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Tropical Pastures Program
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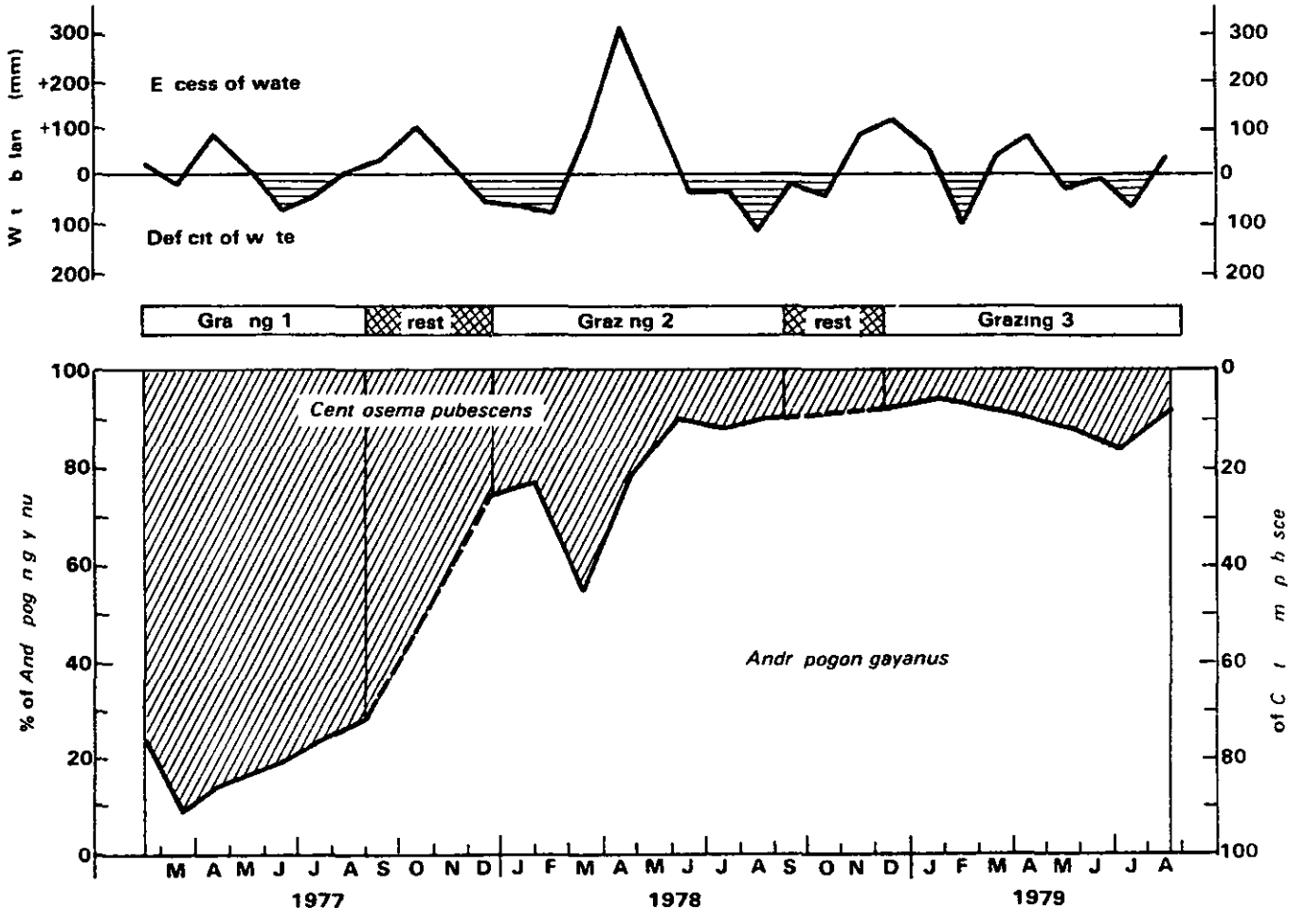
FORAGE AGRONOMY (CIAT-QUILICHAO)

Within the reorganization of the Tropical Pastures Program agronomic work in CIAT Quilichao is mainly confined to basic research in support of other sections of the Program and to testing methodologies with emphasis on the regional trials network as well as to demonstration experiments for training activities

Germplasm Evaluation

Of the experiments that have been established in previous years the grazing trial at El Limonar (near CIAT Quilichao) with five *Centrosema pubescens* accessions (CIAT Nos 438 442 455 456 and 469) in mixture with *Andropogon gayanus* CIAT 621 was evaluated during its third year under rotational grazing This area started with an extremely high proportion of legume in the mixture the botanical composition however changed rapidly and stabilized after the second year at a grass/legume ratio of 85 15 (Figure 10)

Despite the decreasing proportion of the legume it is important to stress the fact that the productivity of the sward increased The stocking rate was increased from 2 3 head/ha during the first grazing period to 2 7 head/ha during the second year and finally to 4 6 head/ha in the third year These stocking rates were rotationally applied with a grazing period of 15 days at



F g re 10 P oport ons of *And opogon gay nus* and *Cent o ema pubescens* n m ture unde graz ng (1 2 3 head/ha 2 – 2 7 head/ha and 3 4 6 head/ha)

