Germplasm Screenıng and Genetıc Improvement

Germplasm Collectıon and Preservatıon

The Genetıc Resources Unıt of CIAT has the respon sıbılıty for collectıng evaluatıng conservıng maıntaınıng and dıstrıbutıng germplasm of *Phaseolus* specıes ın cooperatıon wıth the Bean Program

Acquısition of *Phaseolus* Germplasm

Durıng 1980 the *Phaseolus* germplasm collectıon of CIAT ıncreased to 30 692 samples wıth the addıtıon of 1475 accessıons thıs year In addıtıon to the four cultıvated specıes *(P vulgarıs P lunatus P coccıneus* and *P acutıfolıus)* the collectıon also ıncludes 10 wıld specıes ıdentıfied ın collaboratıon wıth the Unıversıty of Gembloux Belgıum The major *Phaseolus* collectıons of the Unıted States Department of Agrıculture and of Cambrıdge Unıversıty England have now been duplıcated ın CIAT as have tradıtıonal materıals from other banks ın Japan Europe and other locatıons

Fıeld collectıons over the past four years have added numerous new materıals to the germplasm bank In 1980 two collectıon trıps ın Brazıl provıded 338 samples of *P vulgarıs* and 55 *P lunatus* materıals (as well as varıous samples of *Vıgna* sp *Cajanus cajan* and *Arachıs hıpogea)* These trıps were conducted by CIAT and the Empresa Brasıleıra de Pesquısa Agropecuarıa (EMBRAPA) wıth fınancıng by the Internatıonal Board for Plant Genetıc Resources (IBPGR) Other field collectıons have also been made ın Peru Mexıco and Spaın

Of the total number of accessıons of the *Phaseolus* bank some 51% are from Central and South Amerıca 10% came from Asıa the Mıddle East and the Far East 9% orıgınated ın Europe Afrıca and North Amerıca each were sources for 4% and the other 22% are from other regıons or theır orıgıns are unknown

Seed Increase and Evaluatıon

Insofar as possıble materıals of hıgher prıorıtıes for utılızatıon by the Bean Program or others have been multıplıed assıgned a CIAT accessıon number and evaluated Table 1 shows the present status of seed multıplıcatıon ındexıng and evaluatıon as of September 1980

T bl 1 Numbe s f *Ph e l* accessıon on ha d seed d d luated by the CIAT Ge tı Re ources Unıt as f Sept mb 1980

Spec e	N f sampl	N ce ns creased and ndexed	No of access ons e aluated	N of d scrıptors
Ph l ulg ıs	27 404	13 495	10 000	32
Pha lus lun ıus	1900	698	200	32
Phas ol o eu	1098	300		
Pha eolu cuı fol u	129	118	50	32
W ld *Phas olus* pp	73	10		
U d t f d *Ph lus* mat al	88	5		
Total	30 692	14 626	10 250	

ld f d *P hus P m lf P nsıs P f l f m P gh P m pus P ped lla P p l hy P g l d* and *P parv lu* M h b m pe m

Commercıal species Sınce 1977 consıderable emphasıs has been gıven to ımprovıng the qualıty of seeds ın the *Phaseolus* bank Durıng seed ıncrease all materıals showıng vırus symptoms (ı e bean common mosaıc vırus) bacterıal blıght and anthracnose are rogued routınely Of the 14 626 accessıons now ıncreased and stored ın the germplasm bank most have been replaced wıth recently harvested seeds provıdıng them a hıgh germınatıon percentage and a lower frequency of seed borne dıseases

Thirty two descriptors of bean growth performance and seed qualities are sought during evaluations for later indexing Table 2 summarizes the numbers of accessions for which various characters have been obtained Evaluation of more accessions continues meanwhile a catalog has been completed with evaluation information for 10 000 accessions Jointly with the *Phaseolus* Germplasm Advisory Committee of IBPGR new descriptors have been added to provide a more intensive documentation of the collection

Preliminary evaluation of *P lunatus* and *P acutifolius* have begun and will utilize some of the *P vulgaris* descriptors More than 200 accessions of *P lunatus* have been evaluated selected materials from this collection have been distributed widely in Latin America

T bl 2 N mb f f **Phaseolus ulgaris** e luated at CIAT P lm f h f 30 p m ry pe fo m ch t

Ch te	N a ce aluat d
Day t m g	4929
Hypoc tyl l gth	4918
Hyp tyl l	8684
Le fl t l gth	4801
C py h ght	6401
Leafl t w dth	4801
N d t fl we g	6845
No ode at m t ty	5832
Days t flowe ing	6971
Fl weri g du at o	6938
Flowe c l	8694
G wth hab t	9846
Pl t he ght	7360
Stem thi kn	4786
N aceme pe pla t	7690
N pods pe plant	8890
Bran h gl	3665
S d pe pod	6544
Seed hape	10 258
Major seed color	10 256
Seco dary seed l	10 256
Seed brillian	10 290
Se d we ght	9940
Y ld pe pla t	4542
Total dry matter	4562
Reacti n t rust	2084
R ct t anthracnose	10 000
Reaction t bea comm m sa c virus	10 000
React o t b ct rial bl ght	4000
R ti t l afh ppe	8682

Cha rs w h risk h se ec mm ded by th *Phas lus* Germplasm Ad ry C mm ttee he I te nati nal B d f Pla G Res ce J ly 1978

Other *Phaseolus* materials The use of some wild forms of *P vulgaris* and *P coccineus* for improving crops of *P vulgaris* is being studied in collaboration with the University of Gembloux Belgium

In the case of wild *P vulgaris* some 336 accessions have been seed increased Of the 90 accessions evaluated up to now for morphological and agronomic characters none was interesting as a source of plant architectural characters

For disease and pest resistance promising materials have been selected for their promise against common bacterial blight (three accessions) angular leaf spot (one accession) bean golden mosaic virus (two accessions) and the leafhopper (15 accessions) These materials will be considered as sources of germplasm for a crossing program with cultivated *P vulgaris* after additional testing

A method for increasing seed of *P coccineus* was initiated The efficiency of pollination (measured in seed production) increased 10 30% when honeybees were used instead of manual pollination All pollinations were done in cages each of which hold nine plants to prevent outcrossing among accessions

Pollination experiments are now being repeated to compare seed yield and cross pollination by manual means honeybees and bumblebees A large scale seed increase of the *P coccineus* collection will be made following this study

Distribution of *P vulgaris*

In addition to distributing *P vulgaris* germplasm to team members of the Bean Program for their respective disciplinary evaluations and for utilization in the crop improvement projects the Genetic Resources Unit also sends materials to other centers institutions and national programs A total of 3245 samples were distributed outside CIAT during 1980

These materials are being evaluated and promising materials will form the parents of their crossing programs Within CIAT those accessions that conform to the commercial types (seed size color etc) are further evaluated between the Genetic Resources Unit and the Bean Program

Bush Bean Improvement

The preliminary evaluation of germplasm bank accessions for general adaptation and agronomic traits continued during 1980 All Bean Program disciplines contribute to the screening and selection of germplasm accessions and in the reselection of hybrid progenies Selected accessions from the first 13 500 bank entries (previously evaluated in hill plots) were reevaluated in row plots at CIAT Palmira and Popayan Some 500 accessions subsequently entered the crossing nursery and another 1700 accessions have been multiplied for more thorough evaluation

Hybridization activities during 1980 focused on specific character development the improvement of selected widely grown cultivars and the recombination of multiple disease and insect resistances into well adapted progenies with commercial grain types

Table 3 reports crosses made during 1980 grouped by breeding project or objective The apparent reduction in the number of crosses for architectural traits and for low soil P and the absence of new crosses for national program cultivars reflect the lack of new base parents in those projects as well as the incomplete disposal of segregating materials from the previous cycle of crosses

T bl 3 B h be mad th CIAT Be P gr m d n g 1980

B dıng p j t	N f se
D seases	
A g la l f p t	101
A th	115
Bean omm m sa rus (back osses mult pl g)	220
Bea golden m sa	151
C mm b t l bl ght	322
Hal bl ght	1
P wd ry m ld w	51
R t	38
W b bl ght	51
Wh te le f pot	16
Insects	
Bea pod wee l *(Ap)*	51
Le fh ppe *(Emp s)*	85
Oth f ct rs	
A ht t	55
Ea ly m tu ty	4
Lat m tu ty	2
L g t m g rmpl m mp m t	181
Low l P t l ra	1
Mis ella	48
M lt pl fa t	665
Imp d t g f t	202
T tal	2380

Breeding activities for resistance to powdery mildew and halo blight were initiated in 1980 and the project on long term germplasm development has been divided due to its unique management In this project general improvement of germplasm accessions is designed to amplify the genetic base of future experimental lines and to increase the value of hybrid populations from subsequent cycles The selection and grouping of bank accessions for hybridiza tion are based on geographic origin and grain type This should gradually reduce the need for improvement of specific national cultivars Since hybrid populations from these crosses are seldom subjected to severe climatic and disease stress and selection pressure is generally low (30-35%) relative progress is expected to be slower

Crosses designed to improve national cultivars have produced within a relatively short period of time improved experimental lines with grain types similar to Flor de Mayo Pinto and Ojo de Cabra (all from Mexico) Carioca Mulatinho Bica de Ouro and Roxao (all from Brazil) an array of small seeded red types for Central American preferences and several Pompadour and Calima types While all of these new lines are resistant to BCMV many also carry desirable sources of resistance to anthracnose bacterial blight halo blight and/or rust For several color groups *Empoasca* resistance is markedly superior to that found in comparable local varieties

A list of experimental lines grouped according to specific and multiple factor projects which were advanced to the 1980 VEF for testing is summarized in Table 4

I bl 4 Exp r m t l b h bea l nes that w ad an d t th 1980 U f m Bea T m N sery (VEF)

B d g p j t	N of li e	Gra type
Diseases		
A g la le f p t	19	B az l
A th ac e	32	B az lia Me ca othe s
Be g ld m s c u	19	Central Am ca Brazil a
C mm b t al bl ght	71	Various
Halo bl ght	15	Me can
Insects		
Be p d w l *(Ap n)*	9	Ce t al Am ca
L fh pp *(Empo)*	11	V n
Other f ctors		
A h t tu	40	B azilia
Lo g t m g mplasm mp m t	11	
Low l P t l	22	B azilia
Mult pl f t	112	V n
Imp m t f nat nal lt rs	13	Various
Total	374	

Clımbıng Bean Improvement

Methodology Thıs year parental varıetıes selected from the germplasm bank and from advanced breedıng lınes were formed ınto populatıons for ımprovement by hybrıdızatıon and selectıon (Table 5) Varıabılıty ıs sought ın parents of other graın types only when a populatıon lacks some specıfic varıabılıty as ıs especıally the case wıth some dısease and pest resıstances The purpose ıs to define more clearly the objectıves for partıcular graın types and to lımıt segregatıon ınsofar as possıble to the prıorıty factors Internatıonal trıals of clımbıng bean lınes are formed from the best of the approprıate populatıons

T ble 5 Cl mb g be mp eme t p j t d p rıty d sease a d nse t re sta ces so ght by th CIAT Bea P g m l t t l m t g o f Lat n Amerı a and gra type pref ences

Clım t	P p lat	G typ	D se se								Inse ts	
			BCMV	BYMV	ANT	ANG	ASC	RUST	CBB	HALO	EMP	APION
W m (18 25 C)	VNB[1]	Sm ll bla k	X					X	X		X	
	VRB	Sm ll ed	X					X	X		X	
	VCB	Wh te m y ll w ffe	X	X	X	X						
C l (13 18 C)	VNA	Bl k	(X)		X	X	X					X
	VRA	R d	(X)		X	X	X			X		
	VCA	Wh t me y ll w	(X)		X	X				X		X
	VNU	N	(X)		X	X	X			X		

BCMV be mm m BYMV be y ll w m sa ru ANT thra ANG g la l f p ASC A hy l f p CBB mm b ıal bl gh HALO h l blıght EMP *Empoa* APION *Ap*
BCMV d bl ll m t l b rm lly mp rta t d sease ool l mat (X)
V d f VINAR(l lY ld d Ad p N ryf bea Lat Am ca) N R d C f bl k d d m l re p ly B f l wl d A f h ghl d d U f h na b g (ll Sp h)
N yp f be p pped h l d mm ın h ghl d reg

Tabl 6 C pp g y t m sed f sel t o p p l mb g bean mp eme t p j ct

Cl m t a d l at o	Mea temp tu (C)	Nu ry d ge at on		
		Singl plant select F_2/F_4	F mily trıal F_3/F_5	Ad ced trıals (VEF) F_6
Warm				
CIAT P lm	25	R	A	A
CIAT P pay	19	R	A	A
Cool				
ICA La S l a	17	R	R	R
ICA Ob	13	A	A	A

R R lay pp g w h m (be pl d l phy l g cal mat y f maız)
A A ocıa d pp g h m (b pl d m l ly w h m)

Clımbıng bean breedıng projects were dıvıded among locatıons last year wıth most selectıon for the warm clımate populatıons beıng done at CIAT Palmıra and CIAT Popayan and for cool clımate populatıons at ICA La Selva and ICA Obonuco All field selectıons are done under relay croppıng or assocıatıon (sımultaneous plan tıng) wıth maıze accordıng to the scheme presented ın Table 6 Relay croppıng wıth ıts hıgher seed multıplıcatıon rate ıs more suıtable for sıngle plant selectıon but ıs not possıble at ICA Obonuco due to the long growıng cycles of both crops

