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Germplasm Development

The Germplasm Development section undertakes cassava germplasm collection and introduction maintenance of the field collection of approximately 2600 clones evaluation for a broad range of agronomic and morphological traits in diverse environments and development of gene pools for adaptation in three high-stress environments

CIAT has developed a multi stage genetic improvement procedure involving 1) evaluation of germplasm accesions in various environments for possible recomendation directly as new cultivars or for potential contribution as parents in a hybridization program 2) formation of broad based gene pools with high levels of resistance and/or adaptation in specific environments and 3) fine tuning of the final product in the varietal improvement stage to assure acceptability in all aspects by producers processers and consumers All stages involve inputs of the entire interdisciplinary team

Germplasm Introduction and Maintenance

Introduction of cassava germplasm from outside Colombia is now limited to either meristems or to true seed to minimize the possibility of introducing pests and diseases The Genetic Resources unit this year transferred to CIAT some 150 selected clones from the Brazilian collection at Cruz das Almas Bahia This introduction helps alleviate a relatively minor representation of Brazilian material in our collection and the exchange is expected to expand in the future Previous introductions by meristems culture from Peru and the Amazonas region of Colombia are now planted in the field for multiplication and later evaluation

A pathogen free germplasm bank is being formed from clones which have passed through meristem culture and are free of systematic pathogenic infection Utilizing isolation from other cassava fields and strict quarantine procedures it is hoped this bank can continue to provide clean planting material for evaluation within and outside CIAT's facilities

Germplasm Evaluation

Germplasm evaluation is proceeding along three principal routes a) evaluation for adaptation resistance yield and root quality in moderate to high stress environments in Colombia b) evaluation of relatively stable morphological traits in CIAT Palmira in order to eventually aid in defining similarly groups and duplications in the bank c) special studies of selected groups of germplasm accessions for post harvest root deterioration early maturity and root cyanide content

Media Luna and Fonseca

Given the high priority of the North Coast environment representative of major cassava growing areas of the Americas and Asia evaluation is carried out in two sites—Media Luna Magdalena and Fonseca the Guajira Media Luna has moderate rainfall (800 1200 mm/year) with a long dry season Fonseca has low rainfall (700-1000 mm/year) and a long dry season during which mites (*Mononychellus* sp) are severe In order to increase the probability of identifying promising material the first accessions screened on the North Coast were preselected based on mite resistance and/or origin in a similar environment

Germplasm evaluations in Media Luna were begun in the 1978 79 cycle with about 400 accessions In 1979 80 103 of these were selected for further evaluation and the 17 best planted this year in a replicated yield trial At Media Luna the 17 clones have produced an average root yield of 10 5 t/ha (max 21 7 t/ha) average dry matter of 31 8% (max 36 8%) and average stake production of 7 9/plant

T bl 1 Lnea lat m g s l t t n ca sa g rmpla m luat at F seca the Guaj ra (fo May 1980 harvest)

	Pube	Leaf ret t o	B chng h b t	M t d mage[4]	R t we ght pe pla t	F liag w ight pe pla t	Harv t dex	R ot dens ty
P besc	1 000	0 468	0 082	0 579	0 328	0 286	0 015	0 111
Leaf t nt		1 000	0 362	0 606	0 094	0 057	0 039	0 138
B h g h b t			1 000	0 289	0 074	0 217	0 148	0 197
M t d m g				1 000	0 045	0 072	0 001	0 074
Root we ght pe pla t					1 000	0 598	0 391	0 01
F liag w ght pe pla t						1 000	0 368	0 162
H rv t d							1 000	0 301
R t d ns ty								1 000

S bjec l t f d y f p be ce f th pe l p besce ce 3 h ghly p bescent
S bj l f pe t f m reta g l es t harv t
N mb f l l f bra h g h rvest
S bj t lua f m t d m g peak f nf t tı l littl damag 5 re d mage
By p f gra ty m hod m as g dry matt t

(max 14/plant) These values equal or exceed those of the local check variety Secundina An additional 240 clones have been planted in an observational yield trial