30 day intervals during a period of 7 8 months each year

In this way the first resting period which coincides with a rainy period after a build up of N in the soil by the legume strongly favored the growth of *A gayanus* The second grazing period with a dry period helped the *C pubescens* spp to recover With the increased precipitation *A gayanus* finally covered 85 90% of the population in the sward This proportion has been held more or less stable throughout the past year with no large effects from grazing treatment nor climatic conditions

This apparent stability in the mixture and the greater productivity of the sward at this equilibrium state in an interesting finding which will be followed at least for one more year

The forage potential of *A gayanus* CIAT 621 was further assessed in grass/legume associations under cutting and in grazed swards in comparison with other vigorous grasses Of eight grass species grown in mixed swards with *Desmodium ovalifolium* the highest yielders (in declining order) were *A gayanus* CIAT 621 two intermediate growth forms of *Panicum maximum* cultivar Makueni and CIAT 673 and *Brachiaria decumbens* cultivar Basilisk *Echinochloa polystachya* was the least productive species In this experiment a highly desirable 60 40 percent grass legume balance was maintained with the three most productive tufted species under cutting every six weeks A significantly lower legume content 30 percent on the dry weight basis was recorded in the *B decumbens/D ovalifolium* association (Table 13)

As indicated in CIAT Annual Report 1978 an apparently higher protein content of *A gayanus* was observed when associated with *C pubescens* spp than with *S guianensis* (Figure 11) However with data made available during this year it was found that the higher protein content in the samples on offer of *A gayanus* is due mainly to a confound effect of the amount of dry matter included i e samples of *A gayanus* in most of the cases were smaller when associated with *Centrosema* spp than with *S guianensis* This difference which is especially clear during the first year is possibly the effect of differences in maturity status which in the case of *A gayanus* may be a result of preferential grazing Figure 12 shows the relationship between the size of the samples on offer of *A gayanus* and its protein content This relationship is expressed by the equation $\hat{Y} = 69\ 8\ X^{0\ 32}$ based on averages of the samples on offer of the grass associated with all the legumes considered in the trial These results seem to confirm the explanation

Tabl 13 Y elds (6 week harve t nte val) o ght g a pecie each grown n a o at on with D mod um ovalifol um CIAT 350 at CIAT Qu l chao l 8 1979

Gr spec s	CIAT a s on No	D y matt G	y eld (kg/h /y a) Legume	T tal	G a	Legume
Bra h a a de umb ns	664	7317abc[1]	3229b	10 547ab	o9	4 30 6
Pa um m x n um cv Makuen	622	6727abcd	4636a	11 363abc	59	2 40 8
P ma nu n	673	7494ab	4828a	12 322ab	60	8 39 2
And opogon gayanus	62	7580a	5225a	12 805a	59	2 40 8
P m mu n	671	5335bcde	4888a	10 22 bc	52	2 47 8
P max mum	661	4549de	5671a	10 220b	44	55 5
P max mum	669	5126 de	5289a	10 415abc	49	2 0 8
Ech ochloa poly tach a	commer ial	4305e	4645a	8 9 0c	48	1 51 9