Germplasm Evaluation In CIAT Palmıra and CIAT Popayan a collectıon of 479 clımbıng varıetıes from Guatemala maınly wıth small black graıns was evaluated ın assocıatıon wıth maıze for yıeld and field resıstance to local dıseases and pests A total of 17 selectıons was taken from the two locations In ICA La Selva 723 materials were evaluated in relay cropping with maize these were collections from Spain and Portugal and the highlands of Colombia Ecuador and Peru Fifty six selections were made In ICA Obonuco 204 materials consisting mainly of collections from the highland of Ecuador and Peru were evaluated in association with maize and 16 selections were made

Yield trials were also planted in the four locations to evaluate more thoroughly the 180 selections from germ plasm made last year Among the five highest yielding varieties in each location black seeded materials from Guatemala predominated at CIAT Palmira various grain colors including black accessions from Guatemala and Mexico were predominant at CIAT Popayan and ICA La Selva and various colors except black from Colombia and Ecuador predominated in ICA Obonuco Table 7 shows yields and other characteristics for the groups at each location Days to flowering and physiological maturity increased as temperature decreased day length was constant as all are within 6 of the equator Seed weight also increased as temperature decreased Genetic effects were similar to the environmental effects varieties adapted to cold temperature locations (group 4) tended to be later and have larger grains at all locations

Large interactions of varieties with temperatures were evident particularly between groups 4 and 1 At CIAT Palmira there was no significant difference between yields of groups 2 and 3 and at ICA Obonuco groups 1 to 3 did not differ (Table 7) Otherwise all differences were significant The results indicate that none of the locations is dispensable but that ICA La Selva and CIAT Popayan are the most similar The best overall performance of all varieties occurred at ICA La Selva

T bl 7 Ch te t of f u g ps f l mb g bea ari t luated w th maize f locati ns

Locat	Pl t g y t m	V tal gro p	Be y eld (kg/h)	Days to fl w g	Days t phy l g cal m t r ty	100 seed we ght (g)
CIAT Palm	A	1	1406	46	93	21
(25 C)		2	804	42	93	24
		3	752	42	94	25
		4	23	64	102	32
		LSD 5%	150	Mea 49	96	26
CIAT P pay	A	1	871	52	93	23
(19 C)		2	1574	47	100	30
		3	1277	52	102	30
		4	96	67	113	31
		LSD 5%	208	Mean 55	102	29
ICA La S l	R	1	2127	63	137	26
(17 C)		2	2611	62	130	35
		3	3076	63	139	32
		4	1186	76	153	40
		LSD 5%	348	Mean 66	140	33
ICA Ob	A	1	84	99	188	22
(13 C)		2	139	96	189	38
		3	78	96	188	36
		4	1635	103	188	56
		LSD 5%	222	M 99	188	38

A A oc t h m R l y pp g h m
G p l high t y ld g f t CIAT P lm 2 h ghe t yield g f iet t CIAT P p 3 h gh y ld g f t ICA La Sel
4 high t y lding f ICA Ob

The behavior of varieties in group 4 (adapted to cold temperatures) was completely opposite that of varieties in the other groups indicating a sharp break in adaptation between 13 and 17 C Varieties in group 4 have certain characteristics in common with *P coccineus* subsp *polyanthus* from which natural introgression may have occurred

Single Plant Selection Nurseries Single plant selection nurseries in each location consist of populations in generations F_2 and F_4 the latter having passed the progeny yield trials in F_3 The number of populations handled and the number of selections made are shown in Table 8

Considerable emphasis was placed on selecting materials with highland adaptation since the large grain types adapted to cool temperatures had previously received little attention

Tbl 8 Dtbt f lmb gb gl pl t ele t rsene (F_2/F_4) 1979 80 se o

At ty	Locat on and seas						T tal
	CIAT P lm a		CIAT Pop y	ICA La Sel		ICA Ob	
	1979B	1980A	1979B	1979B	1980A	1979B	
No f p pul t	77	132	10	84	25	17	345
N f pl t	16 600	13 120	3600	32 680	7511	5100	78 611
N f pl t sel t d	188	279	42	707	334	291	1841

Progeny Trials Progeny trials were planted for the first time in ICA La Selva and ICA Obonuco in the second half of 1980 Beans were planted at relatively low densities (40 000 plants/ha) with no disease control and only minimum control of pests so as to favor relatively rustic types capable of producing under low input conditions

Likewise in CIAT Palmira and CIAT Popayan a total of 881 progenies in 228 families was tested (Table 9) The usual negative relationship between bean and maize yield was found at CIAT Palmira and selections were taken from above the regression line as reported last year (CIAT Bean Prog 1979 Ann Rept) Selected lines not only yielded more beans but also permitted a higher than average maize yield Selected progenies were either returned to single plant selections in F_4 or passed on to the VEF stage of testing in F_6

The efficiency of the early generation selection methodology used to maximize bean yields while minimizing losses in maize yield due to competition was tested in a special trial carried out at CIAT Palmira with the maize variety Suwan I The objective was to discover the heritability of selecting for bean and maize yield in F_3 families Families from an F_3 progeny trial therefore were divided into the following groups A) low yield of maize and beans (families 22 25 32 37) B) high yield of maize and low of beans (families 1 2 12) C) high yield of both crops (families 5 15 18 28) and D) low yield of maize and high yield of beans (families 10 21 29) Lines from these families were planted in the F_4 generation in a lattice design and the mean yields of beans and maize per family were calculated and compared with those obtained in the F_3 generation grown the season before (Fig 1)

Table 9 Y ld f l mb g be d maize as c at n bea F_3 d F_5 p ogeny trial at two locat ns

S as	Lo t	N f be f m li	N f p ge y	N f f m l es select d	M a bea y ld (kg/ha)	M be y eld of select ons (kg/ha)	M n maiz y ld (kg/ha)	Mea maize yi ld w th bean select (kg/ha)
1979B	CIAT P lm ra	80	253	27	527	876	5518	5609
1980A	CIAT Popaya	45	140	23	629	755		
1980A	CIAT P p y	58	488	26	592	696		

R g es oeff b w bea d maiz y ld was I 15

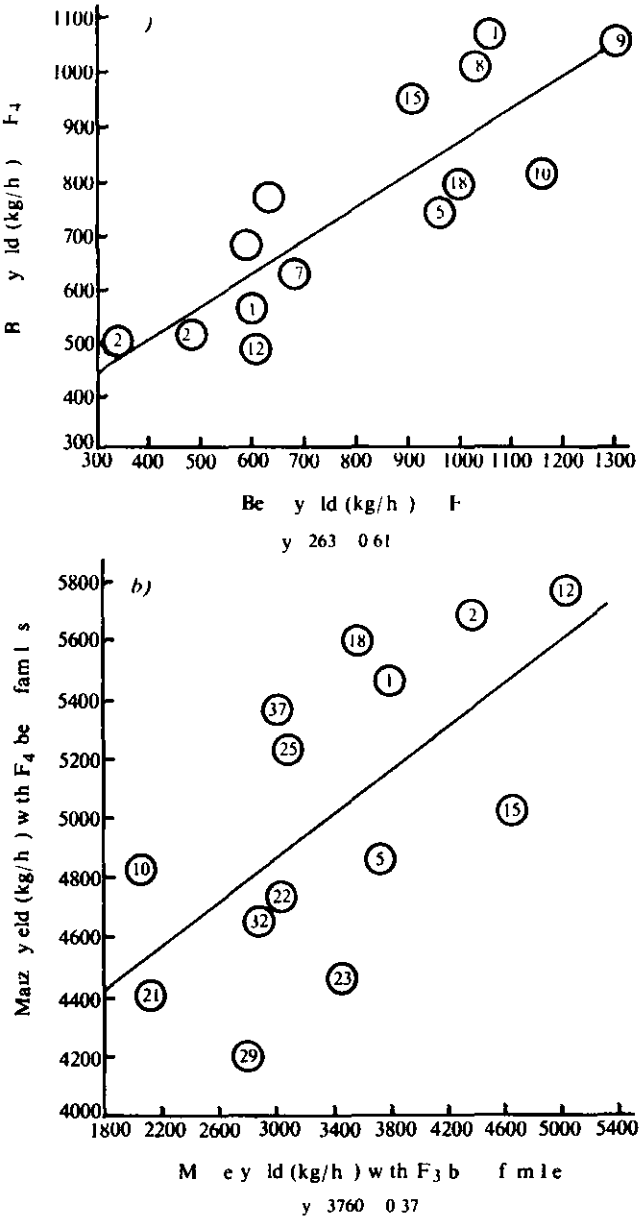


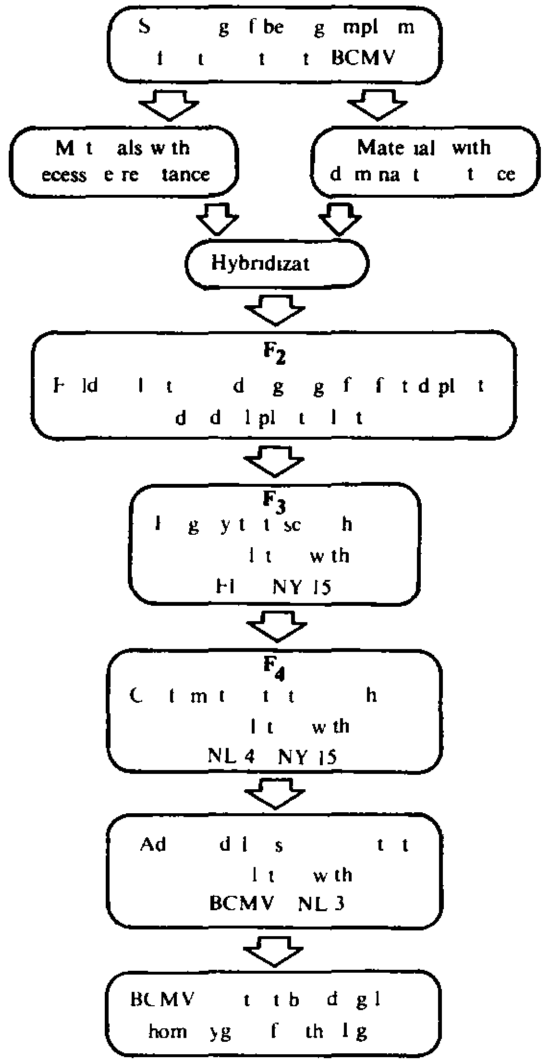
Fig 1) Y ld f lmb g b n f m l l t d th F_3 nd t t d n th F_4 g t b) Y ld f Suw n l m d th th b f l

The lowest value (1 6%) for maize stem lodging was obtained with group B and the highest value (10 0%) with group D This latter group was also the latest to flowering (38 days) and physiological maturity (81 days) while group B was the earliest for both (36 and 77 days respectively) Group C families were intermediate for all characters and generally had a type IVa growth habit These results indicate that bean lines can be selected in the early generations for combined bean and maize yield in association

A total of 86 breeding lines of climbing beans were advanced from progeny trials to the VEF together with 79 selections from the germplasm bank

Resistance to Viral Diseases

Bean Common Mosaic Virus A screening methodology for bean common mosaic virus (BCMV) has been developed and implemented It is based on information available about the genetics of resistance of the host *P vulgaris* and the pathogenicity of the virus The BCMV screening procedure is outlined in Figure 2 Table 10 shows the most representative bean cultivars and BCMV strains grouped according to their respective resistance and pathogenicity genes



F g 2 S g n h d l g f th CIAT Be Pr g m eek g t t b m m ru (BCMV)

T bl 10 G t t t b tw *Phaseolus vulga is* a d prese t t bea mm m sa ru tra ns p e t Lat Ame ca

C lt g p	R t nce g	BCMV t a a d path gen c ty ge				
		Typ PO	FLA P1 1	NY 15 P1 2	NL 3 P1 1 2	NL 4 P1 1 2
Recess e esist						
Do bl Wh t						
Im	b 1					
R dl d (1 1 B	b 1					
M h l t	b 2					
P t 114	b 1 bc 2					
G t N th 31	bc 1 b 2					
D min t esist						
W du a	I				N	
J b l	I b 1				N	
T p C p	I b 1				N	
Am d	I bc 1					

A d g E D jth Pl Breed g I (IVT) h N th l d
FLA Fl d NY 15 N Y k 15 NL N h la d
M sa N y m bl k

As a first step an attempt is made to introduce a dominant gene called the necrosis (I) gene into mosaic susceptible bean germplasm The dominant I gene prevents the systemic infection of the plant and consequently the transmission of the virus in the seed of plants possessing this gene Since beans are the primary source of BCMV in the field the dominant I gene has conferred stable resistance against BCMV to some of the bean cultivars grown for many years in Latin America such as Porrillo Sintetico Jamapa ICA Pijao Mulatinho and Bico de Ouro

Recessive genes can also protect bean cultivars against some but not all strains of the virus (Table 10) Therefore considering that BCMV strains have been widely distributed into most bean growing areas via infected seed the Bean Program is not entirely relying on these recessive genes as a stable source of BCMV resistance Some of these genes specifically bc 1^2 and/ or bc 2^2 of the Great Northern 31 group of bean cultivars however protect dominant I gene materials against BCMV strains such as NL2 NL3 NL5 NL6 and NL8 which can induce a hypersensitive reaction resulting in the death of the plant This phenomenon of systemic necrosis known as black root has not however been observed at significant incidence levels in commercial fields of cultivars possessing dominant resistance Nevertheless the Bean Program as a second step in the breeding for BCMV resistance is already attempting to incorporate these recessive genes into I gene materials This year F_3 families from crosses of multiple (recessive + dominant) sources from the Plant Breeding Institute (IVT) the Netherlands crossed to tropically adapted CIAT lines were reselected in the Netherlands and backcrossed to the best CIAT breeding lines

