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Appendix A

Grain Legume Production

ANNUAL PROGRESS REPORT

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IMPROVEMENT OF FOOD LEGUMES FOR THE TROPICS

Prepared by

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U.S. Agency for International Development

with

Agricultural Research Service
U.S. Department of Agriculture

SUMMARY

Research was continued at the Federal Experiment Station, Mayaquez, Puerto Rico, to develop disease resistant germ plasm of beans (*Phaseolus vulgaris*) and cowpeas (Southern peas) (*Vigna sinensis*) for tropical areas, especially those in Latin America.

Beans: Screening for resistance to the white fly (*Bemisia tabaci*) transmitted viruses, (Rhynchosia mosaic virus, Pseudo curly top virus, and Golden yellow mosaic virus) was continued in cooperation with the Puerto Rico Agricultural Experiment Station. Several lines shown to be resistant in the field were tested subsequently in the greenhouse under very severe conditions, and one line, R19, was found to be tolerant to the disease, the only one of thousands of lines tested in Puerto Rico and elsewhere. One hundred thirty-five crosses have been made using R19 as the resistant parent. One hundred twenty-eight lines and hybrids selected for disease resistance in Puerto Rico were grown at Mayaquez and in El Salvador in cooperation with the Ministry of Agriculture, and comparisons were made on reaction to four diseases. A number of lines were resistant to one or more diseases at one or both locations. Eight wild beans collected in Central America by the USDA were highly susceptible to viruses but some showed resistance to bacterial blights and rust. Two hundred forty black-seeded hybrids were screened in Puerto Rico for resistance to mosaic, bacterial blights, angular leaf spot and rust. In addition 332 P.I. accessions were screened for resistance to rust. The study of the relationship of plant habit to leaf webber infestation was continued.

Cowpeas: Over 500 P.I. accessions of cowpeas were screened for field tolerance to powdery mildew, Puerto Rico cowpea mosaic, bacterial blight, and *Cercospora* leaf spot. Three lines were resistant and six partially resistant to powdery mildew; 10 lines were resistant to mosaic; 21 lines were resistant to blight; and 21 resistant to *Cercospora* leaf spot. Thirty-one lines of cowpeas were planted in both Puerto Rico and El Salvador and disease reaction and agronomic characteristics compared. Results indicated that lines believed similarly for agronomic characteristics in both places, but that incidence of diseases varied indicating the possibility of different races of the pathogens being present at each location. The uniform Southern Pea Conference nursery was grown in Puerto Rico and observed for yield and disease reaction. Several lines showed resistance to specific diseases and adaptability to the tropical environment and the reaction of 32 P.I. accessions of cowpea to pea weevil was studied.

Screening for field resistance to Rhynchosia Mosaic Virus (RMV) and Golden Yellow Mosaic Virus (GYMV) in bean PI accessions.

N. G. Vakili and W. Santiago

The same bean plot grown in the South Field for the purpose of screening against Golden Yellow Mosaic virus (GYMV) and pseudo curly top (PCT), which was reported in the December 1970 semester report, pages 166-168, was maintained for further observations and disease recording. This plot consisted of 116 lines, 90 of which were planted in a replicated plot at Las Gomez. In order to lengthen the growth period of the plants, vines and shoots were trimmed, a soluble fertilizer with 20-20-20, N-P-K formulation, was sprayed twice on the foliage and fungicides were applied at 5 to 7-day intervals as conditions required.

This screening test started on October 21, 1970, and the plot was abandoned on March 30, 1971. The virus incidence peaked about late December, at which time 72% of all plants were infected with white fly (Bemisia tabaci) transmitted virus diseases (Table 2).

Dr. Julio Bird (UPR, Rio Piedras) maintains that Rynchosia mosaic virus causes symptoms similar to those that I have been reporting as pseudo curly top virus (PCTV). That is: suppression of growth, distorted thick and brittle leaves, and a dull yellow to dull green mosiac of leaves. Henceforth, in future screening reports the name Rynchosia mosaic virus (RMV) shall replace the pseudo curly top virus (PCTV) designation. The golden yellow mosaic virus (GYMV) does not cause any leaf distortion or growth suppression, but results in vein clearing and bright yellow mosaic on leaves. Both virus diseases are transmitted by B. tabaci.

Based on the above distinction, each plant in the field was classified as infected with GYMV, RMV, or GYMV/RMV, which indicated that both types of symptoms could be recognized on the same plant.

Interesting relationships between plant habit and symptoms expression were observed in the field which are also reflected in the data summarized in Tables 1 and 2. Table 1 gives the number of accessions which contained plants displaying only GYMV or RMV or either virus diseases. As data in Table 1 indicate, among the PI accessions with bush type habit, the number of GYMV to RMV susceptible accessions approximate a 1/3 ratio. However, the reverse relationship occurs among the semi-vine type accessions; that is, a ratio approximating 3 GYMV to 1 RMV susceptible accessions. All three groups of virus infections were evenly distributed among the vine type accessions. When accessions were totalled for their response to each virus disease grouping, the sampled population ratio turned out to be an almost perfect dihybrid ratio of 1:2:1 for GYMV: GYMV/RMV: RMV, respectively.