1 Values w th n the same column follow d by the same letter are not s gnif antly different at th 0 05 l v l

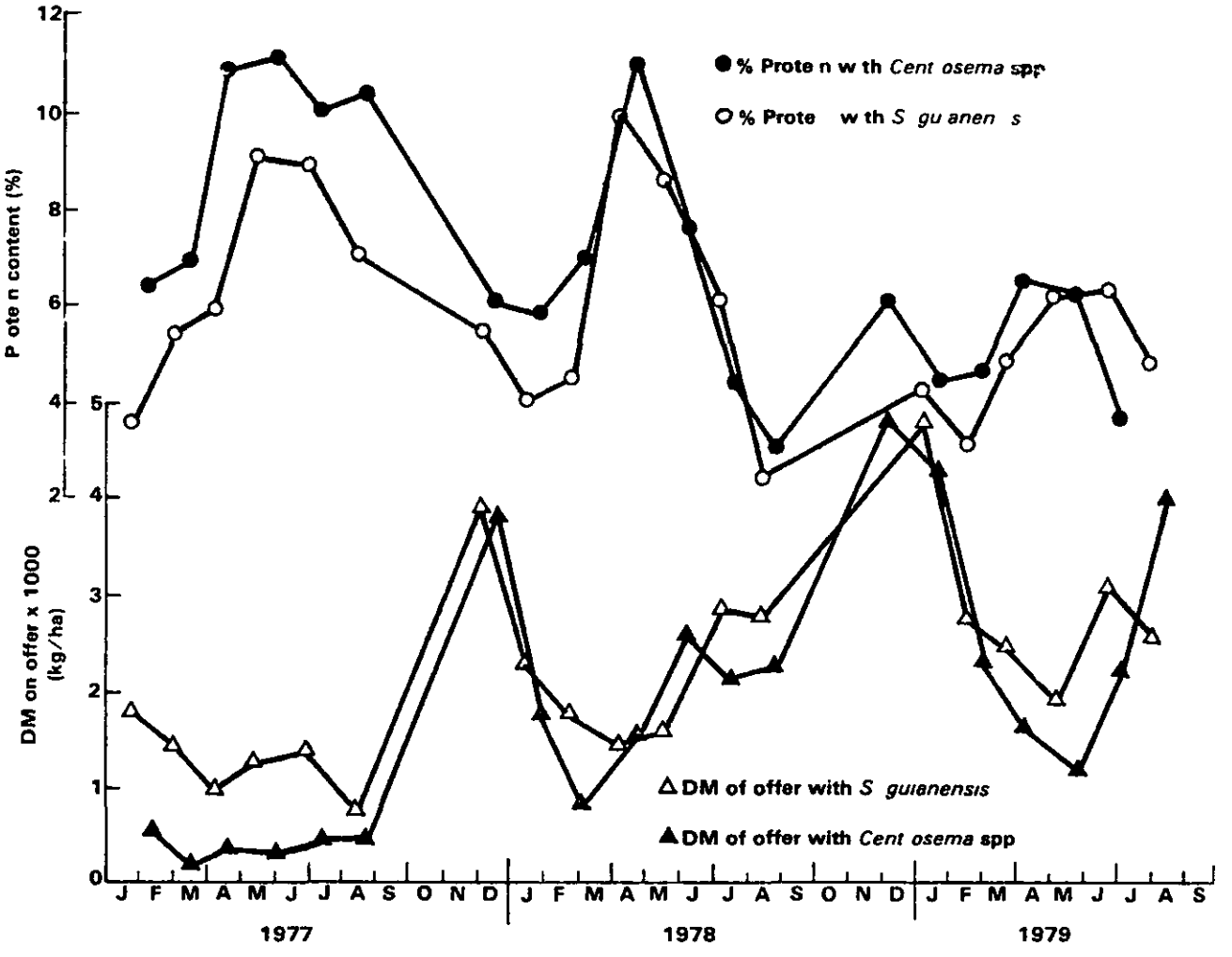


Figure 11 Protein percentage and dry matter on offer of *Andropogon gayanus* in samples from mixtures with *Centrosema pubescens* and *Stylosanthes guianensis*

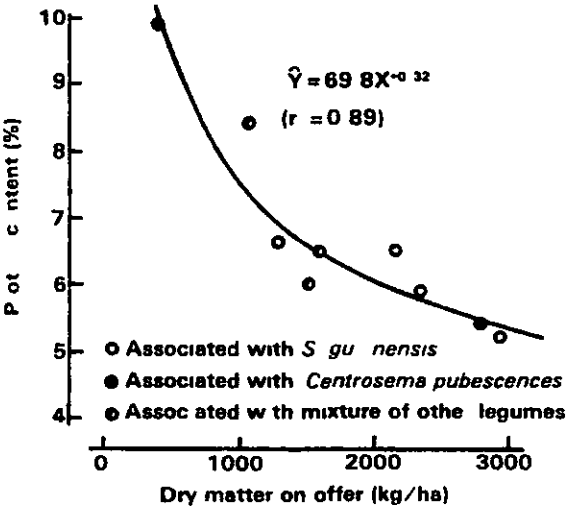


Figure 12 Protein content of samples on offer of *Andropogon gayanus* associated with different legumes

given above for the differences observed in the protein content of *A gayanus* when associated with two different legumes

Herbicide Selectivity and Control

Weeds can become a problem during pasture establishment on acid infertile soils when the natural fertility is higher in new soils or after P fertilization To study the selectivity of chemicals on the establishment of promising pasture legumes 11 pre emergence and 4 post emergence herbicides were tested Table 14 shows the results of the best chemical treatments

When considering the possibility that *A gayanus* could become a weed for other crops seven post emergence herbicide treatments were applied The

Table 14 Select vity and w ed ont ol of sel cted he b cides 60 day after the establishment of fo age l gume p s at CL f Quil ch o