In Fonseca 329 accessions were planted in an obser vational yield trial in May 1979 and harvested at 12 months Under this high stress *environment* very striking differences among clones were noted Good mite resistance (13% of the clones showed low damage levels) high root dry matter (11% gave above 33% dry matter) and high harvest indices (14% had indices above 60%) were measured A few clones showed good levels of all of these variables Fifty seven accessions were selected and planted along with those selected in Media Luna An additional set of 317 germplasm accessions were planted in an obser vational yield trial

Phenotypic correlations among several traits indicate the interrelationships among traits and possible im plications for breeding (Table 1) Of special interest is the high positive correlation between pubescence of the apex and *Mononychellus* mite resistance also observed previously by the Entomology section Pubescence can be easily selected for with or without mite attack and also confers resistance to thrips Although other mechanisms are certainly operating to confer resistance to mites pubescence may be the simplest to manage Root yield was not correlated with mite damage possibly because planting at the beginning of *the rainy season* permited good plant development before mite attack became severe The data suggest that high yield potential and mite resistance may be combined to produce superior lines for these conditions Mite attack tended to be more severe on highly branched types although the reason for this is not clear Root dry matter content was not related to severity of mite attack

Selection for this environment will continue principally based on root yield harvest index root dry matter content and moderate to high levels of mite resistance

Carimagua

Most of the germplasm bank has been evaluated in Carimagua and superior accessions are being evaluated in the second year of a replicated yield trial From data accumulated over several cycles only a small percentage of accessions show stable adaptation in this high disease stress environment (Table 2) These are being recommended as sources of CBB and superelongation resistance and yield potential in acid infertile soils Since several of the accessions appear morphologically identical a continuing search for germplasm adapted to this environment will be important

A Cuban collection of 69 clones was planted in an observational yield trial and several show good levels of resistance to CBB superelongation and anthracnose Cuba has superelongation only in a few areas and CIAT assists in evaluating their *lines so they* can quickly take preventive measures should the disease become endemic in Cuba

Table 2 Cassa a g mpl sm access ns showing good adaptat on tn Ca m gua accord g to the react t two maj d m c dis ase

Acce	CBB res tance	Superel gat on ta ce
Group A		
M B 5 M B a 22 M B 29 M Col 1940 d M P 51	MR	R
Group B		
M Col 1894 M C 1 1772 a d M C 1 1900	MR	R
Group C		
M Col 2052 d M P 12A	R	R
Group D		
M Col 1914 M C 1 1916 M Ecu 82 M P 12B M P 19 M Pa 90 M P 101 M Pa 103 M Ve 38 and M V 77	R	R
Group E		
M Pa 97	R	MR

Selected th ba f 2-4 se f l t f d ease res ta ce and 1 2 se so l f y ld plicat d tr al
MR= mod t ly ta t R= esi ta t
Acce w th h f th g p B nd D ppea ry imila m rph l gical ly t ll th rs wi h ea h gr p nd may be ge tically dentical

Popayan

In a yield trial of a collection of 18 clones from high altitude areas of Southern Colombia M Col 1522 (CMC 92) a regional variety of Popayan gave the highest yield (12 8 t/ha compared to 8 1 t/ha for the best accession) Several of the accessions however had higher dry matter content (up to 36 9%) compared to the 29 2% of M Col 1522 In all the regional trials planted at Popayán as well as in previous replicated yield trials M Col 1522 has consistently been the highest yielder This variety is very vigorous highly branched has moderate dry matter content and is moderately resistant to *Phoma* leaf spot and *Oligonychus* mites The goals for this environment are to improve upon the plant type (less branching) dry matter content yield potential and disease resistance of M Col 1522 Large-scale germplasm evaluation has begun with a planting of 438 accessions mostly collected from areas above 1500 masl In the overall germplasm improvement program the high altitude areas are being given less emphasis than other environments

CIAT Palmira

Reevaluation of post harvest root deterioration In the preliminary germplasm evaluation at CIAT Palmira from 1973 74 one of the evaluation parameters was post harvest deterioration In order to confirm sources of resistance to deterioration a group of those accessions initially classified as grade 1 (139 accessions) were reevaluated in a replicated trial in CIAT Palmira Deterioration was measured by two methods a) as in the original evaluation by storing whole roots at ambient temperature for one week then rating deterioration which included both physiological and microbial effects and b) by the method described by the Pathology section last year (CIAT Cassava Prog 1979 Ann Rept) which determines only physiological deterioration There was as wide a range in the reevaluation trial as in the original and the mean rating for the two evaluations was practically equal (Table 3) These results illustrate a low consistency across years for root deterioration when measured on a single row basis