Table 1.--Relationship between plant habit in *Phaseolus vulgaris* and susceptibility to white fly (*Bemisia tabaci*) transmitted virus diseases among PI accessions screened.

Plant habit	Number of accessions infected with GYM	GYM &/or RMV	RMV	Total
Bush	4	16	20	40
Semi-vine	19	35	6	60
Vine	5	6	5	16
Total	28	57	31	116

Table 2.--Relationship between plant habit in *Phaseolus vulgaris* and susceptibility to white fly (*Bemisia tabaci*) transmitted virus diseases

Plant Habit	Number of plants infected with GYM	RMV	CYM & RMV	Total infected	Percent infected	Total number of plants screened
Bush	100	372	27	499	81	553
Semi-vine	307	116	48	471	60	779
Vine	98	72	1	171	67	252
Total	505	560	76	1,141	72	1,584

Table 2 gives the summary of data on the relationship between each plant type and the number of plants which were infected with GYMV, RMV, or both diseases. As the data indicate, the number of plants infected with GYMV as compared with those infected with RMV, among the bush type, approximated a 1/3 ratio, respectively. Again the reverse ratio held true for the plants in the semi-vine type. That is, the ratio between the semi-vine plants susceptible to GYMV and those susceptible to RMV was approximately 3/1, respectively.

Among both the bush type and the semi-vine habit, there were plants which displayed symptoms of both virus diseases.

Based on impressions gathered from field observations and data summarized on Tables 1 and 2, the following postulates about: a) relationships between plant habit and susceptibility to the two white fly transmitted viruses, and b) relationship between susceptibility to the two virus diseases are presented below:

1. Factor(s) conditioning susceptibility to GYMV and RMV are linked in repulsion.

2. Factor(s) conditioning susceptibility to GYM and RMV are linked to factor(s) conditioning plant habit.

3. Factor(s) governing bush characteristic are epistatic to factor(s) conditioning susceptibility to GYMV.

4. Factor(s) conditioning semi-vine characteristics are epistatic to factor(s) governing susceptibility to RMV.

5. Factor(s) conditioning vine habit seem to be independently inherited from those conditioning susceptibility to the two virus diseases.

6. Symptoms suggesting susceptible response to both virus diseases in the same plant is due to crossing-over between the factor(s) which condition susceptibility to either GYMV or RMV.

No bush type PI accession with resistance to RMV was encountered in this screening trial. The severity of symptom expression to RMV varied among the bush type PI accessions. Even plants within the same accession varied in their symptom expression. Three of the bush type accessions displayed field tolerance to RMV infection. These were lines PR70-2B-R-85, PR70-2B-R-106, and PR70-2B-R114, while one bush type accession, line PR70-2B-94, displayed tolerant response to GYMV infection.

Field resistance to GYMV and RMV was observed in none of the 60 semi-vine type PI accessions screened (Table 3). Response to GYMV infection varied from severe bright yellow mosaic to small yellow lesions on the leaves. The small yellow lesions remained localized and infected plants outgrew the disease. On the other hand, in the highly susceptible accessions, GYMV infection becomes systemic, which induces prolonged vegetative growth. For example, 12 out of the 14 plants in line PR70-2B-R32, produced very few flowers and did not set any pods while displaying vigorous vegetative growth. The remaining two plants produced less than five pods each with only a few poorly developed seeds. All 14 plants showed severe symptoms of GYMV. On the other hand, not a single plant in PR70-2B-R19 showed GYMV symptoms which could have been rated any higher than "very slight," and for all practical purposes appeared disease free.

Table 3.--Response of nine semi-vine type *Phaseolus vulgaris* PI accessions to white fly (*Bemisia tabaci*) transmitted virus diseases.

Field source	Number of plants infected with virus diseases		Total no. of plants	Remarks
	GYM[1]	RM[2]		
70-2B-R7	2	3	17	Excellent row, diseased plant with slight response, 40% foliage at 2 1/2.
-R19	0	0	15	Excellent row, purple red.
-R25	9	3	15	A single disease free plant selected
-R30	3	1	17	Disease free plants selected
-R31	0	3	13	Disease free plants selected
-R33	7	0	17	The 7 plants with moderate GYM symptoms.
-R34	6	0	16	Disease free plants selected
-R46	6	1	16	The 6 plants with moderate GYM symptoms.
-R65	1	4	13	Disease free plants selected

1/ and 2/ indicate severely infected plant unless otherwise noted.

Rhynchosia mosaic virus symptoms were first to appear in the screening plot. This disease was followed by CBMV disease symptoms and finally GYMV. At 1 month after sowing 219 seedlings displayed RMV symptoms while only 90 seedlings displayed GYMV symptoms (these reports, 1970, p. 168, Table 1). But, at 2 months after planting, 560 plants had RMV,,while 505 showed GYMV symptoms (Table 3); that is, a 2.5 and 6 fold increase for RMV and GYMV, respectively, during the second month of the screening trial.

Close observation suggested that a number of plants with symptoms which appear initially as if caused by CBMV infection would develop into GYM symptoms as infection advanced with leaf maturation.