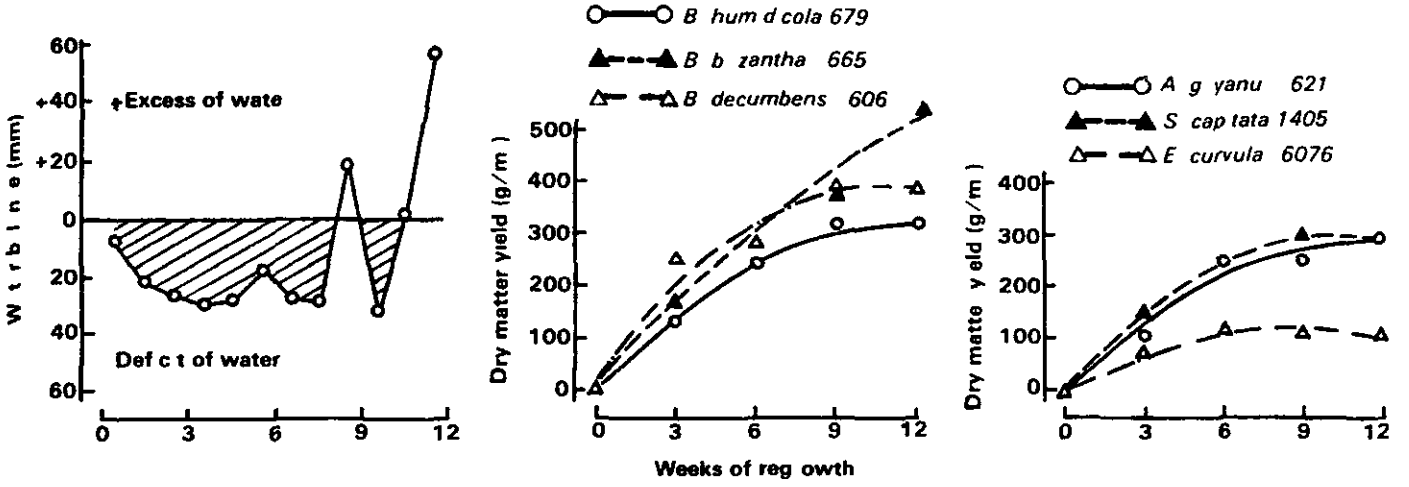
Herb cid (kg /n)	Toxoc tv ndex[1] S cap tata[2]	S u anensis 136	S hamata 147	D ovalifol um 350	C pubescens 438	P phaseolo des 9900	Weed ont ol (%) Grasses	B oad leaf weeds	Total
P em g nce									
Alachlo (l 0)	0	0	0	1	0	0	80	13	58
L nu on (l 0)	0	3	0	4	0	3	80	74	97
Fluo odif n (3 0)	2	3	2	0	2	0	96	96	73
O a n (l 0)	1	0	1	2	0	1	81	89	80
Chlo amben (l 0)	1	0	0	3	0	0	80	79	80
Alachlor + l nuron (l 0 + 0 8)	1 1	1	0	1	0	0	95	65	88
L nuron + flu odifen (l 0+3 0)	0	0	1	5	0	0	88	89	88
Po t mergence									
tazon (l 0)	0	0	0	0	0	0	30	90	70

1 Rating 10 = dead and 0 = no damage
2 S cap tata 1019 1078 1405

Tabl 15 Eff ct of post mergence h rbic de treatments on the control of Andropogon gayanus 621 at CIAT Qu l chao 1979

T tment[1]	Rate of appl cat on (kg a /ha)	A gayanus plants controlled (%) at (day after t eatment) 15	30	45	60
Atrazine + surfactant	1 25 + 0 5	0	0	0	0
Dalapon + surfactant	8 0 + 0 5	30	43	58	
Dalapon[2]	6 0 + 6 0	0	62	68	71
At ne + d e l o l	1 25 + 12	3	0	0	
D u on + su factant	1 0 + 0 5	0	0	0	3
Paraquat + u factant	1 5 + 0 5	36	0	0	10
Glypho at	1 5	78	80	75	70
Ch ck		0	0	0	0

1 Surfactants were applied at 0 5% and d e el o l at a rate of 12 liters
2 Two appl cat ons the ecord 17 days after the f rst



F g e 13 Growth curves of e ght g ass ecotypes and o e legume d ng dry pe od CIAT Q I ch o (J ne 4 August 28 1979)

two more effective treatments were dalapon in two applications and glyphosate (Table 15) This research will continue by applying the two selected herbicides at different rates on different growth stages of *A gayanus*

Methodology Studies

Methodological studies were initiated by using germplasm material established in a former grass agronomy experiment (40 grass ecotypes in association with *Stylosanthes capitata* CIAT 1405) The objective of these studies is to establish growth curves during the period of minimum and maximum precipitation for grass and legume germplasm that is being distributed for testing in the Regional Trials Network Figure 13 shows the growth curves for 5 of the 40 grasses evaluated during a dry period These studies will be complemented with leaf stem ratios and tissue analyses So far it is possible to observe even under a mostly negative water balance a faster regrowth of *Brachiaria* spp Another interesting observation is the similarity of the regrowth rates of *A gayanus* 621 and *S capitata* 1405

PROMISING GERMPLASM FOR THE MAJOR ECOSYSTEMS

For each ecosystem germplasm under evaluation is classified into previously established categories of promise (CIAT Annual Report 1977 page A 16) on the basis of results of germplasm evaluation conducted by the Program s agronomists in the major research sites and by collaborators in regional trials

In the past years germplasm evaluation was concentrated in Carimagua in the Colombian Llanos Orientales as a major research site representative for the ecosystem hyperthermic well drained tropical savanna By late 1978 germplasm evaluation was extended to the thermic well drained tropical savannas where experiments are conducted in collaboration with EMBRAPA at the Cerrado Center (CPAC) Planaltina Distrito Federal Brazil Consequently to date the classification of germplasm into categories of promise is mainly restricted to the ecosystem represented by Carimagua and only tentatively feasible for the ecosystem represented by the CPAC For both ecosystems some preliminary results from the first regional trials can be added

