Brachiaria* spp. derive directly from natural germplasm accessions collected in east Africa (Keller-Grein, et al. 1996). Deficiencies of these cultivars are recognized: *B. decumbens* is susceptible to spittlebugs (Homoptera: Cercopidae), while the resistant *B. brizantha* cv. 'Marandú' is less persistent owing to poor edaphic adaptation.

The need for *Brachiaria* breeding has been recognized for at least two decades (Ferguson, 1974). Genetic recombination was hampered by apomictic reproduction of most *Brachiaria* spp. and by ploidy barriers between species. These obstacles have been largely overcome with the creation of a tetraploidized sexual biotype of *B. ruziziensis* (Swenne et al, 1981). Applied *Brachiaria* breeding projects are underway in Colombia (CIAT) and Brazil (CNPGC/EMBRAPA) (Valle and Miles, 1994; Miles and Valle, 1996). These seek to combine the broad edaphic adaptation and other desirable agronomic attributes of *B. decumbens* cv. Basilisk with spittlebug resistance.

ADVANCES

Inheritance of apomixis. Genetic control of apospory was studied in *Brachiaria* using completely sexual biotypes in crosses with compatible apomicts. Mode of reproduction was determined by analysis of embryo sacs (Young et al., 1979). A simple tetrasomic control is indicated (Table 1), with apospory dominant to sexuality. Observed ratios are compatible with random chromatid assortment. Selfed progeny of sexuals and sexual x sexual hybrids are always sexual. Sexual x apomictic hybrids segregate close to 1:1 indicating that aposporous parents are simplex (Aaaa).

Biotechniques. We are seeking a molecular genetic marker tightly linked to the apomixis locus for early assessment of reproductive mode genotype. RAPD and AFLP markers have been screened (Tohmé et al., 1996). Several RAPD markers located approx. 15 cM of the apomixis locus were quickly identified (Tohmé et al., 1996). However, further progress has proved difficult as neither RAPD nor AFLP markers have been found in the intervening chromosome region.

Similar results have been obtained using maize probes for RFLP and AFLP at the Institute for Grassland and Environmental Research (IGER, UK) laboratory. To date a significant though weak linkage has been found for one marker (umc 379), and further screening is in progress (M. Hayward, personal communication).

Methodology for regeneration of plants from callus culture has been developed for six *Brachiaria* spp. (Tohmé et al., 1996). A modest project is currently underway to develop protocols for direct transformation of *Brachiaria* by particle bombardment (W. Roca, personal communication).

Evolution of breeding methods. Breeding methods should aim to exploit the unique properties of apomixis by developing apomictic cultivars. Current breeding methods have evolved empirically. We are developing broad-based sexual tetraploid populations (Miles & Escandón, in press). These sexual populations can be improved by conventional selection methods. Subsequent hybridization with an appropriate apomict should yield superior apomictic segregants. Selection on hybrid performance, such as with recurrent selection for specific combining ability (Hull, 1945), may be more efficient as apomictic testcross progenies are produced each generation.

Current situation and perspectives

CNPGC. A polycross block was established in 1994 with 15 selected sexual hybrids. Open pollinated seed has been collected and half-sib families will be evaluated in 1996 for vigor, adaptation, and spittlebug tolerance. Fifty-six hybrids initially selected for adaptation, leaf:stem ratio, profuse flowering, and spittlebug tolerance are being further evaluated in a small-plot, agronomic trial. After two years, elite sexual hybrids will be introgressed into the sexual population and apomicts advanced to grazing trials.

CIAT. Four selection cycles have been completed. Populations have been upgraded for agronomic traits such as vigor, growth habit, and leaf-stem ratio. Assessment of spittlebug reaction has been inadequate and little progress has been made in recovering resistance. A two-year field evaluation, with glasshouse assessment of spittlebug reaction, is being implemented.

Several apomictic segregants have been evaluated in replicated, single-row plot, agronomic trials. Two of these have advanced to small-plot grazing trials. Recent observations suggest that spittlebug resistance of these selections is inadequate.

The most obvious genetic advance achieved from the breeding work is in the sexual populations. Hybrid-derived sexual clones are far superior to the original tetraploidized sexual *B. ruziziensis* which barely survives in field trials in Colombia due to poor edaphic adaptation and susceptibility to spittlebug (Table 2).

Constraints

The major obstacles to achieving our breeding objectives are:
- Assessment of spittlebug resistance is laborious and time-consuming (Lapointe et al., 1989; 1992). Molecular marker technology or biochemical characterization of resistance may contribute to achieving simple, inexpensive, and reliable evaluation methods.

- We lack a clear understanding of the factor(s) involved in edaphic adaptation. Physiological studies and molecular markers may lead to the development of quick, reliable evaluation methodologies.

- Assessment of reproductive mode is still tedious and cannot be done before flowering. A molecular marker tightly linked to the apomixis locus would represent a significant breakthrough.

- We are only beginning to achieve a full understanding of the genetics of reproductive mode in *Brachiaria*. This understanding should eventually facilitate manipulation of apomixis.

- Current breeding methods may be far from optimum. Theoretical as well as further empirical study should contribute to developing efficient schemes.

CONCLUSIONS

Brachiaria breeding has been possible only in the past 10 years with the creation of a sexual, tetraploid *B. ruziziensis* cross-compatible with *B. decumbens* and *B. brizantha*. Basic biological knowledge of the plant and its genetic manipulation have been developed. Significant genetic progress can be documented. Accumulating knowledge of the genetics and physiology of *Brachiaria* will lead to improved efficiency in breeding programs and hence to more rapid and more efficient realization of breeding objectives.

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Table 1
Segregation for mode of reproduction in inheritance of apomixis studies.

Crosses	Plants observed SEX	APO	Expected ratio	Chi^2
Sexx selfed aaaa	68	0	1:0	-
SEX x SEX aaaa	38	0	1:0	-
Apo x Apo				
Aaaa x Aaaa	4	9	1:3	0.096
SEX x APO				
aaaa x Aaaa	451	404	1:1	2.58
chromatid segregation			15:13	0.231

Source: Valle, C.B.do (unpublished data presented at "Harnessing apomixis: A new frontier in Plant Science", College Station, Texas, Sept. 1995 -"Inheritance of Apomixis" Valle, C.B.do, Glienke, C. and Leguizamon, G.O. p.23)

Table 2
Forage dry matter yield in wet or dry season of Belgian tetraploidized sexual *B. ruziziensis* compared with a selected hybrid-derived sexual clone at Carimagua, Colombia.

Genotype	Forage yield Wet	Dry
	g/plant	
Sexual hybrid	175	84
4x *B. ruziziensis*	59	5
Checks:		
cv. Basilisk	246	85
cv. Marandú	343	174
$LSD_{0.05}$	80	49

Source: I.M. Rao, et al. 1996.