The actual screening methodology (Fig 2) consists of four main steps

a) Inoculation of bean germplasm with several BCMV strains to furnish breeders with information on the genetics of resistance of selected accessions
b) Roguing of BCMV susceptible plants in F_2 nurseries planted under high natural virus incidence conditions to facilitate the selection of individual symptomless plants
c) Inoculation of seedlings grown from 20 seed samples of the individual selections made in the field with a mixture of BCMV strains to detect homozygous resistant F_3 lines under screenhouse conditions (Fig 3)
d) Confirmation test on F_4 lines to identify and eliminate materials which possess only recessive genes for resistance to BCMV and performance of the necrosis test on selected symptomless lines to ascertain the presence of the dominant I gene (Fig 4)

The combined field screenhouse and glasshouse evaluations done this year for BCMV involved more than one-quarter million plants or an average of 2000 inoculated and evaluated per working day The efficiency of selection of homozygous BCMV resistant lines in the F_4 was above 95% for those materials which followed the recommended screening procedure

F g 3 *I l t n f b dl ngs n th enhouse to d t t hom ygou sist to bean mmon m rus (BCMV) t the* F_3 *t g*

F g 4 *U f th ne o t t t d t t p of the d m n nt I g n fo ist nce to b n omm mo ru (BCMV) Th l f t l ft nd t th th pl nt th I g n but th l f t ght h w no t ymptom f llo g th n l t on w th t st in f BCMV*

Bean Yellow Mosaic Virus Bean yellow mosaic virus (BYMV) continues to be a severe problem in some bean growing areas around the world In Latin America Chile is the country most affected due to the favorable environ ment abundant vectors and both mosaic and necrosis inducing strains of the virus

CIAT's initial efforts to control this virus are therefore directed towards the development of resistant cultivars with the cooperation of Chilean scientists It has been observed that the resistance sources selected to transfer recessive genes that protect dominant I gene bean cultivars against necrotic strains of BCMV namely Great Northern and IVT selections seem to confer some degree of resistance to some BYMV strains Thus progenies of crosses with these materials will be simultaneously evaluated in Chile for their resistance to mosaic and necrosis inducing strains of both BCMV and BYMV

Soybean Mosaic Virus Reports from Brazil were investigated concerning the development of systemic necrosis in dominant I gene bean cultivars infected with some strains of the common soybean mosaic virus (SMV) At CIAT several isolates of SMV obtained from infected soybean seed were tested on the BCMV differential cultivars Results indicated that while all isolates induced vein necrosis on inoculated primary leaves of some I gene cultivars it remained localized unlike the necrosis induced by BCMV necrotic strains which spreads from inoculated leaves to the entire plant Also the SMV isolates tested at CIAT caused systemic necrosis in some non I gene cultivars such as Double White suggesting that genetic interaction between *P vulgaris* and BCMV differs with respect to SMV Soybean mosaic virus however should be taken into account whenever beans are grown near soybean fields

Bean Chlorotic Mottle In 1980 a preliminary study on the etiology of this disease was completed Results obtained so far indicate the existence of a virus complex rather than a single white fly borne virus as believed earlier The viruses frequently found associated with the chlorotic mottle syndrome include cucumber mosaic virus bean mild mosaic virus and a strain of bean southern mosaic virus Also a geminivirus similar to the whitefly borne agents was isolated at Wageningen the Netherlands from plants collected at CIAT The epidemiology of the virus complex will be studied in bean nurseries at CIAT to further delimit the problem and assess its economic significance

Bean Golden Mosaic Virus Breeding efforts in the bean golden mosaic virus (BGMV) project during 1980 shifted towards specific goals for several grain types For black seeded types where excellent levels of BGMV resistance exist in the new Guatemalan varieties (CIAT Bean Prog 1979 Ann Rept) crosses and progeny management are designed to incorporate earliness and resistance to common bacterial blight and anthracnose into superior BGMV materials

For bean consumed in Central and South-central Brazil good levels of BGMV resistance have been available for several years But testing and reselection of more resistant progenies as well as the recombination with additional factors have become difficult due to the prevalence of severe virus insect and temperature conditions in the BGMV nurseries More work is needed in Brazil to clarify the problem

Work on Pompadour types for the Dominican Republic has progressed slowly for two reasons a) the susceptibility of parental types to BCMV which necessitates reselection and b) the general susceptibility of Pompadour to *Empoasca* and common bacterial blight Several in teresting selections with a small Pompadour grain type are currently being progeny tested

Small brilliant seeded reds have also been slower to advance due to overall disease susceptibility (including BCMV) and a lack of continuity in the evaluation/selec tion/progeny testing process

Most BGMV crosses now involve only parental lines resistant to BGMV so that the best F_2 plants with resistance to rust and the leafhopper may be bulk harvested according to grain type and evaluated in the F_3 under local (BGMV) conditions by the national program

Results from testing the 1979 International Bean Golden Mosaic Virus Nursery (IBGMVN) in two locations are reported in Table 11 Few hybrid selections were well adapted in both locations

The adaptation and BGMV resistance of the predominantly non black hybrids were generally less than that of the five blackseeded check varieties which have been extensively used as parents in the BGMV project A few materials were superior to the group of checks at each location

T bl 11 Mean daptat o a d b g lde mosa c rus ore f 145 ad anced sele t ons evaluated G tem la and B azil compared t mea l f th f be t select o s and a group f f e es sta t check a et

Locatio	Adaptatio			Be g ld n m sa c us		
	A g ll lect ns	Best 5 select o	Checks	A e age ll elect	Best 5 le t n	Ch ks
Guatemala	3 9	2 7	3 6	7 5	4 6	6 4
Braz l	3 8	2 6	3 2	7 2	5 4	6 0

M l f ad p wh l cell t 5 ry p

Mea l f be g ld m sa scep bil y wh re l mm 9 ry uscept bl

Resistance to Fungal and Bacterial Diseases

Bean Program germplasm and breeding progenies were routinely evaluated for their disease resistance in specific breeding projects and nurseries such as the 1980 Bean Team Nursery (VEF) and Preliminary Trials (EP) Primary emphasis continued on identifying and selecting for resistance to rust anthracnose angular leaf spot and common bacterial blight Advanced materials primarily EP entries were also evaluated for resistance to pathogens causing the lower priority diseases powdery mildew halo blight white leaf spot root rots and root knot nematodes

Various germplasm accessions and Program-developed materials were resistant to halo blight white leaf spot and powdery mildew the latter disease reduced yields of susceptible materials up to 69% in Popayan Very few or no advanced lines expressed promising levels of resistance to root rot or root nematodes respectively

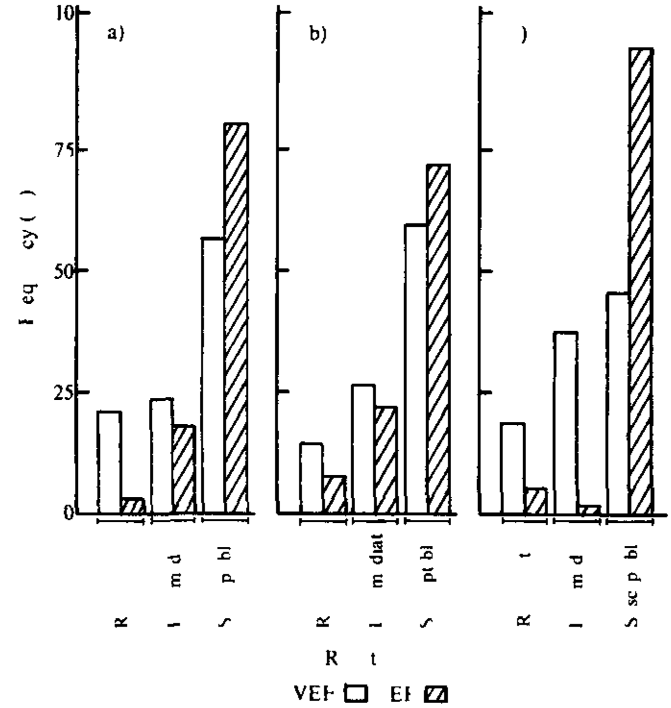
Fungal Pathogens

Uromyces phaseoli (rust) and *Colletotrichum lindemuthianum* (anthracnose) are highly variable pathogenically due to the existence of numerous physiological races that differentially infect diverse sources of plant resistance

Recent research at CIAT confirmed reports that *Isariopsis griseola* (angular leaf spot) also exhibits pathogenic specialization This inherent variation has complicated CIAT based efforts to identify and develop improved germplasm with resistance to rust anthracnose and/or angular leaf spot populations endemic to diverse bean production regions throughout Latin America and now Eastern Africa

Primary emphasis is placed upon utilization of CIAT based resources and scientific expertise to most efficiently screen large numbers of germplasm at CIAT Palmira for resistance to local populations of the rust fungus and at Popayan for resistance to local populations of anthracnose and angular leaf spot pathogens Entries with high or intermediate resistance levels are sequentially evaluated at the primary site to verify their disease reactions and/or at secondary field sites or in the glasshouse to identify more stable and widely based sources of resistance effective against different regional populations of each pathogen This disease resistance strategy allows the Bean Program to identify and then distribute agronomically desirable resistant materials for further testing on an international basis in formal nurseries such as the International Bean Yield and Adaptation Nursery (IBYAN) and International Bean Rust Nursery (IBRN) or in informal nurseries upon request by collaborators and out posted CIAT staff

The value of this regional testing for identifying more stable resistance to rust angular leaf spot and anthracnose is apparent in Figure 5 which illustrates the degree of race and site specific resistance that was eliminated in the 1979 VEF/1980EP test Subsequent international testing schemes such as the IBRN further confirm stability of a resistance source or alert programs to the presence of races that differ from those available in Colombian screening populations Table 12 summarizes the international reactions received to date for various entries submitted to the 1979/1980 IBRN based upon their rust reactions in the previous 1978 VEF 1979 EP regional trials in Colombia Anthracnose and angular leaf spot resistant germplasm identified in Colombian trials will also be increasingly tested on an international basis in order to identify more stable disease resistance for use by collaborators and CIAT workers



F gu 5 *R t n f 105 b t th 1979 Be T m N y (VEF) d th 1980 P l m) 7 l (EP) t p thog lly bl f th d) A gul le f pot b) Ru) A th*

Table 12 Int t n l Bea R t y (IBRN) pe f m n e f CIAT g mpl m l ted f u t ea t p g al t l C lomb a

E t y	R t e t 1978 VEF d 1979 EP	Ru t at ng 1979/1980 IBRN R	I	S
Pint N 650 (S pt bl h k)	S pt bl	1	0	17
BAT 445	I t m d t	11	7	0
BAT 256	I t m d t	14	3	1
BAT 76	I t m d t	15	3	0
BAT 332	Re ta t	11	4	3
BAT 93	R t t	12	6	0
BAT 261	R t t	13	5	0

P l m ry p t m h f ll g mbe f IBRN loc t Bra l 3 C l mbia 5 D m R p bl l E d l M 2 P l R p bl f So h Af l l l U ed St 3
R l med S p bl

Anthracnose Emphasis has again been given to identifying sources of anthracnose resistance broader than those found in Cornell 49 242 (G 5694) More than 50 bank accessions are in the final stages of evaluation and purification From a limited number of crosses made in 1978 32 bush bean lines involving five different sources of resistance were developed for Brazil and Mexico Now that more and better sources of resistance are available and since hybrid lines from this project also carry resistance to BCMV bush bean crossing activity in 1980 was expanded to include commercial grain types for Argentina and the Andean highlands Also up to three parents have been crossed together with the objetive of combining unique sources of resistance in representative commercial types

In the climbing bean breeding program germplasm selected from 1979 evaluations was advanced to multiloca tion yield trials and separately tested under controlled conditions for resistance to anthracnose and bean common mosaic virus (BCMV) Disease reactions given in Table 13 indicate a high frequency of resistance to anthracnose among the selections High levels of natural infection were present in the field especially in ICA La Selva The levels of resistance to BCMV were much lower and all resistant material had either black or white grain color

The modified backcrossing program initiated in 1979 to incorporate resistance to both anthracnose and BCMV into high yielding climbing bean accessions was extended to include in addition to Cargamanto two red seeded highland adapted lines ICA L 32980 M(4) and ICA L 32980 M (8) and two Peruvian highland varieties (canarios) Ancash 143 and Compuesto 11 The program was initiated using Cornell 49 242 as the donor parent for BCMV + anthracnose resistance but this source has now been superseded by three climbing bean breeding lines V7917 V7918 and V7920 These are resistant to BCMV and at least six races of anthracnose including those known to be virulent to the Cornell resistance source (as determined in the collaborative program with IVT the Netherlands) From the backcrossing program with Cargamanto 57 progenies from double resistant plants are in yield trials

T bl 13 Freq y f ista t th a a d bea c mm mosa c s d t ted by o l t o de o t olled d t n in sel t f m l mb g b g rmplasm e aluat s

D	N f l t t st d	D se rea t f qu cy (%) R	I	I	S
A th a	58	19	28	19	34
Be mm m ru	57	14			86

A h R l m d rat ly ta t hypoc yl l l m d ly p bl hyp yl l S usc pt bl
B mm m es Fl d d NY 15 R ta S scep bl

Angular leaf spot Crossing activities were intensified in 1980 when six new parents resistant to Colombian isolates of angular leaf spot were identified All hybrid materials including 19 experimental lines developed from the crosses involving line A 21 were transferred to this project However it was learned that in Costa Rica A 21 was among the most susceptible materials to the angular leaf spot pathogen This information and the fact that pathogenic variation has recently been noted between isolates collected from different parts of Colombia may make breeding for resistance to this disease relatively difficult

Bacterial Pathogens

Xanthomonas phaseoli (common bacterial blight) and *Pseudomonas phaseolicola* (halo blight) are serious bacterial diseases of beans They vary in pathogenicity due to the existence of various isolates or strains differing in the degree they may infect a variety Some researchers feel that halo blight pathogenic variation actually occurs from pathogenic races that differentially infect sources of resistance Work is currently underway at CIAT to characterize the pathogenic potential of Colombian collections of halo blight and to determine whether this variation is caused by races or simply by isolates possessing different degrees of virulence as is the case for common bacterial blight