A comparative classification of germplasm into the three highest categories of promise for the two well drained savanna ecosystems (Table 16) indicates that (1) the grasses *Andropogon gayanus* and *Brachiaria decumbens* and the legumes *Stylosanthes capitata S guianensis* tardio and *Desmodium* (syn *Codariocalyx) gyroides* show the broadest range of

Table 16 Germplasm o fo~age species n the three highest ategories of promise for the trop cal well dra ned hyperthermic and thermic savanna ecosystems as of November 1 1979

Spe es	Hypertherm c savannas (Carımagua Llanos) No of access ons n category of p om se III	IV	V	Thermic savannas (CPAC Cerrado) No of a ce s ons ın category of promise III	IV	V
And opogon gayanus			1		1	
B a h ar a de umbens		1			1	
B num d ola		1				
S ylosanth cap tata	4	1		4	1	
S b t ta				1		
S gu n ns s tardıo	1			1		
S aff l oca pa	1					
S ham ta	1					
S s bra					1	
Zo pp	9	1		1[1]		
D s nod m ovalıfol um		1		1[1]		
D gy o d s	1			1		
D h t orhy llum	1					
P e r phaseolo des		1				
A hy omene pp	4					
Gal a t ata				1		
Ce t o r pp				1[1]		
C po_on um mu unoides					1	

1 T ntat ve las ıf cat on

adaptability to well drained savanna ecosystems ın general (2) *Zornia* spp *Desmodium ovalifolium* and *Pueraria phaseoloides* seem to be better adapted to the hyperthermic Llanos ecosystem (longer growing season than ın 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 ın humid ecosystems ın Bolivia Brazil Colombia Peru and Venezuela ındicates 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 con siderably lower than under savanna conditions

FORAGE IMPROVEMENT

Improvement of Legumes

The objective ıs to develop screenıng methods evaluate germplasm accessions create new and desirable genetic recombinations and stabilize these desirable characteristics ın superior plants suitable for grazed pastures within the target area Research ıs centered mainly on species of *Stylosanthes Cen trosema* and *Leucaena*

Stylosanthes capitata

While most accessions of *S capitata* have appeared resistant to anthracnose significant damage has been observed ın certain accessions at both Carimagua and the CPAC ın Brazil The wide distribution of the causal agent *Colletotrichum* within the target area suggests that a thorough knowledge of the genetic basis of resistance ıs 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 tardio types collected in Venezuela and Brazil have appeared resistant to both constraints at several locations A greenhouse screening of these tardio 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

Table 17 Frequency o forage d seases in 20 s tes of the Regional Trials network

D ases	Bol v a		Bra l				Col mb a				E uador		P u			Ven u la					
	Santa Cruz	San Ignacio	B a l a	Set Lagoas	Goiania	Campo Grand	S Qu l chao	Ca imagua	La Libe tad	San Jos del Nu	P ch l ngue	Santo Domingo	Pucallpa	T apoto	Yurimaguas	Ju p n	Uracoa	El T g e	At pi ir	Gu h	Tot l S tes
Anth acnos [1]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	19
C co po a leaf spot [1] (n Pa cum max mum)	+	+			+	+	+	+	+	+			+	+		+	+	+	+	+	15
C ospo a leaf pot (n C nt o ma spp)	+	+			+	+	+	+	+	+				+		+	+	+		+	13
Root krot nematod [1]							+														1
Blight [1]								+	+	+											3
Spha eloma scab [1]			+				+	+	+												4
Smut (U t lago) [1]		+	+	+	+	+		+	+											+	8
Smut (U ocyst)					+																
Camptome s l af spot [1]							+				+										2
Rust (Uromyce)			+		+	+	+							+				+			
Ru t (Pu in a)							+														
Fal u t [1]			+	+	+	+					+										5
Rh o ton a solani	+							+	+	+		+						+		+	
Rhyn hospo um leaf spot [1]								+	+												2
D echslera leaf spot	+							+													2
Littl l af v rus	+		+			+	+	+				+									7
E got					+																1
G be ella inflorescence blight					+																1
Botryt s inflorescence blight										+											1
Black mold			+			+															2
Powdery m ldew	+		+	+	+		+										+				6
Slime mold							+														1

1 Di eases considered as important

anthracnose in Colombia were only slightly affected at several sites in Brazil These observations suggest the presence of different races of *Colletotrichum* spp at different sites

Severity

At CIAT Quilichao and Carimagua anthracnose severely affected accessions of *S guianensis* late flowering *S capitata Centrosema* and *Aeschynomene* spp However tardio types of *S guianensis* and *S capitata* CIAT 1019 1315 and 1405 were resistant Although several accessions of *Centrosema* spp were defoliated CIAT 5052 5057 and 5066 were resistant

Accessions of *Aeschynomene* spp were devastated at CIAT Quilichao however the hairy and/or sticky accessions CIAT 7259 7260 7262 and 7274 from Venezuela were resistant Anthracnose spotting was moderate to severe on *Zornia* spp and on mature leaves of *Desmodium* spp

Field screening

Due to the extensive indigenous population of anthracnose fungi glasshouse screening is not feasible except for specific studies Field screenings at various sites continued to identify accessions with resistance to local *Colletotrichum* spp races At