This screening trial suggested that in PI accessions there are sources of resistance to strains of GYMV and RMV present in Puerto Rico.

Comparison of the field screening with greenhouse screening for Rynchosia mosaic resistance

N. G. Vakili and J. Bird (Dr. Julio Bird, UPR, Rio Piedras)

Seeds of the nine PI accessions which were selected for freedom from golden yellow mosaic virus (GYMV) and Rynchosia mosaic virus (RMV) disease symptoms (reported in the preceeding screening trial), were sent to Dr. Julio Bird of the University of Puerto Rico at Rio Piedras for greenhouse screening against RMV. Also included were seeds of seven other accessions which had shown distinct susceptibilities in the field (Table 1).

The relative resistance of bean accessions to mosaic virus of Rynchosia minima was tested in the greenhouse. For this purpose stock cultures of the vector, Bemisia tabaci, were maintained on virus infected Rynchosia minima plants in the greenhouse. Test plants, at the first trifoliolate stage, were planted on benches adjoining the virus source. The mosaic affected Rynchosia plants were disturbed daily in order to disseminate the viruliferous white flies. Test plants were retained in the greenhouse until maturity. Observations on the response of the varieties were made every 2 weeks. Table 4 gives the comparison of field and greenhouse screening results on the 16 PI accession lines.

Table 4.--Comparison of responses of 18 bean (*Phaseolus vulgaris*) accessions to Golden Yellow Mosaic Virus (GYMV), *Rynchosia* mosaic virus (RMV) and Common Bean Mosaic Virus (CBMV) screening in the field with RMV and CBMV screening in the greenhouse.

No.	Field number	Field screening Mayaguez Virus diseases GYM	RM	CBM	Total	Greenhouse screening[1/], Rio Piedras Number and RMV symptoms Severe Response	Mild Response	CBMV inf.	Total no. of plants
1	70-2B-R7	2	3	0	17	0	3 mild, rest speck	0	20
2	-R19	0	0	0	17	0	All very mild speck	0	30
3	-R25	9	3	0	15[2/]	5	25 speck	0	30
4	-R30	3	1	0	17	9	19 speck	0	28
5	-R31	0	2	0	13	4 moderate	25 speck	0	29
6	-R33	7[3/]	0	0	17	9 moderate	11 speck	0	20
7	-R34	6	0	0	16	7	21 speck	0	28
8	-R46	6	1	0	16	0	All very mild, chlorotic speck	0	30
9	-R65	1	4	0	13	0	All speck	0	30
10	-R4	0	0	19	20	0	3 very mild, rest speck	7	25
11	-R17	0	13	0	18	10	19 speck	0	29
12	-R41	0	6	12	18	15	13 speck	11	28
13	-R86	0	20	8	20	15	speck	15	30
14	-R93	2	19	0	19	13	15 speck	0	28
15	-R102	0	13	2	14	9 moderate	7 speck	11	27
16	-R111	16	0	0	16	0	2 mild, blotching, rest speck	8	30

1/ Summary of two disease recordings
2/ Single plant selected for resistance represents the line

As data in Table 4 indicate, there is a very close correlation between the results obtained from field screening trial and those gathered from inoculation tests, using Bemisia tabaci as insect vector and Rynchosia minima as inoculum source, in the greenhouse. However, during the field screening test, there was not a single R. minima plant, either disease or disease free, within 1/2 mile distance from the field. The predominant source of inoculum around the screening field was an abundance of severely GYM infected Phaseolus lathyroides. Also, there were some patches of Sida carpinifolia intermixed with a few plants of S. rhombifolia which were infected with Abutilon mosaic or infectious chlorosis. Bird in 1969 showed that white fly transmits RMV from Rhynchosia minima to P. lathyroides. Hence, it could be deduced that the GYMV part of the disease complex was either transmitted from Sida species or again from P. lathyroides. However, Bird, in his virus transmission studies, was unable to infect beans with the viruliferous white flies from Sida plants. The above discussion points to P. lathyroides as the source of both GYMV and RMV disease complex in the beans tested. However, it does not rule out Sida species as another source of RMV infection in beans. A line for line comparison between plants grown at the South Field and those in the "Sida plot" at Las Gomez (these reports, 1970, pp. 166-168), strongly suggest that Sida species in Puerto Rico should be considered as one of the sources of RMV disease incidence in beans, as is shown by the data in Table 5. In presenting the data in Table 5, lines which at the South Field displayed distinct susceptibilities to either GYMV or RMV were chosen and compared with their replicates in the Sida plot. However, in the Sida plot, not a single incidence of GYMV disease occurred among the lines which showed a high incidence of this disease in the South Field. From these data one may conclude that the chances for RMV incidence is extremely high when bean lines susceptible to RMV disease are planted adjacent to Sida species supporting Abutilon mosaic. This conclusion concurs with the results obtained by Costa in Brazil and Gamez in Costa Rica, but differs with results obtained by Bird in Puerto Rico.

Table 5.--Comparison of 11 bean lines, with distinct susceptibilities to GYMV and RMV diseases grown at Las Gomez (Sida plot) and the South Field.