A highly significant correlation exists between the measures of physiological deterioration at three days and physiological plus microbial deterioration at one week (Table 4) As previously observed in CIAT deterioration was highly positively correlated with root density (dry matter content) and also with harvest index Although no cause/effect relationships can be implied selection for high root dry matter content and high harvest index will tend to increase deterioration problems

Table 3 C mp ri betwee prelim nary e aluatio of cassa a germpla m b nk cce s ns f p t harvest deterioration and ree aluatio of clo es selected f th r resistance t d t ri rat o

E al at n per od	Rat g class	Frequ cy	Perce t
E aluat d n 1973-74 nrepl cated ingle-row plots	1	169	9
	2	273	15
	3	480	26
	4	498	27
	5	405	22
Mean 3 4			
E aluated 1980 in two repl cat ons f single- ow plots (ll m terial lected f om within lass 1 f 1973-74 valuat o)	1 0-1 9	10	7
	2 0-2 9	61	45
	3 0-3 9	49	36
	4 0-4 9	15	11
Mean 2 9			

1=litt d t ri rat afte week rag 5=hgh d te rati

T ble 4 L relat mo g e luat n for cassa a t
p stharve t d t t oot de s ty a d harv st nde

	Phy l gical d t at o	Phys ological m c ob l g d t t	d l	R t de ty	H rv t d
Phy l g cal d te orat	1 00	0 67		0 78	0 64
Phy ol gical d m b olog cal dete t n		1 00		0 42	0 34
R ot d ty				1 00	0 58
H rv t d					1 00

Mea ed h ee d y f h rv t 15-cm se t f w hd t l d red w h PVC f lm l l w d 10 d t
Phy l g l d m b l g cal d ra m red se d y f h rv t ed ta t d mb t d l_l w d t ra 5 se d t

Gene Pools for Environment Adaptation

Pool formation Broad based gene pools continue to be developed for adaptation in the environments represented by Media Luna and Fonseca Carimagua and Popayan Initial parental components are selected from the germ plasm bank based on environment performance Emphasis is given to including a wide diversity of material having insect and diseases resistance tolerance to soil and climatic stresses high yield potential and good root quality Since few accessions combine all these characteristics others are included having less favorable expression of certain traits Through recurrent selection gene frequency for all traits can be increased

Gene pool formation and improvement is a two-stage process In the first stage recombination is effected in open pollination blocks each block representing selection for a particular environment A polycross scheme is utilized where several replicates of each genotype are planted in random mixture to maximize the admixture of pollen among different genotypes Individual polycross blocks are isolated from each other by at least 12 m by planting male-sterile filler rows A study this year showed this isolation distance to be sufficient to prevent most contamination under conditions at CIAT Palmira

Cassava is not particularly well adapted to the exploita tion of open pollination crossing schemes however good management can overcome these problems making open pollination an effective breeding tool The advantage of open pollination is production of a large number of seeds with minimum labor requirements A major difficulty is the great range in time to flowering and number of flowers produced among clones Furthermore the earliest and most prolific flowering types are less desirable from a plant type viewpoint since early flowering is associated with early and frequent branching Branching is controlled on highly branched types to make flower production more uniform There are no known effective means for increasing flower production of very late branching types

Individual plants are coded and each flower raceme tagged and covered after pollination to catch seeds at maturity Seeds from the same clone among the various replications are combined and planted together as a half sib family having a known female parent and a mixture of male parents Family performance is a measure of general combining ability of the female parent

The polycross blocks were modified this year to permit gradual incorporation of genes for characteristics oc curring in a background basically unadapted to the environment in question The unadapted genotypes were planted as borders surrounding each of the replicates of the polycross block To avoid contamination of the basic gene pool with pollen of this unadapted germplasm border plants were emasculated weekly The progeny of the border rows will be backcrossed several times to the basic pool to combine the adaptation of the pool with the character being introduced