Carimagua large plantings of 75 accessions of *S capitata* and 130 accessions of *S guianensis* were established for screening purposes to monitor the expected anthracnose epidemic and to isolate pathogenic races to these species in the Carimagua environment for further studies

Burning to control anthracnose

Although the use of resistant varieties is the most desirable method to control anthracnose of tropical forage legumes burning is proving a potentially successful temporary control measure Ten months after burning affected plots of *S capitata* at El Limonar near CIAT Quilichao susceptible accessions CIAT 1078 and 1097 had only 29% as much anthracnose as unburnt (Table 18) In Carimagua three months after burning plots of CIAT 1078 these only showed 50% as much anthracnose as unburnt plots (Table 19)

Host plant resistance studies

Studies are underway to compare anatomical chemical and developmental characteristics of susceptible 136 type *S guianensis* and resistant fine stemmed *S guianensis* tardio as well as those of susceptible late flowering *S capitata* CIAT 1078 and 1097 and the resistant accessions CIAT 1019 and 1315

Legume germplasm evaluation

Screening of new germplasm of *S capitata* and *S guianensis* for resistance to anthracnose was initiated in the glasshouse and in the Carimagua environment in collaboration with the Legume Breeding section of the Program

Blight

In Carimagua *Sclerotium rolfsii* again affected *Stylosanthes* spp from July to November of this year Counts of dead plants were made at various sites for *S capitata* CIAT 1019 (5%) 1097 (7%) 1315 (9%) 1318 (11%) 1325 (7%) 1338 (6%) 1339 (7%) 1342 (11%) 1405 (6%) and *S bracteata* CIAT 1281 (14%) CIAT 1019 was severely affected (75%) at San Jose del Nus Colombia and moderately affected (20%) at La Libertad Colombia Soil populations of sclerotia of this pathogenic fungus are being monitored in Carimagua

In glasshose trials with 70 day old plants most legumes including the promising *S capitata* CIAT 1019 and 1315 *D ovalifolium* CIAT 350 and *Z latifolia* CIAT 728 were highly susceptible to *S rolfsii* (Table 20) Studies on changes in the susceptibility of *S capitata* CIAT 1019 with age showed that plants with 10 24

Table 18 Effect of bu n ng on th ncidence of anthracnose n Stylosanthes cap tata susceptible access ons CIAT 1097 and 1078 5 and 10 months after treatment at El L monar near CIAT Quilichao

CIAT acc sion No	T atm nt	Months after burning	No of lesions on st ms	Dry we ght of sample (g)	No les ons/ 10 g dry matter
1097	Without burning	5	415 3	45 9	90 5
	Burning		2 7	6 0	4 5
	Without burning	10	338 0	63 4	53 3
	Bu n ng		51 7	33 5	15 4
1078	W thout bu ning	5	445 0	75 1	60 5
	Burn ng		38 3	36 3	10 6
	W thout burning	10	381 7	46 4	82 3
	Burn ng		74 0	31 2	23 7

Table 19 Effe t of burning on the incidence of anthracnose on Stylosanthes ap tata CIAT 1078 1 2 and 3 months after treatment in Carimagua

T eatment	Months after burning	No of les ons on st ms	Dry we ght of sample (g)	No le ons/ 10 g d y matte
Without burning	1	87 9	17 1	51 4
Burn ng		15 5	17 9	8 7
Without burning	2	150 0	101 0	14 9
Burning		7 8	41 0	1 9
Without burning	3	199 0	97 9	20 3
Burning		79 4	71 2	11 2

Tabl 20 Rea tion of trop cal forage legumes to Sclerotium rolfsii

Susceptible	No of accessions	Moderately su cept ble	No of access ons	Res stant	No of ac ss o
Calopogo um mucuno des	1	Gentro ema pubes ens	1	Leucaena leuco phala	4
D smod um ba batum	1	De modium canum	1		
D smod um d stortum	1	Desmodium heterocarpon	2		
Desmodium heterocarpon	3				
Desmod um heterophyllum	1				
Desmodium ovalifol um	1				
Macroptil um p	1				
Puerar a phaseolo des	1				
Stylosanth s cap tata	11				
S ylosanth gu anens s	14				
Stylosanthes hamata	4				
Stylosanthes humil s	1				
Stylo anthes scabra	7				
Stylosanthe vi cosa	3				
Zornia latifolia	2				
Total	52		4		4

weeks were more susceptible than older and younger plants

Studies are continuing on the susceptibility of promising legumes under pasture conditions the susceptibility of progeny of plants surviving inoculation and the effect of soil and organic matter content in it on the pathogenicity of the fungus to *S capitata* CIAT 1019

Root Knot Nematode

Surveys of indigenous legumes and savanna plants at Carimagua have failed to detect *Meloidogyne javanica* At CIAT Quilichao however various weed hosts were found and plots of *D ovalifolium* CIAT 350 and *Cordariocaly x gyroides* were severely affected In a screening trial carried out in pots resistance was found in *Stylosanthes* spp *Z latifolia P phaseoloides* and *Leucaena leucocephala* (Table 21) Most accessions of *Desmodium* spp were susceptible except for *D distortum* CIAT 335 and *D heterophyllum* CIAT 349