Field number	Number of diseased plants in South Field plot with Phaseolus lathyroides and Sida			Number of diseased plants in Las Gomez plot with Sida spreader lines		
	GYM	RM	Total	GYM	RM	Total
PR70-2B-R9	17	0	17	0	0	6
-R20	11	1	19	0	0	9
-R24	13	0	15	0	1	9
-R32	14	0	14	0	0	13
-R34	6	0	16	0	0	9
-R48	10	0	19	0	0	9
PR-70-2B-R8	0	13	13	0	5	13
-R62	0	14	14	0	7	7
-R78	0	20	20	0	14	18
-R82	0	10	12	0	10	15
-R87	0	15	15	0	17	17
Total	71	73	174	0	54	124
Percent Infected	41	42		0	42	

As data in table 5 indicate, the following lines were resistant to RMV inoculation tests in the greenhouse: 70-2B-R7, -R19, -R46 and -R65. The line 70-2B-R19 has been subjected to six inoculation tests up to date and has retained its resistant response. This is a very promising line as a source of multiple disease resistance. It is resistant to GYMV, RMV, CBMV, tolerant to rust infection (0-2 index), has excellent root system and is highly vigorous.

Hybridization of Phaseolus vulgaris for resistance to Rhynchosia mosaic virus.

N. G. Vakili and J. Santiago

One hundred and thirty-five crosses were made between MZ-70-2B-R19 (a selection which has proved resistant to both in field and in greenhouse screening) and the variety Santa Ana, which has been free from Rhynchosia mosaic virus in Nicaragua. Only 24 of the crosses set pods and produced 37 F_1 hybrid seeds. The F_2 progenies will be inoculated under controlled conditions at Rio Piedras for screening of the segregants.

Comparison of responses of 128 selected bean accessions and hybrids to disease incidence in El Salvador and Puerto Rico.

N. G. Vakili, B. Patino and R. Cristales (Patino and Cristales, Ministerio de Agricultura y Ganaderia, El Salvador)

Seeds of 128 bean PI accessions, selections and black-shiny hybrids were sent to El Salvador for adaptability and disease resistance tests on May 14, 1970, from FES, Mayaguez. These seeds were sown on January 18, 1971, and disease responses were recorded on March 17, 1971. The planting consisted of one row of each seed source which included 10 to 15 plants. Table 1 provides a comparison of disease incidence occurring under natural field conditions in Puerto Rico and in El Salvador, except for CBMV, which was field inoculated in Puerto Rico. Diseases enumerated in table 6 are: Common Bean Mosaic Virus (CBMV), Col. 3 and 4. Of the 128 lines inoculated with CBMV in Mayaguez, 51 developed no symptoms, 36 were resistant, which includes very slightly and slightly susceptible responses, and 40 were susceptible, which includes the range of responses from moderately to highly susceptible. At San Andres, only three rows had all susceptible plants. One row, which showed CBMV susceptible response in San Andres, was virus free at Mayaguez. Six CBMV infected plants were found in six rows, one diseased plant per row. The rest of the plants in 118 rows were free from CBMV infection.

Golden Yellow Mosaic (GYM), table 6, Col. 5 and 6, "Moteado Amarillo," or GYM incidence in San Andres area is extremely severe, as indicated by the response rating in column 6 of table 6. All plants in 124 of the 128 lines tested showed susceptible response varying in the range of moderate to highly susceptible. There were no Witches'-Broom type or Pseudo Curly Top response among these plants, but Golden Yellow Mosaic. Two entries showed slightly susceptible response. These were accession PI 173024 and selection PI 306162-B. A very slightly susceptible response, which is indicated

by small and isolated chlorotic lesions, was displayed by accession PI 312078. The most surprising response was that of a stringless pole bean, PI accession 281594. In this row, 9 of 11 plants were completely free from yellow lesions or vein clearing, while two plants were susceptible.

At Mayaguez only 21 of the 128 accessions had shown any response to GYM and Witches'-Broom or Pseudo curly top. However, intensity of GYM infection in the field has increased, but by no means does it equal the epidemic conditions present in El Salvador. The intensity of GYM infection in the field in Mayaguez, which was induced by spreader rows of Phaseolus lathyroides, is about 40 to 50% of the natural disease frequency in San Andres.

Common Bacterial Blight (Xanthomonas phaseoli), table 6, Col. 7 and 8. This disease is present both in Puerto Rico and in El Salvador. During unexpected rainy periods it could cause severe reduction in yield. Since beans are grown intensively and year around in El Salvador, it is essential that sources of resistance and/or tolerance to the disease be located and utilized in the breeding programs. (Note. The "None" designation does not indicate resistance.) Sixteen of the 128 lines have been free from common bacterial blight infections at both locations.

Rust (Uromyces phaseoli var. typica), Col. 9 and 10. Rust is prevalent during the winter planting in San Andres area. Although it occurred with wider virulence, the disease pressure was not severe enough to cause total defoliation as it occurs in Isabela, Puerto Rico. Only 14 bean lines maintained their rust resistance at both locations. None of the bean lines displayed susceptibility to prevalent rust races in Puerto Rico and resistance to those in El Salvador. Or, in other words, rust races in El Salvador were more pathogenic than those present in Puerto Rico.

