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Table 16. Germplasm of forage species in the three highest categories of promise for the tropical well-drained, hyperthermic and thermic savanna ecosystems, as of November 1, 1979.

Species	Hyperthermic savannas (Carimagua-Llanos) No. of accessions in category of promise			Thermic savannas (CPAC-Cerrado) No. of accessions in category of promise		
	III	IV	V	III	IV	V
Andropogon gayanus			1		1	
Brachiaria decumbens		1			1	
B. humidicola		1				
Stylosanthes capitata	4	1		4	1	
S. bracteata				1		
S. guianensis "tardío"	1			1		
S. aff. *leiocarpa*	1					
S. hamata	1					
S. scabra					1	
Zornia spp.	9	1		1[1]		
Desmodium ovalifolium		1		1[1]		
D. gyroides	1			1		
D. heterophyllum	1					
Pueraria phaseoloides		1				
Aeschynomene spp.	4					
Galactia striata				1		
Centrosema spp.				1[1]		
Calopogonium mucunoides					1	

1 Tentative classification.

adaptability to well-drained savanna ecosystems in general. (2) *Zornia* spp., *Desmodium ovalifolium* and *Pueraria phaseoloides* seem to be better adapted to the hyperthermic Llanos ecosystem (longer growing season than in the thermic Cerrado ecosystem), while *Galactia striata, Colopogonium mucunoides* and *S. scabra* seem to perform better under the thermic Cerrado environment, where insect pests and disease stresses are apparently lower.

In addition to this, preliminary information from the first regional trial conducted at a series of sites in humid ecosystems in Bolivia, Brazil, Colombia, Peru and Venezuela, indicates that *B. decumbens, D. ovalifolium* and *P. phaseoloides* are well adapted to tropical forest ecosystems. Also, the performance of *A. gayanus* under humid conditions seems to be considerably lower than under savanna conditions.

FORAGE IMPROVEMENT

Improvement of Legumes

The objective is to develop screening methods, evaluate germplasm accessions, create new and desirable genetic recombinations, and stabilize these desirable characteristics in superior plants suitable for grazed pastures within the target area. Research is centered mainly on species of *Stylosanthes, Centrosema* and *Leucaena*.

Stylosanthes capitata

While most accessions of *S. capitata* have appeared resistant to anthracnose, significant damage has been observed in certain accessions at both Carimagua and the CPAC in Brazil. The wide distribution of the causal agent, *Colletotrichum,* within the target area suggests that a thorough knowledge of the genetic basis of resistance is required.

A greenhouse screening of *S. capitata* collection for seedling resistance to five isolates of anthracnose has been started by the Plant Pathology Section. These results will be used in conjunction with field observations of the anthracnose reactions of the *S. capitata* collection at Carimagua, Brasilia and elsewhere to plan future breeding for resistance. In mid-1979, a space planted nursery was established in Carimagua, containing 9000 F_2 progeny of the crosses *S. capitata* 1078 x 1019 (late x early), 1097 x 1078 (late x late), and 1019 x 1097 (early x late); subsequently it was oversown with *Andropogon gayanus*. This nursery is being used to select superior F_2 plants combining high dry matter yield and prolific seed production with drought resistance. It will also provide an indication of the range of variation which can be expected from crosses between distinct *S. capitata* types.

Stylosanthes guianensis

While common *S. guianensis*, typified by CIAT 136 and 184, is highly susceptible to both anthracnose and stemborer, the tardío types collected in Venezuela and Brazil have appeared resistant to both constraints at several locations. A greenhouse screening of these tardío accessions for reaction to anthracnose is being planned. Results obtained from these experiments in conjunction with field screenings should provide valuable information for future breeding work.

Centrosema pubescens

C. pubescens is widely distributed throughout South America and exhibits an extensive range of variation. Commercial ecotypes of this species are not well adapted to growth in acid, infertile soils, and tend to be susceptible to anthracnose. A preliminary breeding program has been started with the goal of adapting *C. pubescens* for use in the target area. Specific objectives include (1) tolerance to high levels of Al in the soil and low pH; (2) vigorous early growth and nodulation; (3) anthracnose tolerance; and (4) commercially acceptable seed yields.

Eight *C. pubescens* ecotypes selected for vigor in pots of Carimagua soil were intercrossed, and several F_2 populations produced. F_2 seedling populations, as well as new ecotypes are first screened in sand culture (pH 4.2, high Al), and the selections then screened in Carimagua soil, to isolate genotypes with higher acid tolerance. Progeny of selected plants will be evaluated under field conditions at Carimagua.

Leucaena leucocephala

The *L. leucocephala* breeding program is based on hybrids between *L. leucocephala* and *L. pulverulenta* which have been backcrossed several times to *L. leucocephala* cv. Cunningham to produce fertile lines. The aim of this program continues to be the development of productive lines with (1) tolerance to high Al and low soil pH, and (2) lower levels of foliar mimosine. A procedure has been developed to screen progeny of the original lines previously selected for good growth in Carimagua soil. This involves (1) growth of large numbers of seedlings in sand culture (pH 4.2, high Al) and selection of those with best root and top growth; (2) selected seedlings are transferred to 15 cm-diameter pots of Carimagua soil and given a restricted nutrient supply. An acid-tolerant rhizobium culture is used to inoculate the selections.