As roots of some grasses produce toxins to nematodes two studies were initiated to determine the effect of root knot nematode on *D ovalifolium* CIAT 350 association with various grasses a pot trial with 54 accessions of 25 grass species was established and also a field trial in a nematode infested plot at CIAT Quilichao with *Andropogon gayanus* CIAT 621 *Brachiaria decumbens* CIAT 606 and *Panicum maximum* CIAT 604

Camptomeris Leaf Spot

Camptomeris leucaenae continued to damage *Leucaena leucocephala* CIAT 734 at CIAT Quilichao A screening trial to observe reactions of 38 accessions of *Leucaena* spp to the fungus was established near an infested pasture of *L leucocephala* 734 After eight months exposure 21 accessions including commercial cultivars Cunningham and Peru were moderately to highly susceptible to *C leucaenae* (Table 22) Potencial resistance was found in six accessions of *L leucocephala* and several accessions of five other *Leucaena* spp

Fertilized plots of *L leucocephala* 734 located near infected plots were only slightly damaged by Camptomeris leaf spot Leaf tissue analyses showed higher levels of K Ca and Mg and considerably higher levels of Zn and B in leaves from fertilized plots in contrast to leaves from non fertilized plots Two experiments were established to determine the effect of various fertilizer treatments on the susceptibility of CIAT 734 to the fungus One study will determine the effect of four levels of P_2O_5 K_2O Mg Ca Cu Zn B and Mo while the other will determine the effect of different combinations of Zn Cu and B on Camptomeris leaf spot

Table 21 Effect of M lo dogyne javan ca olated from D smod um ovalifol um CIAT 350 on other trop cal forage legumes

L gum	No of accessions	React on[1]
Calopogon um mu uno d s	1	3
C nt os ma pu be n	1	2
Coda o alyx g od	1	4
Desmod um ba batum	1	2
De mod m d sto tum	1	1
D mod um het o a pon	3	3
D mod um h t o a pon	3	2
D mod um h t o a pon	1	1
D modi m h t rophyllum	1	1
D mod um o alifol um	1	4
L u ae a l u o phala	1	1
Ma op i um sp	1	2
Puer a ph olo d	1	1
Stylo nth ap tata	6	1
Stylo anth gu anens	2	1
Stylo anthe hamata	1	1
Zorn a latifol a	2	1

1 React on. 1 = no galling 5 = severe galling

Cercospora Leaf Spot

In the target area Cercospora leaf spot affecting *Panicum maximum* is a widespread disease Damage to this species is moderate to severe *P maximum* cultivars Green Panic Makueni and Guiniensis are

Sixty eight percent of inflorescences of *P maximum* common in San Ignacio Bolivia and *P maximum* colonial in Goiania Brazil were smutted In a trial established in Carimagua to evaluate Cercospora leaf spot on *P maximum* smut destroyed most in florescences of CIAT 604 while Makueni was com pletely resistant It is recommended that seed from infected stands be treated before sowing

Rust

Although *Uromyces appendiculatus* is widespread on *Macroptilium Phaseolus* and *Vigna* spp throughout almost the total target area it affects mature leaves only

Rhizoctonia solani

Generally *R solani* caused slight to moderate damage to *P phaseoloides* and *Macroptilium* spp throughout the target area Plots of *P phaseoloides* at CIAT Quilichao (Colombia) and Santa Cruz (Bolivia) were moderately to severely affected

Black Mold

In 1979 black mold was severe on *Zornia* spp from Brazil and moderate on *Zornia* spp from Colombia at CPAC Brasilia The disease is apparently associated with insect attacks

Minor Diseases

Powdery mildew Drechslera leaf spot little leaf virus Botrytis inflorescence blight slime mold and snow mold were diseases of minor importance detected on legumes at various locations within the target area Ergot Giberella inflorescence blight Urocystis smut and rusts were detected on grasses

Seed Pathology

Surveys on the microflora of forage seed and the effect of seed treatments on pathogens showed that the best and most practical method for reducing levels of storage fungi associated with grass seed is its treatment with captafol Studies are continuing on improving the application method and on reducing the bacterial population Similarly captafol was the best for reducing levels of stored seed fungi and eliminating pathogenic *Colletotrichum* spp associated with legume seed Studies are in progress on the effect of captafol on *Rhizobium* spp

Surveys have commenced on changes occurring in the microflora of green and dry seed of *S capitata* at CIAT Quilichao and Carimagua during the year The effect of inoculating seed of *Stylosanthes* spp with *Colletotrichum* spp on germination and seedling survival is also being studied

ENTOMOLOGY

During 1979 the Entomology Section continued basic studies on the taxonomy and biology of the stemborer *Caloptilia* sp the most limiting insect pest of the genus *Stylosanthes* Work was also intensified to understand the resistance and/or tolerance of several *S capitata* accessions to the stemborer

After two years of monthly field observations at CIAT Quilichao and Carimagua a consistent resistance and/or tolerance reaction to the stemborer damage was observed for several *S capitata* and *S guianensis* accessions