Table 6. Comparisons of responses of 128 selected bean lines to field diseases endemic to Mayaguez, Puerto Rico, and San Andrés, El Salvador

PI Number	Common Bean Mosaic		Golden Yellow Mosaic		Common Bact.Blight		Rust Index	
	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.
155213-A[1/]	V. Sli.	None	None	Susc.	Susc.	Susc.	2-3	3
155213-B	" "	"	"	"	"	"	2-3	3-4
186502-A	Sli.	"	(W.Broom)	M. Susc.	M. Susc.	"	2	4-5
186502-B	"	"	" "	Susc.	" "	"	2	4-5
155213-1[2/]	"	"	None	"	Susc.	"	0-1	3-5
150401	Hi. Susc.	"	"	M. Susc.	--	"	0	5
164760	None	"	"	Susc.	--	"	3-5	4-5
165420-B	Susc.	"	"	"	--	"	0	3, 15%
165455-B	"	1 pl. Susc.	"	"	Susc.	"	0	4
173024	None	None	"	Sli.Susc.	--	None	0	2, 5%
181796-A	None	"	"	M. Susc.	--	"	0	1-2,5%
181796-B	"	"	"	Susc.	--	"	0	1, 5%
190069-A	"	"	"	M.Susc.& Susc.	--	Susc.	3-4	2 & 5
190038	"	"	"	M. Susc.	--	None	0	1-2,5%
201488-1-1[2/]	"	"	"	Susc.	--	Susc.	0	3
203958	"	1 pl. Susc.	"	M. Susc.	--	None	0	3-4
207373-A	M. Susc.	None	"	Susc.	M. Susc.	Susc.	0	0
207373-B	M. Susc.	"	"	Sli. Susc.	" "	"	0	0
209804	None	"	"	M. Susc.	None	None	0	4
212021	"	"	"	Susc.	"	"	0	0-
212024	"	"	Susc.	M. Susc.	"	"	0	1
184783	Sli.	"	None	Susc.	Susc.	"	3-4	4-5,80%
155212	None	"	"	"	M. Susc.	Susc.	0-1	3-4,40%
200974	"	"	"	M. Susc.	Susc.	None	3	4,30%
300662	"	"	"	" "	"	"	2	4
306151	V. Sli.	"	Susc.	" "	"	Susc.	0	3-4
306161	" "	"	None	" "	"	None	2	3-4

(continued)

Table 6. (Continued)

PI Number	Common Bean Mosaic		Golden Yellow Mosaic		Common Bact.Blight		Rust Index	
	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.
310519	V. Sli.	None	None	Susc.	Susc.	None	3	3-4
281594	None	"	"	2 pl. susc.	"	"	0	0
289337-B	"	"	"	Susc.	"	"	0	0 & 4
300659	"	"	"	M. Susc.	"	"	0	0
300680	"	"	"	Susc.	"	"	0	0
304111-A	Sli.	"	"	"	Susc.	"	0	3-4
306154-B	None	"	"	Hi. Susc.	None	"	0	1-2
306160-B	Sli.	None	None	Susc.	Susc.	Susc.	0	3,15%
306162-B	"	"	"	Sli. Susc.	"	None	0	0
307751-B[2/]	None	"	"	Susc.	None	"	0	4-5
307807-B-1	Susc.	1 pl. Susc.	"	"	Susc.	V. Sli.	0	5
307807-B-2[2/]	Susc.	Susc.	"	M. Susc.	"	M. Susc.	0	5
312078	None	Susc.	"	V. Sli.	None	None	0	2-3,10%
150957	Susc.	None	None	Susc.	Susc.	"	0	3-4
151027	None	"	"	M. Susc.	"	"	0-2	4
175257-A[2/]	Susc.	"	W.Broom	Susc.	M. Susc.	Susc.	0	4-5
186504-A-1	Sli.	"	None	"	Susc.	None	0	4-5
186504-A-2[2/]	"	"	"	"	"	"	0	4
186505-A	"	"	"	"	"	Susc.	0	3-4
186505-B	"	"	"	Hi. Susc.	"	None	0	3-4
189015-A	"	"	W.Broom	M. Susc.	"	"	0	3
189015-B	"	"	" "	" "	"	"	0	3-4
190069	None	"	None	" "	None	"	-	5
194576	Susc.	"	None	Susc.	Susc.	"	0	5
195347	None	"	"	"	None	Susc.	-	3-4
195364-A	Susc.	"	W.Broom	M. Susc.	Susc.	None	3	5
195370-A	Hi. Susc.	"	" "	Susc.	"	Susc.	0	4-5
195370-B	" "	"	" "	"	"	"	0	4
200956-A	Susc.	"	Susc.	"	M. Susc.	None	3	5
200967	"	1 pl. Susc.	"	"	None	"	4	4-5
200974	None	None	None	"	Susc.	Sli.	0	4-5
201488	"	"	PCT	V. Sli.	None	Susc.	0	0 & 4

(continued)

Table 6. (Continued)