CIAT's common bacterial blight research has concentrated its efforts upon identifying and incorporating high levels of foliage resistance into agronomically desirable germplasm based upon field and glasshouse inoculations with the single most highly virulent isolate of *X phaseoli* previously collected at CIAT Emphasis is then placed upon progeny verification of this foliage resistance and upon improving the level of pod resistance to reduce potential seed transmission of the pathogen The frequency of resistant entries in the 1979 and 1980 VEF trials reported in a later section clearly indicates the progress obtained Future efforts will emphasize incorporation of resistance into small seeded brilliant reds and opaque cremes as well as increasing leafhopper resistance in blight resistant populations

Research was recently conducted to determine the effectiveness or stability of resistance sources and progeny when inoculated individually in the glasshouse with a range of *X phaseoli* or *X phaseoli* var *fuscans* isolates collected from different regions of Colombia and the world Figure 6 illustrates the response of materials with different levels of resistance ranging from that of the resistant check (P I 196932 an accession of *P acutifolius)* to that of the susceptible check (Porrillo Sintetico) The figure clearly demonstrates the advances that CIAT has made in improving the level of resistance in our breeding lines (resistance derived from the material from the USA which came originally from an interspecific cross between *P vulgaris* and another accession of *P acutifolius)* selected upon their response to CIAT's single isolate (XP 123)

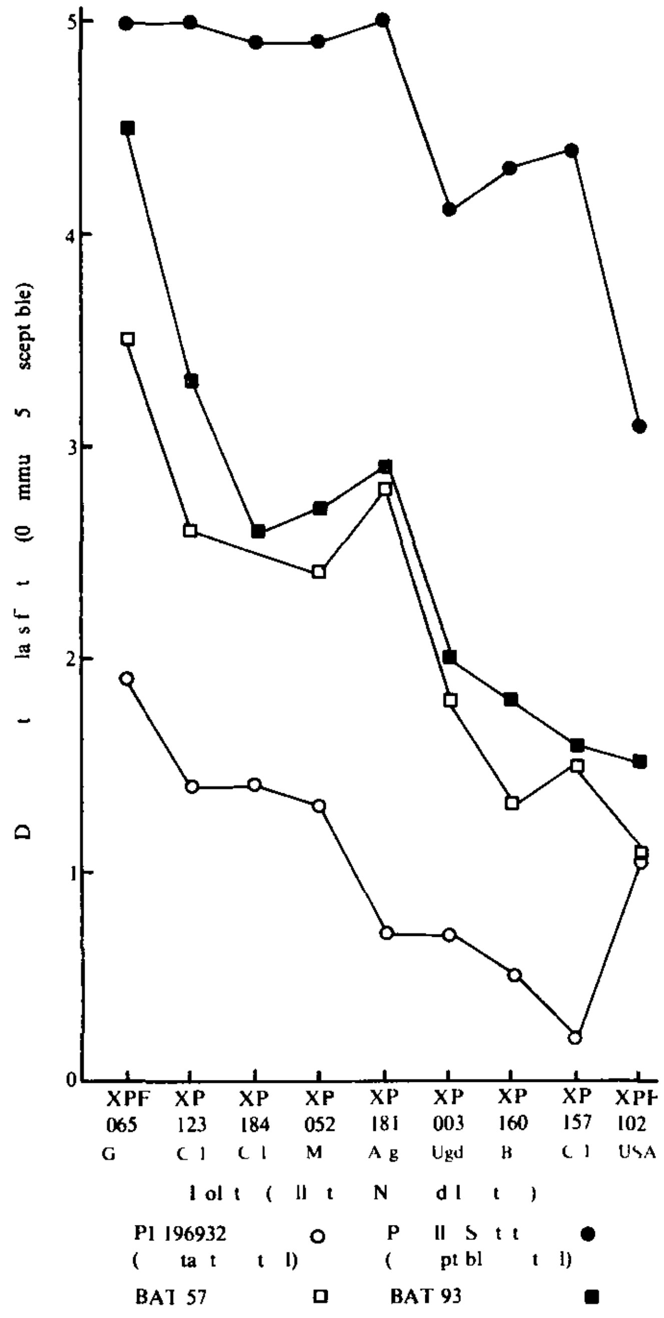


Fig 6 R p f l t db l l t w th d ff t l t f mn b t l bl ght (XP) nd fu us bl ght (XPF) p h g
G t G l C l C l b M M x A g A g t n Ugd Ug d B Br l

The figure also illustrates the extent of pathogenic variation that is inherent within collections of *X phaseoli* (XP) and *X phaseoli* var *fuscans* (XPF) isolates Isolate XPF did incite more infection than XP 123 Therefore disease resistance strategy will continue to be based on screening with the most virulent isolate However the overall stability of advanced resistant selection to collec tions of *X phaseoli X phaseoli* var *fuscans* and eventually other pathogenic species of *Xanthomonas* will also be monitored routinely

Halo blight Fifteen advanced lines for halo blight resistance were developed from older crosses of G 2858 and Aete 1/37 the two sources of resistance to this bacterial disease Currently however emphasis is on seeking better sources of resistance and transferring available levels of resistance into grain types for the Andean highlands and the semi arid temperate regions of Mexico

Resistance/Tolerance to Insect Pests

Emphasis in 1980 continued to be directed to identifying potential parent materials for use in strengthening resistance levels against the leafhopper The screening methodology was modified to provide more accurate assessments of resistance levels expressed in yield trials Basic studies were begun on resistance mechanisms against the spider mite

Leafhopper

Germplasm evaluation Almost 4000 materials from various nurseries were evaluated for resistance to the leafhopper *(Empoasca kraemeri)* in 1980 Only 1 3% of these were rated as resistant (less than 2 on a 1 5 visual damage score basis) most were utilized as parents in the recurrent selection program to increase resistance levels No resistance sources were identified among 128 wild *P vulgaris* entries a few selections were made from interspecific crosses between *P vulgaris* and *P coccineus* and in studies related to the heritability of *Empoasca* resistance in *P lunatus*

New non black entries were included in the international *Empoasca* resistance nursery Updated versions of this nursery were sent to Brazil the Dominican Republic Guatemala Honduras Mexico and Peru for further evaluation

Analyses of yield trials Disappointing results were obtained last year in a yield trial to assess progress in *Empoasca* resistance after two cycles of recurrent selection and intermating (CIAT Bean Prog 1979 Ann Rept) Accordingly a series of yield trials were planned to examine among other factors the potential interactions between planting date and resistance expressed by yield losses

Five sequential yield trials were conducted in 1980 Materials from initial crosses were compared to those from the second cycle of recurrent selection Results confirmed the poor and nonsignificant correlations between insect populations and visual damage scores and between visual damage scores and percentage yield reduction caused by *Empoasca* On the other hand the rank correlation coefficient between unprotected yields and percentage yield reduction was high (-0 748) and significant at the 1% level This suggested that insect counts and visual damage scores could be misleading in selecting for *Empoasca* resistance and that unprotected yield could be a better selection criterion Reproductive adaptation scores in segregating populations under heavy leafhopper pressure should then also be recorded

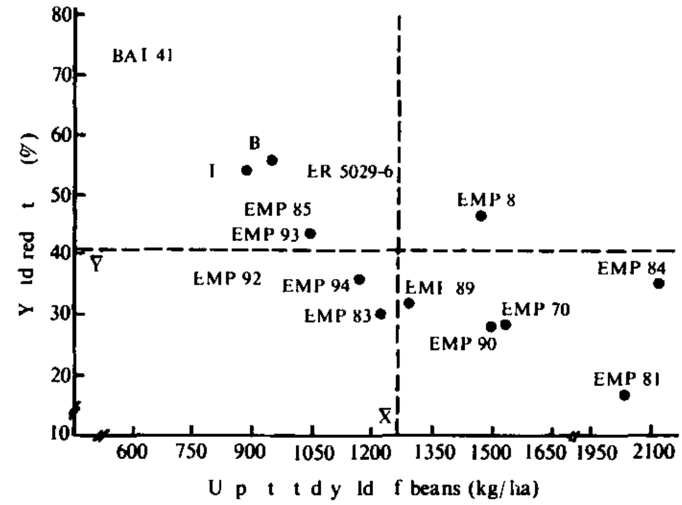
Based on these results selection procedures utilized in breeding for *Empoasca* resistance were modified thusly (a) potential parents would be selected based on visual damage scores and yield loss (b) individual selections in the F_2 would be done on a visual score/reproductive adaptation basis (c) F_3 nurseries would have as many replications as possible and families would be selected for their low visual damage scores and good reproductive adaptation scores and (d) replicated trials would be done in the earliest generation possible they are now being done in the F_4 stage In addition trials will be repeated at least twice per season since a significant genotype x environment interaction was detected

Twenty-eight F_3 families from the third cycle of intermating were then yield tested at the F_4 stage Under heavy infestation (5 8 nymphs/leaf and 3 8 adults/plant) significant progress was detected (Table 14) Thus non black materials such as EMP 81 EMP 90 EMP 83 and EMP 89 not only have a good yield potential when protected but also are significantly superior to the susceptible checks Bunsi and BAT 41 in terms of reduced yield losses Insect counts again did not correlate with percentage yield losses whereas the rank correlation coefficient between unprotected yield and percentage yield loss (r_s = 0 77) was significant at the 1% level In terms of unprotected yield the difference between the susceptible check (BAT 41) and the best material (EMP 81) stresses the importance of this parameter for selection (Figure 7)

T bl 14 M y ld f p t t d d p t t d pl t d y ld l se in F4 be mat rial selected fo th t t th l fh pp *(Empoas k m)* t CIAT P lmira 1980B

ld t f t	S d l	Y ld (kg/h)		Y ld lo (%)
		P t t d	U p tect d	
EMP 81	C m	2385 bc	1978	16 8
EMP 90	B w	2115 cd	1497 b	28 6 bc
EMP 83	B w	1716 d	1215 bcd	30 5 b
EMP 89	C m	1923 d	1290 bcd	31 8 bc
EMP 84	Bl k	3278	2112	35 7 bc
EMP 94	l pl	1903 d	1160 bcde	36 3 bc
EMP 92	Wh t	1456	908 ef	39 1 b
EMP 93	Wh t	1912 de	1048	43 7 b
EMP 82	Bl k	2774 b	1467 bcd	46 8 b
EMP 85	Y ll w	2059 d	1077 d	47 2 b
ER 5029 6	R d	2252 bcd	1093 d	57 1 b
EMP 70	C m bl k	2187 d	1539 b	28 9 bc
ICA I	Bl ck	1954 d	882 ef	54 3 b
ICA B	Wh t	2102 d	941 f	55 7 b
BAT 41	Red	2120 d	605 f	70 4

V l w h l m f ll w d by h sam l g fca ly d ff re h 5% l l
Imp d h k l rm d heck S scept bl heck



F g 7 *R l t h p bet np t d y ld d p nt g yield du t on used by th le fh pp* **(Emp kraemeri)** *n F4 b l ne el t d f ist n t CIAT P lm 1980*

During this experiment significant differences were found among nymphal and adult populations (Table 15) This suggests the possibility of further studying the mechanism of resistance to *Empoasca* Other interesting differences in population counts were found when resistant and susceptible *P acutifolius* accessions were tested for yield losses Some of these materials will be used in the future for this type of basic studies

The *Empoasca* breeding project continued this year into the fourth cycle of intermating Under very high insect infestation (14 0 nymphs/leaf and 8 9 adults/plant) 232 individual plants were selected from 123 F_2 populations Secondary emphasis was placed on non black non mulatinho commercial grain types having resistance to rust and bacterial blight Leafhopper resistant progenies of other commercial grain colors are now available

Tabl 15 A g ymphal d adult p p lat ons f the leafh ppe *(Empoa k m)* F4 bean mat rials sel cted fo th re sta ce t CIAT P lm a 1980B

ld t f t	Nymph p l f	Ad lt p pl t
EMP 82	8 3	4 2 abc
EMP 85	7 4 b	4 5 a
BAT 41	7 4 b	4 1 bcd
EMP 84	6 9 abc	4 3 ab
EMP 93	6 5 b d	4 0 abcd
ICA T	6 4 bcd	4 6 a
ICA Buns	6 0 bcd	3 4 bcd
EMP 70	5 8 bcd	3 8 abcd
ER 5029-6	5 5 cd	3 4 abcd
EMP 90	5 2 cd f	3 8 bcd
EMP 92	5 0 d f	2 9 cd
EMP 81	4 9 d f	3 5 bcd
EMP 83	4 6 fg	3 8 bcd
EMP 89	3 7 fg	3 2 bcd
EMP 94	3 2 g	2 8 d

V l w h l m f ll w d by h sam l t g fca ly diff re t h 5% l l
S sc p bl heck l m d h k Imp ed h k

Spider Mites

After developing a reliable screening methodology for spider mites (CIAT Bean Prog 1979 Ann Rept) more than 500 materials were studied under field conditions Of these 81 were selected for further screening and five were used to study the possible mechanisms of resistance to *Tetranychus desertorum* In the laboratory the total life cycle of *T desertorum* lasted two days longer (12 26 days) when reared on the resistant material BAT 93 The oviposition pattern and adult longevity were also significantly affected by this material

Total mortality on BAT 93 was 30% higher than on the susceptible check ICA Pijao These results which have to be confirmed both under greenhouse and laboratory conditions suggest that antibiosis might play a role as a resistance mechanism to *T desertorum* on beans