Population dynamics studies were continued providing possible explanations of the observed population fluctuations of insects on legumes and grasses Also studies were initiated to evaluate damage caused by spittlebugs (genera *Aeneolamia Zulia Deois* etc) and aphids to *Andropogon gayanus* accessions

Stylo Stemborer

Biology and biological control

During 1979 studies were conducted on the biology of the stemborer confirming last year s results (CIAT Annual Report 1978) and its taxonomic identification as of the genus Caloptilia

The wasp *Bracon* sp (Hymenoptera Braconidae) was again the most frequent parasite of the stemborer larvae found in CIAT Quilichao

Host plant resistance

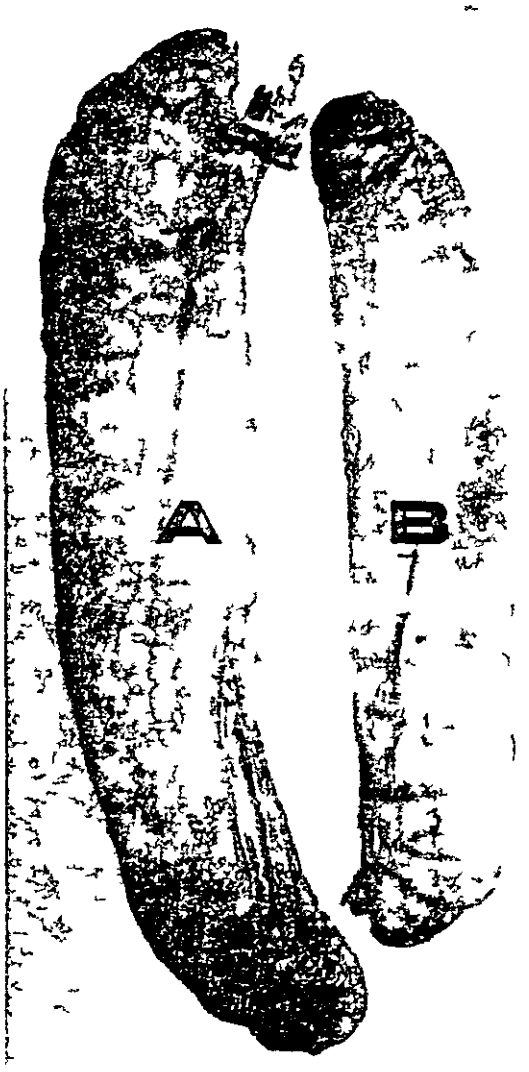
Screening for resistance to stemborer was con tinued at CIAT Quilichao and Carimagua under field and laboratory conditions To date 10 *S guianensis* and 9 *S capitata* accessions have been evaluated At CIAT Quilichao three *S guianensis* accessions (CIAT

No 1312 1062 and 1162) showed less than one larvae per plant and seven *s capitata* accessions (CIAT No 1356 1342 1019 1298 1315 and 1405) showed either no damage or less than one larvae per plant which was lower than the initial level At Carimagua field evaluations were made in *S capitata/A gayanus* mixtures under grazing Mixtures with both *S capitata* 1019 and 1300 showed higher levels of stemborer infestation than *S capitata* 1405 but these are still considered low Thus *S capitata* 1019 and *S capitata* 1300 are considered to be resistant to stemborer (Table 23)

Laboratory studies under controlled conditions (26 C and 65% RH) were conducted utilizing *S guianensis* 136 (considered as susceptible) and *S capitata* 1019 (considered as resistant) to test for oviposition preferences of females of *Caloptilia* Results show a high reduction in oviposition (89 5%) for *S capitata* 1019 compared to *S guianensis* 136 (153 and 1295 eggs oviposited respectively)

Artificial diets were developed with ground dry stems of either *S guianensis* 136 or *S capitata* 1019 as the main components Results showed that pupae reared on the *S capitata* 1019 based diet were smaller (Figure 14) These preliminary results indicate that the possible mechanism of resistance observed in species of *S capitata* could be an antibiotic effect Further tudies on the stemborer progenies will be conducted to determine the possible effects of *S capitata* based diets on the fecundity fertility and longevity of stemborer females

Anatomical studies of stems (Figure 15) as well as chemical analysis of the glandular trichomes found in some *Stylosanthes* spp accessions are being con ducted to detect inter or intra specific differences in order to better understand the mechanisms of resistance to the stemborer observed in *S capitata* spp



F g e 14 D fferenc n s ze of *Calopt l a* sp pupae rea ed on (A) a *Styl s nthes gu nens* CIAT 136 based d et o (B) a *S cap t t* 1019 based d et

Table 23 Res stance to stemborer (Calopt l a p) n two populat on of Stylo anth p t ta mixtur w th And opogon gayanus unde g az ng at Ca magua

S cap tata CIAT No	Damaged plants (%)	No of l va /plant	Tunn l length (m)
1019 + 1300	16 16 (a)[1]	0 23 (a)	0 71 (a)
1405	0 81 (b)	0 01 (b)	0 03 (b)

1 Means w thin columns followed by the same l tter a e nct gnit antly diffe ent at a 0 0ɔ level