PI Number	Common Bean Mosaic		Golden Yellow Mosaic		Common Bact. Blight		Rust Index	
	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.
201333	None	None	None	Susc.	None	Susc.	0	3-4
204963	"	"	"	"	"	"	0	5
207198	M. Susc.	"	"	M. Susc.	Susc.	None	0	3-4
207409	Susc.	"	"	Susc.	M. Susc.	"	0	3-4
207832-A	Sli.	"	"	"	Susc.	Susc.	3	4
207832-B	"	"	"	"	"	"	3	4
208768-A	None	"	"	"	"	"	4	3-4
208768-B	"	"	"	"	"	Sli.	4	3-4
209465	None	"	"	"	"	"	0	3-4
209473	"	"	"	Hi. Susc.	"	None	4	3-4
209475-A	"	"	"	" "	"	Susc.	0	4-5
209475-B	"	"	"	Susc.	"	None	0	3-4,40%
209493	Susc.	Susc.	"	M. Susc.	Hi. Susc.	Susc.	0	2-3
209621-A	V. Sli.	None	None	" "	Susc.	Sli.	0	3-4
209621-B	" "	"	"	Susc.	"	Susc.	0	4
268108-A	Susc.	"	Susc.	Hi. Susc.	M. Susc.	"	2	3-4
268108-B	Susc.	"	"	Susc.	" "	"	2	3-4
268110-A	Sli.	"	W.Broom	"	Susc.	None	3	3
268110-B	Sli.	"	" "	"	"	Susc.	3	3
282008	V. Sli.	"	None	"	M. Susc.	None	2	4-5
287536	None	"	Hi. Susc.	Hi. Susc.	None	"	0	4-5
288014-A-1 2/	M. Susc.	None	Susc.	Susc.	M. Susc.	Susc.	0	2-3,30%
288014-A-2 2/	" "	"	"	M. Susc.	" "	"	0	3
300660	None	"	None	" "	Susc.	"	0	3-4
300662-A	"	"	"	" "	"	"	3	3-4
300678	"	"	"	" "	M. Susc.	"	2	3-4
300665	"	"	Hi. Susc.	Susc.	None	"	0	0-1
303639	"	"	None	M. Susc.	M. Susc.	None	0	4-5
304111	Sli.	"	"	Susc.	Susc.	Susc.	0	3
306159	None	"	"	"	"	None	0	4-5
306160-A-1 2/	Sli.	"	"	"	"	Susc.	0	0-1
306160-A-2 2/	"	"	"	"	"	"	0	3-4

(Continued)

Table 6. (Continued)

PI Number	Common Bean Mosaic		Golden Yellow Mosaic		Common Bact.Blight		Rust Index	
	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.
306161-A	Sli.	None	None	Susc.	Susc.	None	3	3
306161-B	"	"	"	"	"	"	3	3
306162	M. Susc.	"	Susc.	M. Susc.	"	"	3	3
306163-A	None	"	None	Susc.	"	"	0	3
306163-B	"	"	"	"	"	"	0	3
307751-A	"	"	"	"	None	Hi. Susc.	0	1-2
307785	"	"	"	"	"	Susc.	0	0-2
307807-A	Susc.	"	"	"	Susc.	None	3	4-5
308897-A	V. Sli.	"	"	"	"	"	0	4
308897-B	" "	"	"	"	"	Susc.	0	3-4
308911-D	None	"	"	M. Susc.	None	None	0	4
309851	"	"	"	Susc.	M. Susc.	Susc.	0	3-4
309853	M. Susc.	"	"	Hi. Susc.	Susc.	None	0	4-5
309871	Sli.	"	"	Susc.	"	"	0	4
310519	None	"	"	"	"	Susc.	0	4
310544	"	"	PCT	M. Susc.	None	"	0	4
310558	Hi. Susc.	"	"	Hi. Susc.	Susc.	None	0	4-5
310609	" "	"	None	Susc.	M. Susc.	Susc.	0	4
310661-A	" "	"	"	"	None	"	0	4
310667	Susc.	"	"	"	"	"	1	4
310705	Susc.	1 pl. Susc.	"	"	M. Susc.	None	-	4-5
310672-A	"	None	"	Hi. Susc.	" "	"	0	4-5
310711	"	"	"	Susc.	Susc.	"	0	4-5
310712	Hi. Susc.	"	"	"	"	Susc.	0	3-4
310719 2/	Susc.	"	"	"	"	"	0	4
310732-B-1 2/	V. Sli.	"	"	"	"	None	0	3-4
310732-B-2 2/	" "	"	"	"	"	"	0	3-4
310732-A	" "	"	"	M. Susc.	"	Susc.	0	4
310767	Susc.	"	"	Susc.	"	None	0	4
310842	None	None	None	"	"	"	0	3-4

(Continued)

Table 6. (Continued)

PI Number	Common Bean Mosaic		Golden Yellow Mosaic		Common Bact.Blight		Rust Index	
	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.	MYGZ	San And.
310909	Sli.	None	None	Susc.	Susc.	None	0	4-5
311787	None	"	"	"	None	"	0	3-4
311809	Susc.	"	"	Hi. Susc.	M. Susc.	"	0	3-4
311811-A	"	1 pl. Susc.	"	" "	Susc.	"	0	3-4
311944	Hi. Susc.	None	"	Susc.	"	Susc.	0	4
312072-A	Susc.	"	"	"	"	None	0	4-5
312072-B	"	"	"	"	"	"	0	3-4

1/ Selection within PI type range.
2/ Putative hybrid. This system is now replaced by P.R. numbers.