The second stage of germplasm improvement involves selection of the best entries from the polycross blocks based on combining ability and performance within a given environment The selected clones are recombined through controlled pollination In this stage more precise control of parentage is possible and specific combining ability effects can be capitalized upon

Progeny evaluation Progeny of gene pools are being evaluated in Media Luna Carimagua Popayán and CIAT Palmira Evaluation beginning at the F_1 stage (plants from true seed) within each environment has the potential advantage of a high selection efficiency since very large numbers of distinct genotypes are subjected to the particular characteristics of the environment Further studies are needed however to compare efficiency of F_1 selection first in CIAT Palmira versus within the environ ment Seedling plants are rather delicate during the first several weeks after sowing or transplanting and large losses can easily occur from factors unrelated to the plant s

progeny for dry matter content due to the huge number of samplings required however if at some point a rapid and intensive increase in dry matter content is desirable F_1 evaluation would be justified

Seed germination studies Cassava seeds are known to have a dormancy period for several months after harvest Decreasing the lenght of the dormancy period would significantly shorten the breeding cycle For newly harvested seeds a pregermination heat treatment in a dry oven at 60 C for 14 days was found to significantly increase total germination and decrease time to germination (Figure 3) For 3-6 month old seeds no improvement in germination was noted but neither was the treatment detrimental to germination compared to the controls Therefore 0-6 month old seed can safely be heat treated with beneficial effects on the new seeds and no effect on the older seed Results have been confirmed in the field at Carimagua where germination of heat treated seeds of 0-9 months was 47 2% compared to 35 5% for nontreated seeds

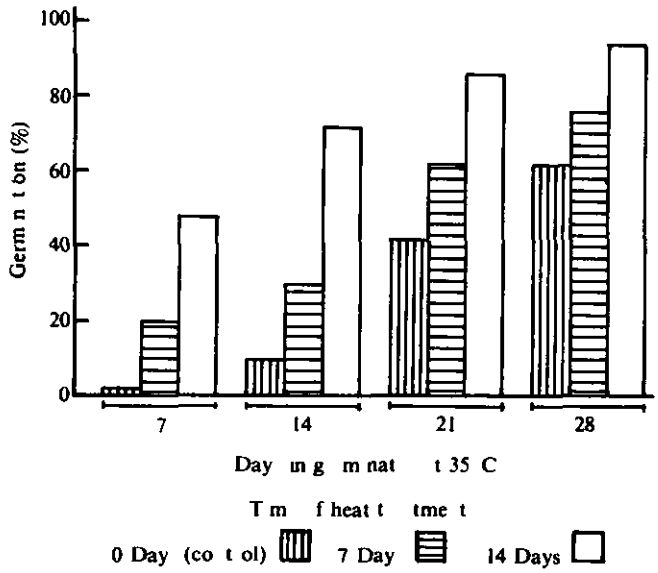


Figure 3 *Effect of pregermination heat treatment (at 60°C 150 days/treatment compo t from x rities) on newly harvested assa a eed*

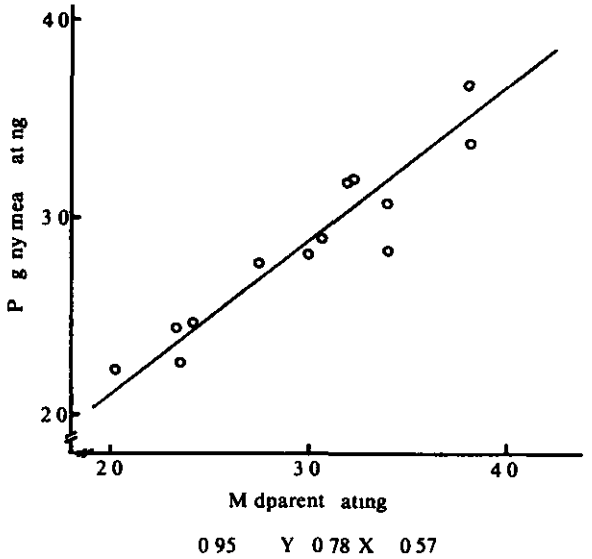
future potential (e g short drought period weed competi tion attack by chewing insects) A further problem is moving large amounts of clonal material back to a centralized location for crossing or stake multiplication These problems are being investigated further to maximize the efficiency of F1 selection Superior hybrids will be tested through the replicated yield trial stage then passed to the Varietal Improvement section as new gene sources