Various screenings, each involving 5440 plants, have been completed. The average percentage of plants finally selected for seed production and further study varied from 1.8 to 5% in the various lines. Selected hybrid *Leucaena* plants showed at least four times as much top growth in Carimagua soil as the Cunningham controls. Acid-tolerant selections are grown at CIAT-Palmira for mimosine analysis and seed multiplication. Superior lines will be field tested first at Carimagua.

Grasses

Andropogon gayanus

A. gayanus has considerable potential as a pioneer grass for the acid soils of the tropics. While present experience is almost exclusively confined to accession CIAT 621, the species shows a high adaptation capacity as it is able to grow in soils with a low fertility status but responds significantly to applied phosphorus and other minerals.

A range of accessions has been assembled from different sources so that desirable characteristics in these can be sought and compared to A. gayanus CIAT 621. Objectives for the improvement of this cross-pollinating species are being formulated. In addition to the evaluation of new accessions, quantification of genetic variability and selection within CIAT 621 is planned. CIAT 621 is very variable for plant type, leafiness, time of flowering, and other characteristics. A recurrent selection program is being developed with initial selection for later, leafier types which can flower and ser seed during a more restricted period. This should improve both seed production as well as forage quantity and quality.

Panicum maximum

Several cultivars of *P. maximum* are widely grown in South America and have proved to give better animal production than most other tropical grasses. However, commonly grown cultivars are generally observed to have higher nutrient requirements and lower drought tolerance than other forage grass species. The aim of improvement work with this species is to identify or develop lines with lower nutrient requirements and better dry season production than those commonly grown.

A collection of some 90 *P. maximum* accessions is available. Fourteen of these have already been observed at Carimagua and preliminary data on two cuts in the rainy season show significant differences among the accessions for dry matter production. Additional accessions will be evaluated under Carimagua conditions to identify genotypes which show promise under nutrient and drought stress conditions on acid soils.

Most *P. maximum* clones are highly apomictic. A crossing technique has been designed, using an apomictic clone as the male parent and a sexual clone (obtained from the Coastal Plan Research Station, Tifton, Georgia, USA) as the female parent. Preliminary observations of hybrid progenies at CIAT-Palmira show a considerable range of variability for grass plant morphology both between and within progenies. As observations on the accessions under Carimagua conditions accumulate, a breeding program may be develop utilizing the better adapted apomictic clones as parental material.

Brachiaria spp.

B. decumbens and *B. humidicola* are promising forage grass species in the target area. Both species are tetraploid apomictics so that a breeding program is impossible, unless sexual types can be found or produced. An attempt is being made to produce tetraploid material by colchicine treatment of *B. ruziziensis*, a sexual, diploid species. The goal is to produce a sexual tetraploid which might be crossed with the tetraploid *Brachiaria* spp., to overcome the barrier imposed by their obligate apomixis. In the meantime, efforts will be made to expand the germplasm collection of species and ecotypes of this genus.

PLANT PATHOLOGY

In 1979, the Plant Pathology section continued to detect, identify and assess diseases of tropical forages within the target area. Studies were initiated on the most important diseases including anthracnose, blight, root-knot, nematode, Camptomeris leaf spot and Cercospora leaf spot. False-rust, Rhynchosporium leaf spot and Sphaceloma scab were detected as new diseases requiring further study.

Disease Survey

Forage diseases were evaluated at the 20 different sites of the Regional Trials Network. Twenty-two pathogens affecting grasses and legumes were identified (Table 17). The most important finding is the existence of different pathogens at different sites. Surveys will continue at these sites and at new ones within the target area. The accumulating results, however, strongly suggest further decentralization of screening for disease resistance, to expose forage to as many potential pathogens as possible.

Anthracnose

Host range

Surveys on the occurrence of anthracnose continued to show the wide-spread distribution and extensive host range of *Colletotrichum* spp. (CIAT Annual Report, 1978). In CIAT-Quilichao, new hosts identified included accessions of *Aeschynomene, Calopogonium, Desmodium, Galactia, Zornia, Pueraria phaseoloides,* and *Stylosanthes.* In Carimagua, extensive surveys detected other accessions of previously reported legume hosts (CIAT Annual Report, 1978). Other hosts found were native savanna legumes *Aeschynomene, Desmodium, Eriosema* and *Zornia* spp., native savanna non-legumes, and a saprophytic phase of the fungi in *Desmodium ovalifolium* CIAT 350 and many grasses. Although *S. capitata* CIAT 1019, 1315 and 1405 were resistant to anthracnose in Colombia, they were susceptible at CPAC-Brasilia. Similarly, *S. guianensis* accessions destroyed by