Yield and Plant Architecture

A general reduction in foliage size internode length and pod size is being sought across the three growth habits of bush beans The objective is to increase the number of pods and seeds per plant two characters highly associated with grain yield Forty lines were developed from crosses made in 1978 in some of them it was possible to transfer the principal architectural traits mentioned above into BCMV resistant lines with better grain types While none of these is exceptionally high yielding all are better than the original base parents It is hoped that these could be directly used by national programs or as parents in crosses to maximize the yield potential of commercial cultivars and further improve specific character expression

Among the lines showing one or more positive characteristics are lines A 55 and A 56 with suppressed branching and erectness A 132 and A 133 with short internodes A 199 (type I) with 10 or more nodes on the main stem and lines A 64 to A 68 A 152 157 and A 201 with a combination of small foliage short internodes and erect canopy

Tolerance to Moderately Acid Soils

The screening methodology for selection of materials efficient in using low soil P and tolerant to moderately high levels of soil Al and Mn has been described previously (CIAT Ann Rept 1978 and CIAT Bean Prog 1979 Ann Rept)

During late 1979 the breeding lines which had been tested for yield in the 1979 EP were tested for P efficiency Yields were generally high ranging from 700 to 2300 kg/ha in low P plots and from 900 to 3100 kg/ha in high P plots Nevertheless the screening method still permitted dis tinguishing between efficient and inefficient materials

Similar to last year s results the 10 materials most efficient in using low soil P and tolerant to moderately acid soils were all black or non red in seed color (Tables 16 and 17)

Lines such as EMP 28 BAT 458 and Carioca were among the 10 best in the combined evaluation for tolerance to acid soils (Fig 8) Last year s report that plants efficient in using low soil P were not necessarily tolerant to moderately high Al and Mn was confirmed

Table 16 Y ld p t tw le l f ppl ed P f th 10 m t ff tl w s l P bea mat ials a l w th l th 10% Al t t t CIAT Qu l h o 1979B

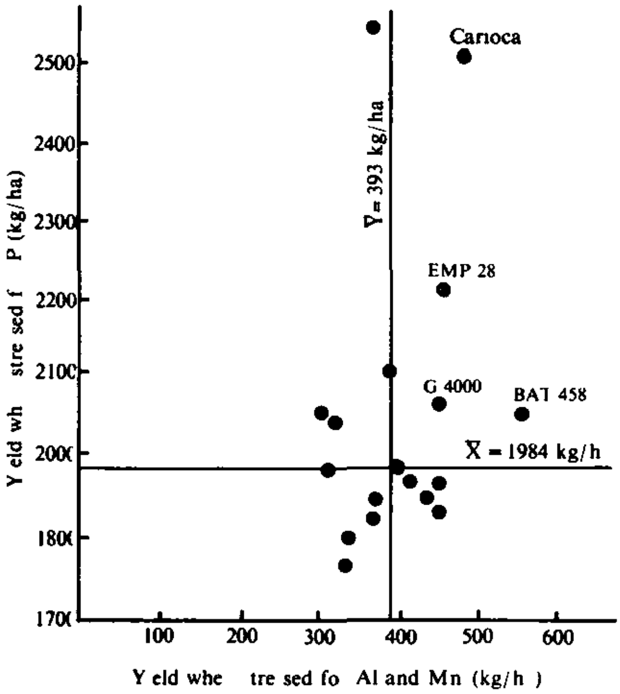
Ident f ca n	Seed l	G wth h b t	Bea y ld (kg/ha) t 50 kg/h P_2O_5	300 kg/h P O	P R ponse f t
Car	C em	III	2558	3129	2 3
BAT 449	Bl k	II	2543	3045	2 0
EMP 28	C em	II	2216	2739	2 1
BAT 115	Bla k	II	2155	3063	3 6
A 22	C m	III	2107	2824	2 9
BAT 458	Bla k	II	2061	2717	2 6
BAT 450	Bla k	II	2057	2715	2 6
BAT 263	Bla k	III	2049	2660	2 5
BAT 317	C me	II	2011	2698	2 8
BAT 76	Black	II	1977	2436	1 8

R p f = (Y ld t hgh P Y ld l P) / (H gh P l P)

T bl 17 Y ld e p t tw l l f Al s t t fo th 10 m t tolerant mat ials to m derately h gh Al d M le l th s l t CIAT Q li ha 1979B

Id t f t	Se d l	Growth h b t	Bea y ld (kg/h) t 65% Al satur t	10% Al sat t	R sp se fa t
BAT 64	Bl k	II	616	2394	32
BAT 520	Bl k	II	555	2297	32
BAT 458	Bl k	II	555	2717	39
C ca	C m	III	472	2311	33
G 3645	Bl k	II	466	2354	34
EM 28	C m	II	457	2739	42
S taya 425	Bl k	II	456	2584	39
A 25	B w	III	452	2446	36
BAT 518	Bl k	II	450	2806	43
BAT 470	Black	II	450	2406	36

R p l = (N -s d y ld — Y ld d t Al M) / (ΔAl sat rat (N d — St t Al M))

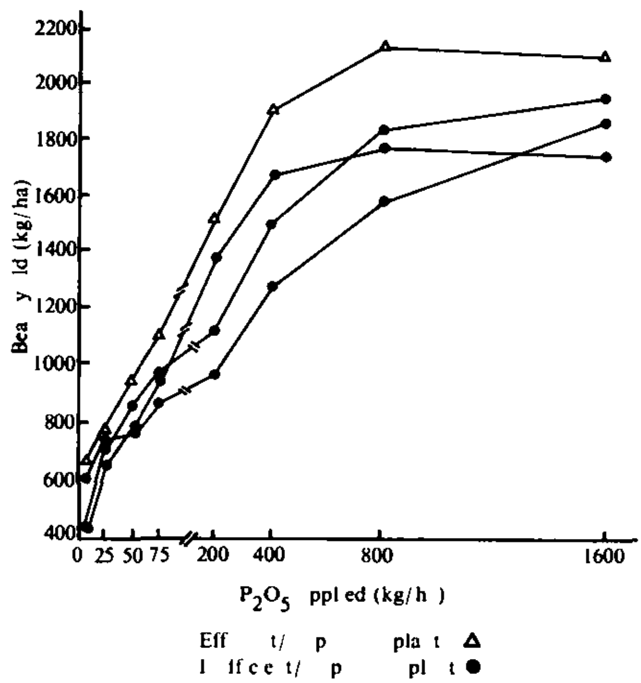


F gu 8 *Combin d y ld lu t ons f bean m t ial ele t d f the tole ance to mode tely a d o l cond t ns*

Stress levels for evaluations One efficient (G 4000) and three inefficient materials (ICA Pijao Diacol Calima and BAT 54) were compared at eight levels of applied P fertilizer (from O to 1600 kg P_2O_5/ha) The experiment was done nearby and on a soil similar to that at CIAT Quilichao

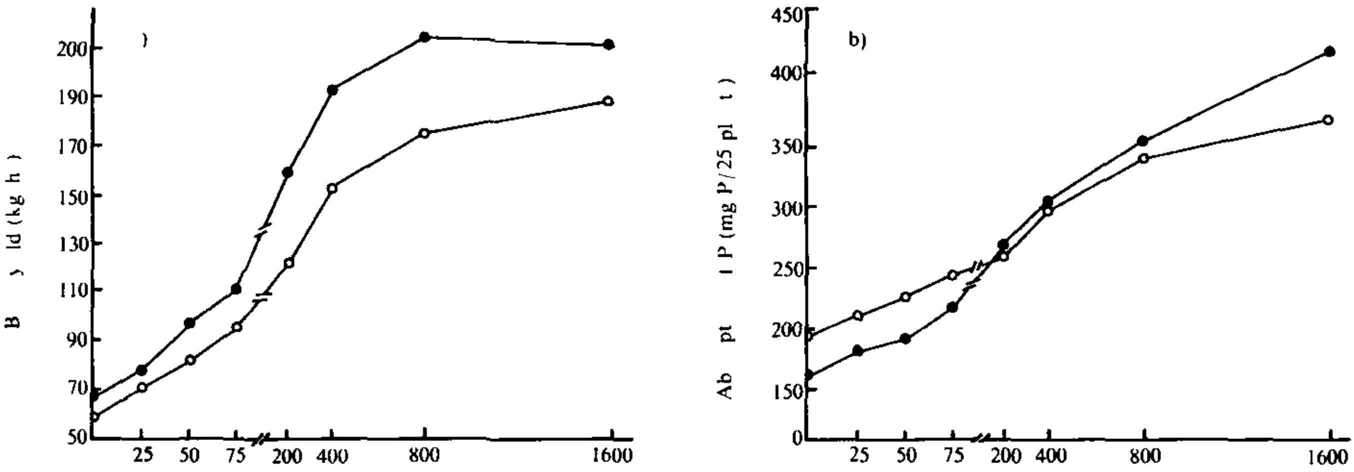
All materials responded to additional P Twenty one days after germination efficient plants looked smaller than inefficient ones but at flowering time efficient plants were slightly more vigorous especially in stem development Measurement of leaf and stem weights 21 days after germination and at flowering confirmed this pattern of development in both types of plants Total leaf area index (LAI) showed little difference between efficient and ineficient plants at lower P levels but above 200 kg P_2O_5 /ha efficient plants produced slightly higher LAI s Vegetative growth cannot therefore be used as a parameter for distinguishing between materials that are efficient or inefficient in utilizing soil P

Within the stress range at the experimental site (0 to 75 kg P_2O_5 /ha) the efficient line G 4000 outyielded the inefficient ones (Fig 9) Diacol Calima yielded similarly to G 4000 at the two lowest levels of applied P This may be explained by its large seed size which supplies sufficient P from the cotyledons during early growth large seed size is common in many Latin American commercial varieties Yield differences at the lowest P levels are very small However between 50 and 75 kg P_2O_5 /ha yield differences are large enough for selection The yield increases up to 800 kg P_2O_5 /ha indicate that the unstressed level of 300 kg P_2O_5 set in previous screenings still permits a response to additional P fertilization



Fg e 9 *Y ldp t ns f b pl nt th t ff t nd n ff nt n the ponse to applied P h ng own n mode tely d l*

P content and absorption in bean plants Increasing the rate of P fertilization increased the P content in leaves stems pod walls and seed of efficient and inefficient plants 21 days after germination at flowering and at physiological maturity No significant differences were found in P content and P absorption between the two types of plants but a consistent tendency was observed At 21 days after germination efficient plants had more P in the leaves but a lower P absorption Phosphorus content and P absorption were higher in stems of efficient plants at flowering and at physiological maturity In the pod wall P content and P absorption were the same in both types of plants And in the seed P contents were the same but P absorption was higher in inefficient plants It can be concluded that materials efficient at low levels of soil P (< 75 kg P_2O_5/ha applied) absorb less P but produce higher yields than do inefficient materials (Fig 10)



F g 10 *Be n y ld d b pt f P in l th t ff ient nd ff ient tl p ns appl d P wh g o n on a n d l d l*

Breeding to improve tolerance to moderately acid soils All of the 22 advanced lines developed from crosses made in 1978 are of Brazilian grain types similar to Carioca or Mulatinho (see Table 4) A few of them are lines derived from crosses in which both parents were tolerant to low soil P More extensive hybridization in this project has been delayed until lines from the earlier crosses have been thoroughly evaluated in CIAT Quilichao and CIAT Popayan to measure advance under selection New crosses made in 1980 were designed to combine tolerance to low P with resistance to anthracnose angular leaf spot and common bacterial blight

Tolerance to Water Stress

Screening for drought tolerant lines continued in 1980 using the two criteria percent yield reduction and the summation of the canopy temperature differential (Σ ΔT°C) during the period of stress

In the past the soil variation found in the field has caused problems A linked randomized block design was used in the field to eliminate this variation

Table 18 *Ph l ulg* h e xhib ting drought tol ce acc d ng to perce tage y ld educt and the cc m lated m f th py temp rature d ff re t al (ΣΔT°C)

Id ntif cat	Y ld (kg/ha)		Y ld d t		Ra k	
	C t l	U d d ught	(%)	ΣΔT°C	Y ld ed (%)	ΣΔT°C
G 5743	2389	2310	3 3	28 9	1	3
A 54	2644	2292	13 3	32 7	2	8
BAT 336	2519	2028	19 5	38 6	7	10
BAT 258	2411	1844	23 5	31 0	12	7
A 27	2987	2126	28 8	27 9	18	2
BAT 131	1932	1391	28 0	25 5	19	1
Ra g			3 3-93 7	25 5 123 1	1 216	1 216
LSD (0 01)			25 6	31 4		

S mm f 23 d y f tress

Whith the aid of the Agroecological Studies Unit a computer program was devised for this experimental design to allow for the screening of a large number of lines The design eliminated 16% of the soil variation normally found in this field Results for the lines that proved to be drought tolerant are presented in Table 18

Factors associated with yield reduction An experiment was conducted at CIAT Palmira to determine the causal factors associated with yield reduction due to drought stress Information was sought to aid in evaluating populations segregating for drought tolerance

Ten lines varying in their tolerance to drought were planted so that they flowered at the same time Irrigation on the stress plots was withheld for 15 days starting at flowering Physiological data were recorded weekly during the entire period of plant growth

The results for the ten lines are shown listed in order of ascending yield reduction (Table 19) In this table all figures shown are differences between controlled and stressed plots expressed as percentages A general reduction of LAD almost equally over all lines was possibly responsible for a basic reduction in yield of not less than 30% In some lines the reduction was much greater than this and the yield depression in excess of that proportional to LAD varied greatly between lines from zero in line BAT 66 to a 33% extra reduction in G3776 This variation in the ability of the canopy to produce under stress would appear to be genetically determined and could possibly be exploited in the breeding programs