Summary of responses of wild Phaseolus vulgaris PI accessions to diseases in El Salvador and Puerto Rico.

N. G. Vakili, B. Patino and R. Cristales

Eight wild bean accessions (conspecific with Phaseolus vulgaris, according to H. S Gentry) were planted in Puerto Rico on September 22, 1970, at Isabela and in El Salvador on January 13, 1971, at San Andres. In both plantings each accession was represented with one row of 25 to 30 plants. Disease incidence was recorded on December 30, 1970, for the Isabela planting and March 17, 1971, for the San Andres planting. Table 7 gives the responses of the eight accessions to prevalent field diseases at both locations.

No common bean mosaic virus infections were detected at San Andres among the plants examined. However, at Isabela normal field incidence of CBMV caused moderately susceptible to susceptible responses. Many of these accessions gave severely susceptible response when inoculated with CBMV (these reports, 1970, p.22).

The response of accessions to Golden Yellow Mosaic (GYM) at San Andres was severe, causing pronounced yellowing of leaves of every plant in each row. In Puerto Rico only one plant was found infected with GYM. This severity of disease in El Salvador could be either due to a more virulent strain of the virus or the abundance of white fly in that country or both.

It is interesting to note that these "wild" beans are so highly susceptible to viruses mentioned above. Gentry in his "Origin of the Common Bean, Phaseolus vulgaris," states that these collections were made at 2,500 to 6,000 feet elevations. Perhaps elevation at which these species grow is the reason for the lack of selective pressure against insect transmitted viruses. At those high elevations, there are very few or no insect vectors such as white flies and aphids. Hence, there is no selection pressure on the wild population for resistance against diseases which are transmitted by these insects.

Accession 325691 was free from common bacterial blight infections (Xanthomonas phaseoli) at both locations. All of the eight accessions were susceptible to Halo Blight (Pseudomonas phaseolicola). The reason for greater blight incidence in Puerto Rico was, most likely, the great amount of unseasonal rainfall which occurred during the past fall and winter. On the other hand, at San Andres the dry season was not interrupted by rains.

During the fall of 1970, rust (Uromyces phaseoli var. typica) was severe in the bean plantings at Isabela. However, three of the accessions were free from any rust infection and the rest displayed three or four pustule types on only 5 to 10% of the leaf surface. At San Andres, on the other hand, every accession was infected and all supported five type pustules.

Table 7.--Comparison of response of eight wild *Phaseolus vulgaris* accessions to prevalent field diseases at San Andres, El Salvador and Puerto Rico

PI Number	CMBV		GYMV		Common Bacterial blight		Halo Blight		Rust	
	El Salv.	P.R.	El Salv.	P.R.	El Salv.	P.R.			El Salv.	P.R.
325676	No inf.	Mod. Susc.	Susc.	1 pl.severe/25	Susc.	Susc.	No inf.	Susc.	5,5%1/	0
325677	"	Susc.	"	" "	No inf.	"	Susc.	"	5,5%	0
325684	"	"	"	" "	Susc.	"	No inf.	"	5,5%	3,5%
325686	"	Mod.Susc.	"	" "	No inf.	"	" "	Mod.Susc.	5,60%	0 & 3
325687	"	Susc.	"	" "	" "	Mod.Susc.	" "	Susc.	5,5%	3-4,10%
325688	"	"	"	" "	" "	Susc.	" "	"	4,60%	0 & 4
325689	"	Mod.Susc.	"	" "	" "	"	Susc.	Mod.Susc.	5,5%	0
325691	"	Susc.	"	" "	" "	No inf.	No inf.	Susc.	5,5%	3-4,5%

1/ Rust infection index of 0 to 5, percentage of leaf surface infected.

Only two accessions, PI 325686 and 325688, had about 60% of their leaf surface infected with rust pustules. The remaining six accessions were "Low Rusters." That is, only 5% of the leaf surface was infected. The "low rusting" or the tolerant capacity for rust infection is a significant feature of these wild beans.

At the high elevations in the tropics, dew forms during almost every night of the dry season. The dew and the mild temperatures provide an optimum condition for rust infection. The "low rusting" capacity of many of the wild accessions is due to natural selections toward a symbiotic characteristic rather than toward resistance which would have in turn selected for a pathogenic rust race.

The disease incidence observations are suggestive, especially in the case of rust, that different strains of pathogens are endemic at two locations.

Screening black shiny seeded hybrids for disease resistance.

N. G. Vakili and W. Santiago

Hybrids of bean (Phaseolus vulgaris) have been obtained through random cross-pollination in the field carried out by the pollen gathering Carpenter Bees (Xylophora brasilianarum). During the past year and a half upward of 300 such hybrids have been screened for either agronomic characteristics or resistance to various diseases. During the fall of 1970 and early winter of 1971, a plot containing 240 selected black and shiny seeded hybrid lines which consisted of F_2 and F_3 progenies were grown for seed increase at Isabela.