Special Studies

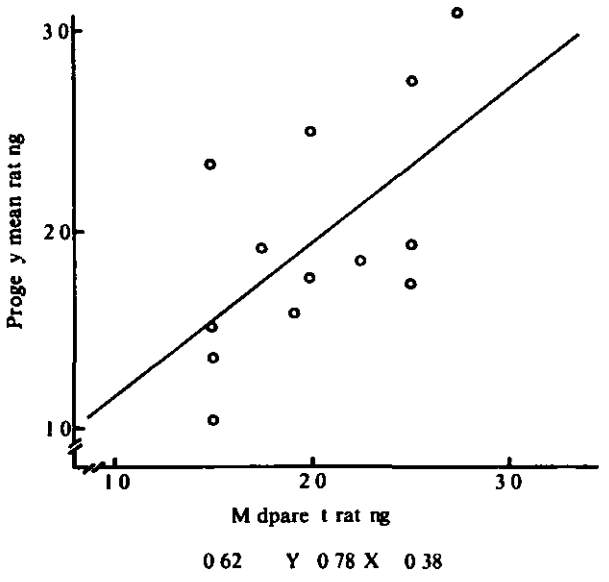
Heritability of mite resistance Mites have been identified among the important arthropod pests of cassava Previous studies (CIAT Cassava Prog 1979 Ann Rept) showed a high broad sense heritability for *Mononychellus* resistance (high consistency across replications in a field across sites and across years)

Studies in CIAT Palmira this year in two F_1 hybrid trials showed high narrow sense heritability ($h^2 = 0.78$) based on midparent progeny regression where the slope of the regression line is a direct estimate of h^2 (Figures 1 and 2)

This study also indicates that when medium to high mite infestation occurs at CIAT Palmira preliminary selection there of individual plants in a segregation population will probably be effective for North Coast conditions



F gure 1 *Reg o f F1 p og ny m an n m dpa ent f ist n t th* **Mo ny hellus tan joa** *m te unde h gh p pul t on l ls t CIAT P lm 1980*



F g 2 *Reg ession of F1 p ogeny mean on midparent f istan e to the* **Mononychellus tanajoa** *m te unde mode ate populat le els t CIAT Palmira 1980*

Heritability of adaptation in low temperature zones Progeny from six cross combinations involving an adapted parent (M Col 1522) crossed with poorly adapted parents were grown in a replicated trial in Popayán along with the parent clones For all crosses mean family yield cold tolerance *Phoma* and anthracnose resistance and general evaluation was intermediate between the parents A few hybrids yielded about the same as M Col 1522

These data show that poorly adapted cultivars are generally unacceptable as parents for production of hybrids in this environment as the proportion of well adapted progeny is very low Adaptation appears to be largely controlled by additive gene effects

Early generation selection for root dry matter content High root dry matter content is an important quality criterion for practically all uses of cassava A study was concluded this year to determine whether selection for root dry matter content on an individual plant basis in a segregating F_1 population could be effective Data from 260 individual plants grown from true seed were compared with the same clones grown in a single row observational yield trial at CIAT Palmira Correlation between the two clonal generations was $r = 0.48$ demonstrating the ability to measure a significant proportion of genetic control of dry matter production compared to environmental effects CIAT does not presently intend to routinely evaluate F_1

Errata

Page	Columm	Element	I rinted	Should be
6	1	Figure 2	M C I 59	M M x 59
6	2	Figure 3	M C I 59	M Me 59
6	2	Figure 3	LSD (I <0 05)	LSD (I <0 05)
7	1	Figure 4	M C I 59	M M x 59
60	2	Second para line 8	more to growth	more top growth
61	2	Line I	and K contents	and K concentrations
20	1	Figure 1	I T I rant III T I t V I I r t	I I te m d ate res ta t III I t m d at r t t V Inte m d t re t t
62	1	Figure 3	St m □	St ms △
64	1	Figure 5	5 0 4 0 N	5 0 4 0 N 3 0
66	1	Figure 8	F g 44	F g 8
93	2	Footnote	L tt du g 1979	l tt d b 1980