Table 19 shows the lines listed by ascending yield reduction with the percent reduction between control and drought plots and selected morphological components For all lines leaf area duration (LAD) was reduced by the stress treatment however genetic diversity did exist between the lines Yield loss was highly correlated with both reductions of LAD (R^2=0 96) and yield/LAD (R^2 0 93) the latter being a measure of leaf area efficiency The data suggest a strong effect of drought stress on photosynthetic efficiency and senescence

Measuring photosynthetic efficiency can be very time consuming Therefore lines that proved to be drought tolerant by the evaluation described above could be further tested for photosynthetic efficiency under stress to determine the best possible parents to be used in a breeding program

Since yield/LAD measures leaf area efficiency it gives a good estimate of the residual effects of other physiological and morphological components affecting yield reduction due to stress Yield per LAD was highly correlated (R^2 0 91) with the $\Sigma\Delta T$ of the canopy The value of $\Sigma\Delta T$ is an index of the stress received by each stressed plot during the stress period (CIAT Ann Rept 1978) The major morphological components affected by the decrease in leaf area efficiency are the number of pods containing seed grain growth rate (GGR) and seed weight Grain growth rate decreased from 10 5 to 8 5 for the tolerant line and from 16 5 to 5 for the susceptible line (Fig 11)

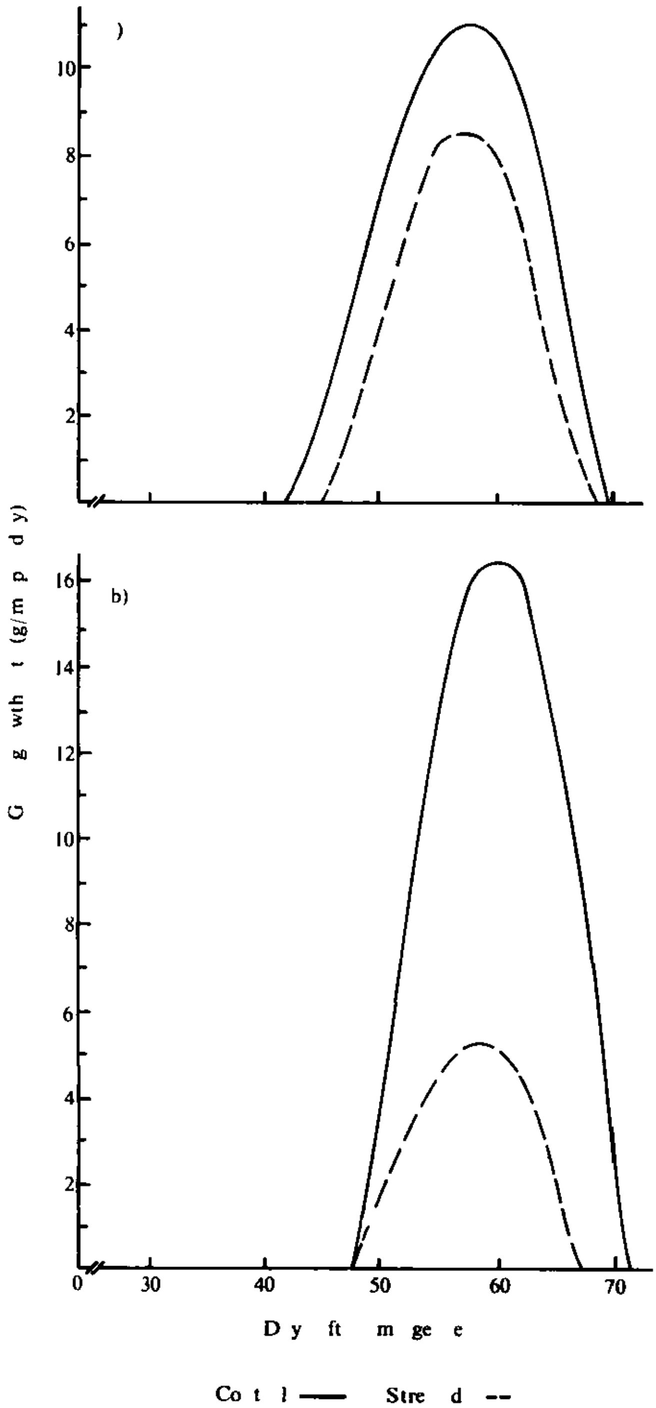
These data further confirm the effect of drought stress on photosynthetic efficiency and possibly photosynthate partitioning

T bl 19 P ce t g red t of selected growth paramete fo d ought tolerant and uscept bl l nes of *Phas lus lg is*

Id t f at o	Y ld	LAD	Y eld / LAD	$\Sigma\Delta T$	Y ld / day	No f nodes	No of filled pods	N f nfilled pod	N b	f ches	S d we ght	B omass	Harv t d x	Max leaf area de	Max p gr wth rat	Ma gra growth t
BAT 83	33	29	6	30	27	11	31	0	9	7	37	0	20	14	28
BAT 66	39	40	0	27	35	29	24	42	11	0	33	0	30	39	23
C 4459	42	30	18	28	38	8	32	17	3	7	39	13	18	21	22
G 4495	5(	29	33	43	44	28	43	13	8	5	56	12	12	6	41
G 4445	55	32	35	57	50	19	48	15	2	13	64	8	14	19	48
BAT 71	57	30	33	46	53	24	24	81	0	6	36	14	19	30	44
BAT 70	58	42	29	42	55	3	30	62	2	12	47	4	40	34	61
G 2005	59	23	47	44	54	14	48	31	27	11	48	3	2	5	46
G 0076	62	34	41	47	61	5	35	49	16	38	49	40	28	9	62
G 3776	69	36	53	49	70	25	44	72	14	41	62	38	28	12	67
Y ld / LAD				91		76	87	77	63	91	88		62	73	92

LAD Le f d t
S mm f ca py mpe d ff tial d ri g pe d f
P rce t ease mbe f f lled pod

It ıs ınterestıng to note that even though crop growth rate ıs affected by drought stress ıt does not greatly affect the reductıon ın leaf area efficıency (yıeld / LAD) This ıs due to the hıgh genetıc dıversıty for GGR that exısts ın the germplasm



Fg 11 G g h f d ought t l nt d d ught us p bl l f **Phaseolus ulgaris**
) D ught t l t (BAT 83)
b) D ught sus pt bl (G 3776)

Variabılıty from Interspecıfic Hybridızatıon

Vıabılıty and fertılıty ın ınterspecıfic crosses Research has contınued to determıne the factors ınfluencıng vıabılıty and fertılıty ın *P vulgarıs* x *P coccıneus* crosses and the ways to allevıate those problems

Vıabılıty and fertılıty ın the F_1 generatıon were dıscussed last year (CIAT Bean Prog 1979 Ann Rept) Important factors were the subspecıes of *P coccıneus* ınvolved ın the cross (F_1 s of *P vulgarıs* x *P coccıneus* subsp *polyanthus* crosses are more vıable and more fertıle compared to F_1 s of *P vulgarıs* x *P coccıneus* subsp *coccıneus)* and the combınatıon of parents

Thıs year s results confirmed those conclusıons for the F_2 generatıon Thıs generatıon ıs characterızed by a very ımportant segregatıon for both vıabılıty and fertılıty Data ın Table 20 show that germınatıon was lower than for ıntraspecıfic materıals and some of the plants dıd not produce any seeds (eıther because they dıd not reach the flowerıng stage or theır flowers remaıned sterıle) The proportıon of seed producıng plants was hıgher ın the *vulgarıs* x *polvanthus* F_2 s but varıatıon exısted accordıng to the combınatıon of parents especıally ın the *vulgarıs* x *coccıneus* progenıes

Seed productıon also varıed consıderably accordıng to the type of cross *(vulgarıs* x *coccıneus* vs *vulgarıs* x *polyanthus)* and the combınatıon of parents (Fıg 12) On the average *vulgarıs* x *polyanthus* F_2 s were about five tımes more fertıle than *vulgarıs* x *coccıneus* F_2 s In some progenıes very fertıle plants were observed (Fıg 12)

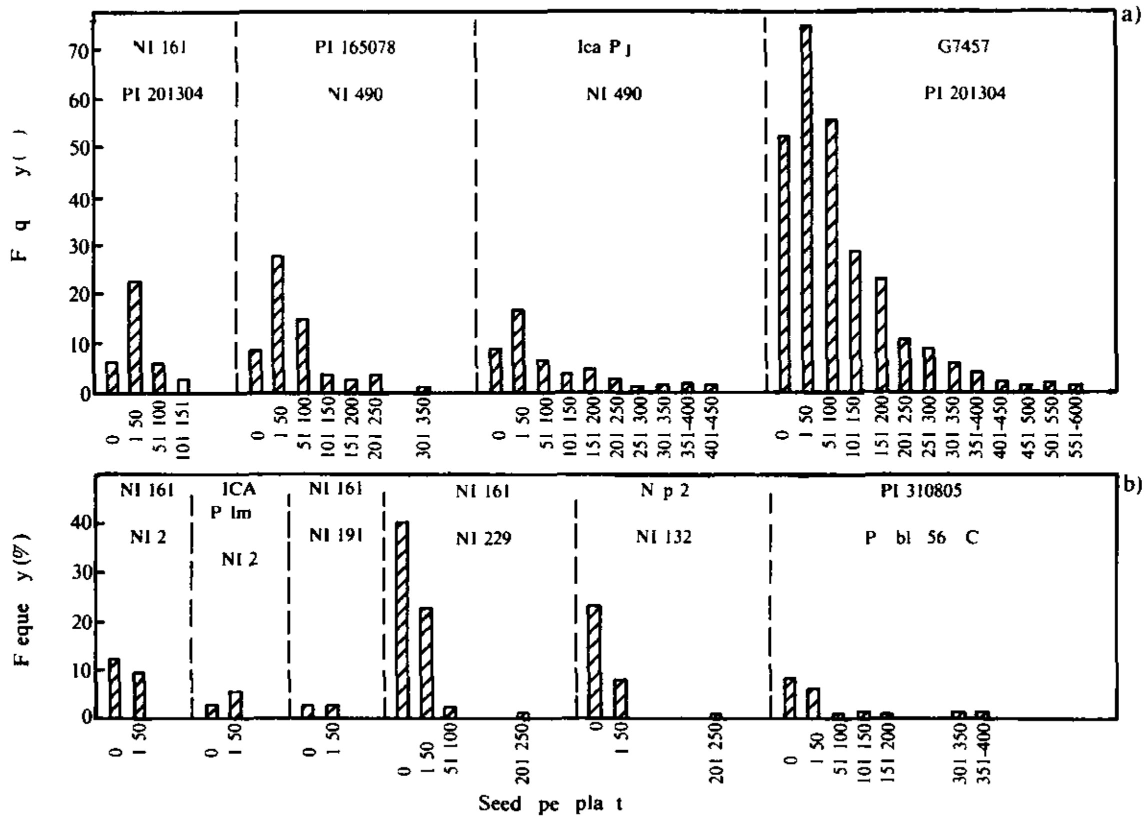
In prevıous trıals the sıze of the F_2 populatıons had always been quıte low Efforts were therefore made to ıncrease the productıon of F_1 plants Manual self pollınatıon (ı e trıppıng of flowers to place pollen graıns on the stıgma surface) was known to sıgnıficantly ıncrease productıon of F_1 s (CIAT Bean Prog 1979 Ann Rept) An addıtıonal ıncrease was obtaıned by plantıng F_1 s dırectly ın the field at very low densıtıes (1x1m) ınstead of ın the meshhouse Increases ranged from sıx to eıghtfold for *vulgarıs x coccıneus* progeny and from four to thırteenfold for *vulgarıs* x *polyanthus* crosses

By combınıng manual self pollınatıons and field plantıng abundant seed productıon was obtaıned for some combınatıons of parental genotypes Large F_2 populatıons wıll allow more meanıngful assessments of potentıals of these ınterspecıfic crosses

Tabl 20 Viab l ty d f rt l ty f F_2 p oge y of o se *Ph olus ulg is x P n* a d *P lg x P u* b p p *l h*

C	N of d plant d	N f d g rm t d	Pl t w th t fl w	Pl t fl w g b t t l	Se d p d c g pl t
ulgari coce n us					
N p 2 NI 132	52	34	14	10	10 (19 2%)
NI 161 NI 191	11	6	2	1	3 (27 3%)
NI 161 NI 2	29	23	6	8	9 (31 0%)
NI 161 NI 229	76	68	23	28	27 (35 5%)
ICA P lm NI 2	13	9	1	2	6 (42 2%)
PI 310805 P bl 56-C	29	25	4	5	16 (55 2%)
T tal	230				
A e ag s %		71 7	21 7	23 5	30 9
vulgari x p ly thus					
NI 161 PI 201304	56	39	4	3	32 (57 1%)
PI 165078 x NI 490	88	64	4	5	55 (62 5%)
ICA P j NI 490	67	51	5	4	42 (62 7%)
G 2047 PI 201304	328	279	24	29	226 (68 9%)
Total	539				
A e g %		80 3	6 9	7 6	65 9

A g p g l l d pl t d



F g 12 *D t but f d p d t o n th F g n t f m of( )* **Phase lus lgaris** *x* **P oc ine** *b p* **polyanthus,** *d (b)* **P ulgaris** *x* **P coccin s**

Variability of progeny Research also continued on the variability generated in progenies Preliminary results suggest a strong differential selection against *coccineus* characters The intensity of this selection seems to depend on the combination of parents involved On the other hand plants which showed a higher number of *coccineus* characters produced less viable and less fertile progeny compared to plants with a lower number of *coccineus* characters

An additional potentially useful character—a long hypocotyl and epicotyl— was observed and tested This character if associated with lodging resistance may reduce disease transmission from soil to foliate thereby reducing yield losses from pod rot This material is an example of novel variation as neither parent expressed this character with the same intensity

Specific crossing projects are now underway or will be started for plant architecture resistance to a disease complex of the Guatemala highlands and resistance to bean golden mosaic virus

Nitrogen Fixation

Breeding for enhanced N_2 fixation in agronomically acceptable bush bean cultivars was initiated in 1978 In 1980 two further cycles of glasshouse selection and intermating were undertaken and field evaluation of F_2 F_3 and F_4 materials was initiated at Popayan and CIAT Quilichao

In the glasshouse phase 202 new crosses were made in 1980 Many of these were between hybrid materials active in N_2 fixation and agronomically promising but not necessarily active N_2 fixing lines from the EP nursery To facilitate the introduction of these new gene sources into the population developed for N_2 fixation the EP lines were planted one week after the other materials grown in N rich soil and always used as the female parent in crosses A total of 114 lines from single plant selections among F_2 and F_3 populations at CIAT Quilichao and Popayan are being evaluated for N_2 fixation and resistance to anthracnose Confirmation tests for BCMV resistance showed that all except six lines were resistant to BCMV

Nutritional and Quality Factors

The Food Quality and Nutrition Laboratory evaluates bean quality (nutritional value and consumer acceptance factors) of all materials of interest to the Bean Program Screening for bean quality has explored the following factors protein content water absorption cooking time broth thickness flavor storability and overall consumer acceptance In addition to monitoring quality factors of beans selected for advanced testing research emphasis during 1980 was on the problem of hard seed coat development in poorly stored beans and on the methodology of conducting limited consumer preference surveys The applicability of bean flour as a component in inexpensive high protein foods was also studied

Quality Evaluations

It is important to combine quality factors such as high protein and short cooking time with selection for agronomic factors Within the 1980 EP lines the following tendencies were observed during several specific studies

Selection for high yield potential did not adversely affect seed protein content (correlation coefficient r 0 104)

Selection for large seed size was not significantly related to seed protein content (over a 100 seed weight range of 14 2 22 7 g)

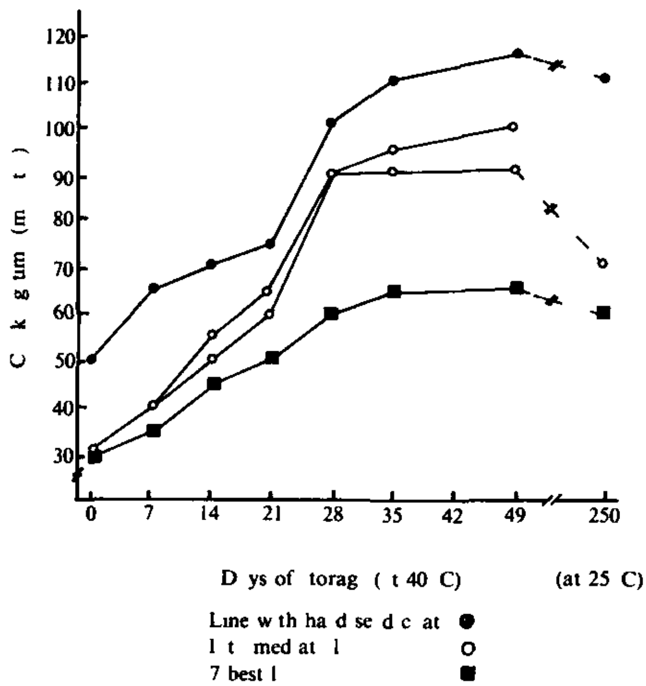
Selection for disease and insect resistance did not seem from preliminary data to be a selection against seed protein content

Selection of entries for incorporation in the 1980 IBYAN was neutral towards both protein content and cooking time but showed a rather strong tendency against hard seed coat which will be discussed later

These studies took into account the effect of storage conditions and hard seed coat development Special care was taken to obtain freshly harvested seed so that variability from storage under uncontrolled conditions could be avoided

Effects of storage time and temperature A group of 30 such freshly harvested lines (all color classes) was tested for quality factors within seven days after harvest and also after being stored eight months at about 25 C in sealed laminate bags to maintain seed moisture at 12% A second group of 50 lines was tested within seven days after harvesting and then every seven days (up to 49 days) while stored at 40 C For nearly every line studied the cooking time for freshly harvested material was 30 minutes After beans were stored eight months cooking times ranged from 30 to 70 minutes

The validity of the accelerated storage test developed last year was shown in these studies (CIAT Bean Prog 1979 Ann Rept) A line which developed a cooking time of 115 minutes during 49 days storage at 40 C had a cooking time of 100 minutes after eight months storage at 25 C (Fig 13) Lines that increased in cooking time to 70 minutes after accelerated storage had cooking time of 60 minutes after eight months of normal storage An intermediate group was found to have cooking times of 90 100 minutes after accelerated storage and of 70 minutes after longer normal storage The cooking time determined after 28 days of accelerated storage was an excellent predictor for cooking times after long term storage It is proposed that this standardized test be used on all lines to estimate cooking times likely to be found in common commercial marketing



F gu 13 *Eff ı f l ı d(ı 40° C) d n m l to g (ı 25 C) o k ng ı m f b ns*

The effects of storage time and storage temperature were studied on a group of 50 1980 EP lines maintained at 12 C and 30 C for two and four months respectively Seeds stored at 12 C (at 12% moisture) had only small increases (from 30 to 34 or 35 minutes) in cooking time even after four months storage Seeds stored at the higher temperature (and 12% moisture) showed nearly doubled and tripled cooking times at two and four months respectively

Although cooking times changed neither storage time nor temperature caused bean thickness to change significantly Changes in flavor and texture after cooking were evaluated for the 50 bean lines above by eight member taste panels Cooking time was not closely related to flavor varietal differences in flavor predominate The correlation between flavor and presence of hard seed coat was strongly negative (r = -0 611) for materials where quality had deteriorated markedly It was not possible to separate clearly the factor of texture in the cotyledon from texture in the seed coat so that the expected positive correlation between cooking time and presence of hard seed coat was not observed

Water absorption The various measures of bean quality tested at CIAT have been found to be essentially unrelated (Table 21) The exception was for water absorption during the initial four hour soaking period and subsequent cooking time in the case of 30 1980 EP lines carefully stored as freshly harvested seed the correlation coefficient was -0 564 for these two factors For the group of 160 1979 EP materials a multiple regression analysis indicated that 67% of the variation in cooking time was due to initial water absorption Both water absorption and cooking time are related to starch emphasizing the role of starch structure in the cooking properties of beans For this same group of materials neither seed size nor seed color significantly affected cooking time

T bl 21 C l t s b twee bea qu l ty f ct rs

F cto	Valu
P t t t wat b pt	0 095
Prote te t k g t me	0 216
P t te t b th pe ce tag	-0 109
C k g t me b th pe ce tag	-0 240
C k g t me w t b pt	-0 564

M ed l f m h 1980 EP d gh m h t 25 C fte harv t Th m rela m d f hly h rvested ma rial w im la V l l b sed l ga hm ransf m w re gnif ca tly d ff re t f m h l g w h m g us

Hard seed coat The effect of hard seed coat (not a starch related phenomenon) on water absorption by the bean during the initial four hour soaking period is considerable one line with hard seed coat absorbed 40% less water than eight normal lines In another group of materials stored eight months average water absorption (measured as the percentage of seed dry weight) for seeds without hard seed coat was 59% while for hard-coated seed it was 21% Neither protein nor seed yield was significantly different for those two groups of materials Reduction in water absorption is now considered the most sensitive measure of hard seed coat since this character is somewhat diluted out during the cooking test and cannot be determined precisely in the mouth

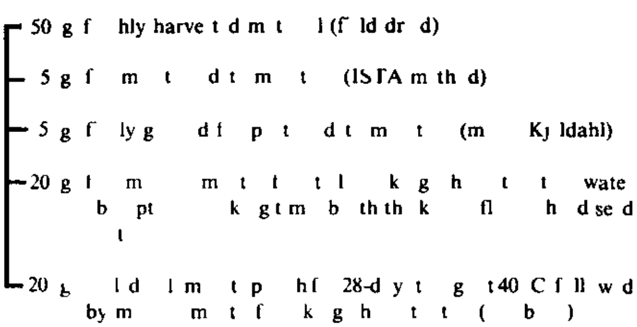
From present understandıng changes ın cookıng tıme and water absorptıon that occur ın a bean seed durıng storage may be summarızed as follows

Stage I (fresh seed) where cookıng tıme ıs very nearly the same for most varıetıes and ıs ındependent of water absorptıon Stage II (ıntermedıate) ın whıch cookıng tıme ıncreases and becomes correlated wıth water absorp tıon and Stage III (seeds wıth hard seed coat) where cookıng tıme reaches a maxımum and ıs no longer correlated wıth water absorptıon

Selectıon by breeders ın the Bean Program has been agaınst lınes havıng hard seed coats even though thıs character was probably not recognızed as dıfferent from other seed characters Of 43 lınes tested and found wıthout hard coats 10 were selected for the 1980 IBYAN of 15 lınes found to develop hard seed coat only 2 were selected for the IBYAN

Whıle not studıed extensıvely treatıng seeds wıth edıble oıls (to reduce storage ınsect ınfestatıon) had a marked ınfluence on water absorptıon Seeds treated wıth eıther maıze or soybean oıl retaıned or ıncreased theır ınıtıal level of water absorptıon over a 49-day storage perıod at 40 C Non treated seeds lost 45% of theır abılıty to absorb water In thıs sense oıl treatment has elımınated the development of hard seed coat ın the varıety studıed Unfortunately oıl treatment dıd not reduce the cookıng tıme for thıs varıety (110 mınutes after 49 days accelerated storage)

Presently the standardızed tests for bean qualıty have been well characterızed and can be recommended for routıne use ın any qualıty evaluatıon program The procedure ıs summarızed ın Fıgure 14 Based on ex perıences ın the CIAT Food Qualıty and Nutrıtıon Laboratory one technıcıan could perform over 1200 of these tests per year



Fg 14 S nn j h t nd d dt t f b q l y us d CIAT

Consumer Surveys on Bean Utılızatıon

The fırst objectıve of thıs work was to defıne and analyze those factors that are ımportant to Colombıan famılıes ın selectıng purchasıng and consumıng beans A second objectıve was to develop a survey methodology that wıll permıt any natıonal or regıonal bean ımprovement program to determıne consumer preferences and consump tıon patterns systematıcally and at relatıvely low cost

Two surveys were made ın Calı and Medellın Colombıa coverıng 450 households representıng about 2500 persons Supplementary surveys at supermarkets and small local markets were also made to gaın a clearer ıdea of buyıng habıts for beans

Surveys were based on background ınformatıon and prevıous experıence made avaılable by the marketıng group of Productos Quaker ın Calı The surveys were conducted wıthın three socıoeconomıc strata of the populatıon The hıgh medıum and low strata comprısed 15 35 and 50% respectıvely of the samplıng populatıon Surveys were done ın urban areas prevıously characterızed for socıoeconomıc factors

It was assumed that for the major part of the consumptıon patterns dıfferences between ınhabıtants of a gıven communıty (taken as a cıty or group of nearby cıtıes) would be relatıvely small For the ınhabıtants of dıfferent regıons consumptıon patterns for beans are lıkely very dıfferent and very characterıstıc These hypotheses were shown to be true

The maın results of the surveys are gıven ın Table 22 Dıstınct dıfferences were evıdent between consumer preferences ın Calı and Medellın In Medellın the Cargamanto varıety ıs preferred almost exclusıvely and beans are eaten more than twıce as frequently as ın Calı even though more people thought beans were expensıve In both cıtıes people eat beans because they lıke them although a large fractıon of people ın Medellın recognızed beans nutrıtıve value Beans are usually eaten as a soup wıth other ıngredıents Most households prepare beans ın pressure cookers usual cookıng tımes reported were one half to one hour

The factor that seemed to lımıt bean consumptıon ın Calı (and even ın Medellın where beans are eaten by many people every day) ıs that people lıke to vary theır dıets Some saıd that ıf other bean recıpes were avaılable they would try them Many housewıves ındıcated they would lıke to try new bean products such as flour (40 and 70% posıtıve responses ın Calı and Medellın respectıvely)

T bl 22 C me p f d t l zat o hab ts fo dry bean d t m d f m h eh ld urv y d in Cal d M d ll C l mb

F ct	Cal	M d ll
1 H u h ld g be (/)	95	96
2 R l t ng be ( )		
P l p l	44	79
b N t t l d	15	59
3 F q y l n mpt (t m /m th)		
H gh/m d m/l w		
m l	6 1/5 0/9 1	13 4/11 0/16 5
b A g	6 5	14 1
4 Be d h t (% f p d t),		
p/p /	56/6/50	96/4/2
5 U l pre o k (/)	80	89
6 G p f d ( )		
m ll/m d m/l g / y l g	6/41/44/20	25/63/6/9
7 G l p ef d (%)		
d/m ttl d/wh t /black	74/23/25/9	27/81/21/
8 C mm l ty p f d (%)		
C gama t	17	92
b C l m	40	
M t	23	
d N m		6
9 Op f be t (/)		
h gh/mode t /l w	13/48/40	51/36/13
10 Qu t ty p h ed mo thly (kg)	2 4	4 5

Such surveys can be carried out by a group of six interviewers (university students were used in these cases) plus one supervisor Four days were required after initial planning organization and training Such survey methods are directly applicable to other areas it is hoped that national agricultural programs will utilize these methods to gain a clearer picture of bean consumption and preference patterns

Bean Flour Development

Studies are under way in the Food Quality and Nutrition Laboratory to study the feasibility of using bean flour as a substitute for defatted soy flour in a low-cost nutritious product suitable for subsidized child feeding programs The product Colombiarina fashioned after the famous Incaparina but based on rice and soy was introduced to Colombia in February 1978 as a part of the Plan Nacional de Alimentacion y Nutricion (PAN) The Laboratory began tests on a rice and bean flour product called Nutribueno formulated to optimize the nutritional value of its two components for protein content and amino acid balance For comparative purposes 100% bean flour was also used in the product testing

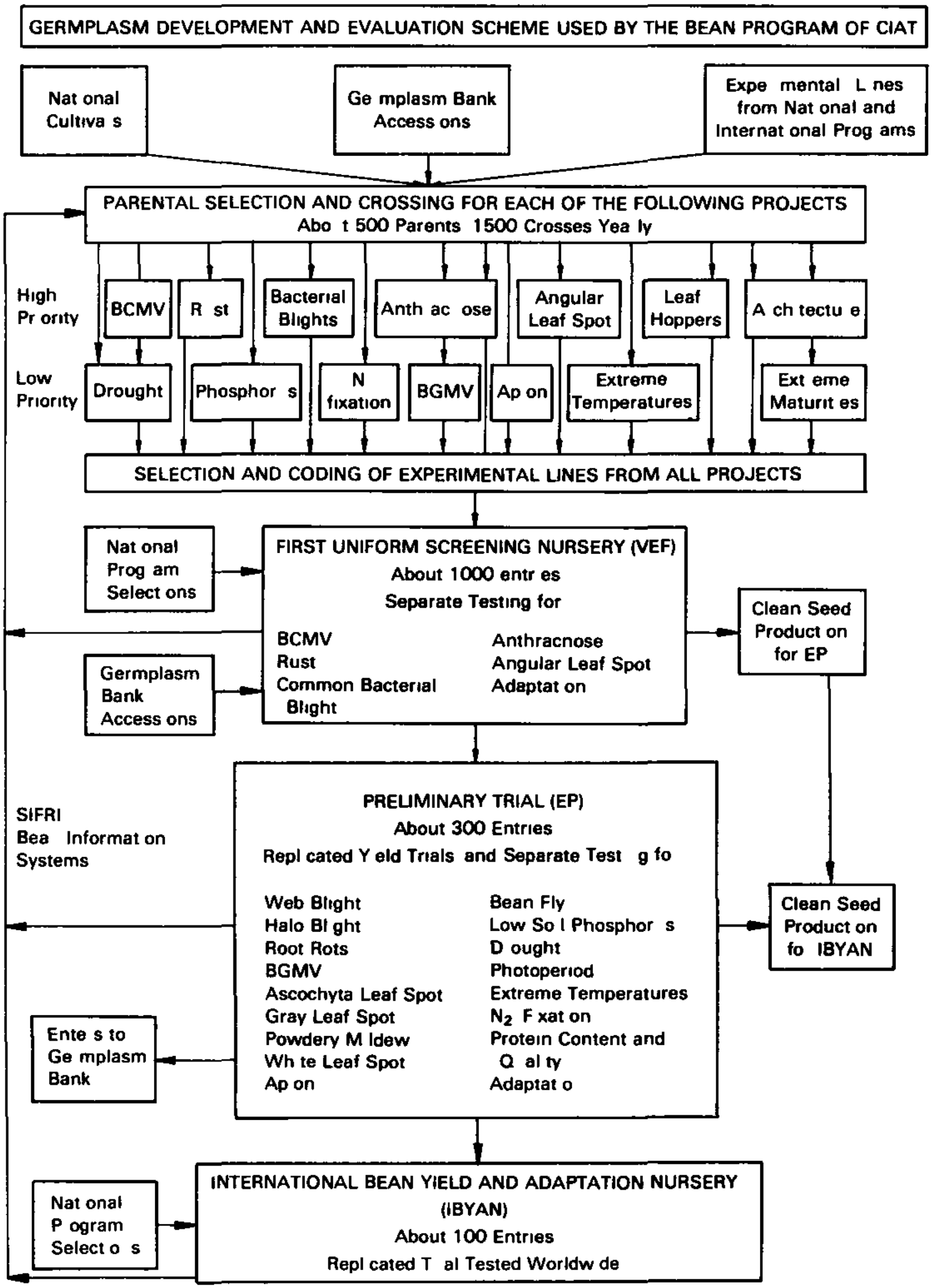
The two cereal legume products Colombiarina and Nutribueno were initially tested in various recipes for flavor texture and appearance (including color) In breads bunuelos and coladas there was no significant difference between Colombiarina and Nutribueno However recipes made from bean flour either at the 10 15% level in breads and bunuelos or at the 100% level in coladas generally received higher scores especially in terms of flavor Studies were then directed to the question can bean flour be utilized in a wide range of recipes as a low cost source of protein (Table 23) that enhances flavor and hence consumer acc ptability?

At the present time bean flour is potentially a lower cost source of protein than the other high protein flours in Colombia (Table 23) Rice is a relatively expensive source of protein although second grade rice can be used for Colombiarina and Nutribueno Because of its relatively poor protein quality (amino acid balance) bean flour is more expensive on the basis of a kilogram of balanced protein than either of the cereal legume flours (but not wheat) However since these products are eaten in conjunction with other foods which tend to balance the overall amino acid composition of the diet the more important consideration here is cost per kilogram of protein and here bean flour is clearly less expensive

T bl 23 N t t te t d l u e t f f h gh p ote n flo

F t	Wh t fl	C l mb n (30% s y/ 70% e)	N t b (40% be / 60%)	Bea fl
I t t t (/)	11 0	18 6	14 7	25 9
Am d	33	82	80	54
L mt g t l m d	l y	Ly	M t/ Cys	M t/ Cy
I g d t t				
p 1000 kg w ght	4 000	17 050	14 740	19 000
p kg d p t	18	92	100	73
p kg l p t	574	112	126	135

C l p p l S p mb 1980


GERMPLASM DEVELOPMENT AND EVALUATION SCHEME USED BY THE BEAN PROGRAM OF CIAT
Nat onal Cultiva s
Ge mplasm Bank Access ons
Expe mental L nes from Nat onal and Internat onal Prog ams
PARENTAL SELECTION AND CROSSING FOR EACH OF THE FOLLOWING PROJECTS
Abo t 500 Parents 1500 Crosses Yea ly
High Pr ority
BCMV
R st
Bacterial Blights
Anth ac ose
Angular Leaf Spot
Leaf Hoppers
A ch tectu e
Low Priority
Drought
Phosphor s
N fixation
BGMV
Ap on
Extreme Temperatures
Ext eme Maturit es
SELECTION AND CODING OF EXPERIMENTAL LINES FROM ALL PROJECTS
Nat onal Prog am Select ons
FIRST UNIFORM SCREENING NURSERY (VEF)
About 1000 entr es
Separate Testing for
BCMV
Rust
Common Bacterial Blight
Anthracnose
Angular Leaf Spot
Adaptat on
Germplasm Bank Access ons
Clean Seed Product on for EP
SIFRI
Bea Informat on Systems
PRELIMINARY TRIAL (EP)
About 300 Entries
Repl cated Y eld Trials and Separate Test g fo
Web Blight
Halo Bl ght
Root Rots
BGMV
Ascochyta Leaf Spot
Gray Leaf Spot
Powdery M ldew
Wh te Leaf Spot
Ap on
Bean Fly
Low So l Phosphor s
D ought
Photoperiod
Extreme Temperatures
N_2 F xat on
Protein Content and Q al ty
Adaptat o
Clean Seed Product on fo IBYAN
Ente s to Ge mplasm Bank
Nat onal P ogram Select o s
INTERNATIONAL BEAN YIELD AND ADAPTATION NURSERY (IBYAN)
About 100 Entries
Repl cated T al Tested Worldw de

Appendix A

Description of *Phaseolus vulgaris* L Growth Habits

Type I Determinate growth habit reproductive terminals on the main stem with no further node production on the main stem after flowering commences

Type II Indeterminate growth habit vegetative terminals on the main stem with node production on the main stem after flowering commences erect branches borne on the lower nodes of the main stem erect with relatively compact canopy variable guide development depending on environmental conditions and genotype

Type IIIa Indeterminate growth habit vegetative terminals on the main stem with node production on the main stem after flowering, relatively heavily branched with variable number of facultatively climbing branches borne on the lower nodes variable main stem guide development but generally showing climbing ability

Type IIIb Indeterminate growth habit vegetative terminals on the main stem with node production on the main stem after flowering, relatively heavily branched with variable number of facultatively climbing branches borne on the lower nodes variable main stem guide development but generally showing climbing ability

Type IVa Indeterminate growth habit vegetative terminals on the main stem with heavy node production after flowering commences branches not well-developed compared to main stem development moderate climbing ability on supports and pod load carried evenly along the lenght of the plant

Type IVb Indeterminate growth habit, vegetative terminals on the main stem with heavy node production after flowering commences branches not well-developed compared to main stem development strong climbing tendency with pod load mostly borne on the upper nodes of the plant

Notes The growth habit classification has been expanded for the climbing types since the 1977 Annual Report Type III materials with some tendency to climb are now recognized as Type IIIb and Type IV has been divided on the basis of vigor and pod distribution

The most important distinguishing features of the growth habits are as follows terminal raceme on main stem for Type I indeterminate with erect branches for Type II indeterminate with prostrate branches for Type IIIa indeterminate with semi-climbing main stem and branches for Type IIIb indeterminate with moderate climbing ability and pods distributed evenly up the plant for Type IVa indeterminate with aggressive climbing ability and pods carried mainly on the upper nodes of the plant for Type IVb

Growth habit is not necessarily a stable characteristc since changes in growth habit may occur from one location to another The classification of growth habit for a particular genotype is only useful in a defined environment particularly with regard to climbing ability

Appendix B

CIAT Accessions of *Phaseolus* Referred to in this Report

CIAT No	Identification	Local register	Source[2]
G00057	Swedish Brown	PI 136735	USA
G00076	Red Kloud		USA
G00118	Forty Days	PI 162566	USA
G00124		PI 163372	USA
G00159	Cali Fasulya	PI 165078	USA
G00489	Raytal	PI 175269	USA
G00687	Windsor Long Pod	PI 182026	USA
G01507	Ojo de Cabra	PI 281988	USA
G01820	Negro Jamapa	PI 309804	USA
G01854	Nima	PI 310512	USA
G02005		PI 310739	USA
G02006		PI 310740	USA
G02047		PI 310805	USA
G02258	Morada del Agua	PI 311904	USA
G02333	Colorado de Teopisca	PI 311998	USA
G02525	Magdalena 3	PI 313624	USA
G02618	Col No 168	PI 313755	USA
G02858	Zacaticano	PI 319665	USA
G02959	Pecho Amarillo	GTA-014	GTA
G03353	Puebla 152		MEX
G03607	C C G B-44	1-462	VNZ
G03645	Jamapa	1 810	VNZ
G03652	Puebla 152	1-820	VNZ
G03658	Mexico 27N	1-867	VNZ
G03776	Venezuela 2	I 1062	VNZ
G03807	Brasil 2 Pico de Oro	I 1098	VNZ
G03834	51051	I 1138	VNZ
G03942	Michelite	B-33	CRA
G04000	NEP Bayo 22	C 286	CRA
G04122	S 166-A N	N 555	CRA
G04393	Tlaxcala 62 C		MEX
G04421	S-630 B	C-63	CRA
G04434	Antioquia 11	P 111	CRA
G04435	Diacol Calima	P 146	CRA
G04445	Ex Rico 23		CLB
G04446	Ex Puebla 152 Brown Seeded		MEX
G04449	Pinto UI 114		USA
G04451	9 Al 2		USA

Appe d x B (cont ued)

CIAT No	Identification	Local register	Source
G04452	ICA Guali		CLB
G04454	ICA Tui		CLB
G04459	NEP 2		CRA
G04460	Pompadour 2		CRA
G04470	Pompadour		DOM
G04482	Zamorano 2		HDR
G04489	Guilapa 72		GTA
G04494	Diacol Calima		CLB
G04495	Porrillo Sintético		HDR
G04498	Sanilac		USA
G04503	Widusa		FRC
G04505	Top Crop		USA
G04523	Linea 17		CLB
G04525	Linea 32		CLB
G04727	Ancash 66		PER
G04816	Mulatinho		BZL
G04821	Iguacu (Lote 4)		BZL
G04824	Roxâo		BZL
G04825	Carioca		BZL
G04830	Rio Tibagi (Lote 10)		BZL
G04978	Amanda —		NLD
G05158	Bico de Ouro 1445	BZL 905	BZL
G05270	Sataya 425		MEX
G05653	Ecuador 299		ELS
G05694	Cornell 49 242		USA
G05702	Cargamanto		CLB
G05708	Sangretoro		CLB
G05743	Preto 897		ATL
G05745	Redlands Greenleaf B		ATL
G05768	Pinto No 650		USA
G05773	ICA Pijao		CLB
G05897	Flor de Mayo		MEX
G06361	Great Northern		USA
G06520	AETE 2	CA 21	UTK
G06719	Jubila		NLD
G06721	Double White		NLD
G07932	Nahuizalco Rojo		ELS
G07951	Aroana		BZL
G09446	Imuna	FRC 542	FRC
G11249	Pinto	IVT 771004	NLD
G11274	Brasil 343 Mulatinho	IVT 77039	NLD
G11488	CENA 164 2 CM CM (12 B) F5		BZL
G12631	Ancash 143		PER
G12709	Mortino	Sañudo 45	CLB
G13497	AETE 1/37		BZL
G13499	Petro 132		BZL

Th G od t cess th mbe assigned t by th ge mplasm ba k f h CIAT Genet R so rces U t BAT A EMP BAC DOR d V odes bel g ma l mp d by CIAT Be Pr gram

ATL A l BZL B l CLB C l mb CRA C t Rica DOM Dom ca Rep blic ELS El Sal d FRC Fra GTA (m l HDR H d ra MEX M PER Peru UTK U ed K gd m VNZ V ne uela