These random population hybrids were selected for consumer preference and resistance to diseases prevalent in El Salvador. During his visit to Mayaguez, March 20-26, 1971, Mr. Bernardo Patino, Head of the Salvadoran Bean Improvement Program, selected seeds of 46 hybrids out of the 240 examined. These selected hybrid seeds will be sent to El Salvador for adaptability and disease resistance tests.

The responses of the 240 bean hybrids to field screening for disease resistance were as follows:

1. Common bean mosaic virus. Summary of observations on natural field infections and results of field inoculations with highly virulent Puerto Rican isolates (obtained by Dr. Alconero), indicate that 63 hybrids were moderately to highly susceptible; 108 hybrids were slightly susceptible; 55 hybrids were very slightly susceptible; and 14 hybrids displayed no susceptible symptoms indicating CBMV infection.

It should be mentioned here, that after repeated field inoculations, it is extremely difficult to ascertain the absence of response to CBMV infection, even though a plant may appear, upon cursory inspection, to be free from any symptoms. Responses designated as "slightly" and "very slightly" susceptible should be considered as "field resistant."

2. Common bacterial blight (Xanthomonas phaseoli). The common bacterial blight incidence recorded was due to natural field infection. However, disease incidence was recorded either after periods of prolonged rainfall or after several repeated overhead irrigation. In the following summary the "No infection" designation does not imply resistance. It only indicates that none of the hybrid plants in the row carried any bacterial lesion. In summarizing the disease response, the highest disease rating for 2 or 3 progeny generations was assigned to a hybrid line. Hence: 145 lines were from moderately to highly susceptible, 35 lines were either slightly or very slightly susceptible, and 60 lines supported no infection.

3. Angular leaf spot (Isoriopsis griseola). This disease has been severest during the warm rainy periods, but it appears in the field after any prolonged rainy spells. Field inoculations can readily be accomplished by spreading infected dried pod hulls on the ground and around the bean rows. Infection is easily disseminated by brushing infected leaves against the healthy plants. Best period for field inoculation is either late in the afternoon or after the rainfall. The following responses were summarized: Highly susceptible, 32 lines; susceptible, 165 lines; moderately susceptible, 28 lines; slightly susceptible, 10 lines; and very slightly susceptible to no infection, 5 lines.

Lines designated as "highly susceptible" would defoliate before pods had a chance to mature properly. In the "susceptible" group, only lower leaves become successively chlorotic and fall, hence forcing early maturation of the pods. Among the lines designated as "very slightly susceptible" only few angular leaf spot lesions could be found on the oldest leaves close to the ground.

4. Rust (Uromyces phaseoli var. typica). Rust incidence has been severe during the past 2 years. Field inoculation is accomplished by brushing infected leaves from either spreader rows or other susceptible bean varieties on the rest of plants in the plot. Screening for rust resistance in the field is relatively a simple and effective procedure. The hybrids were categorized according to their rust reaction index as follows: Index 0 to 0-1, 97 lines; 2 to 2-3, 59 lines; 3, 37 lines; 3-4 and 4, 44 lines; and 5, only 3 lines.

Field Screening for rust resistance.

N. G. Vakili and W. Santiago.

During the summer of 1970, 332 PI accessions were screened for rust (Uromyces phaseoli var. typica). Results of this test were presented in the December 1970 Semester Report. Sixty-nine lines out of the mentioned 332 were selected for their agronomic characteristics and their "0" rust reaction. These selections were planted in the South Field on December 17, 1970.

Selections were planted on five field rows, each 150 feet long and 44 inches apart. Twenty-five seeds per selection were planted in a 22-foot long plot on the field rows. Selections were separated by 3-foot distance. A highly rust-susceptible variety "Blanca" was planted in spreader rows on either side of the rust screening plot. Plants in spreader rows were inoculated when 3 weeks old.

Rust resistance response was observed until 2-1/2 months after planting. Only two selections proved susceptible, while all the rest were highly resistant to rust infection. The spreader rows at this time had lost 80 to 100% of their foliage due to severe rust infection. Prevalent rust races in the field were 3 and 9.

The soil chosen for this test was highly infested with a Fusarium oxysporum fungus which causes bean wilt. This superimposed a fusarium wilt screening test on the rust resistance.

By mid-winter, leafhopper (Empoasca fabae) was abundant in the field which caused severe feeding reaction on the bean leaves. Bean selections were also observed for resistance to Empoasca feeding.

Thirty-seven selections for multiple resistance were made for further screening. Details of this study are on file.

Occurrence of Anthracnose on a PI accession at Isabela Farm.

N. G. Vakili and H. Delpin

During the fall of 1970, seed increase plantings for the world collection of Phaseolus vulgaris PI accessions were started. The first 300 accessions were sown on October 5, 1970, and disease incidence readings were made during the week of December 20, 1970.

Severe Anthracnose (Colletotricum lindemuthiarum) infection was observed for the first time, during the past 2 years, in the lowland tropics. Infection occurred primarily on the pods, while only few leaf lesions were observed. Out of 180 lines observed, seven were infected with Anthracnose and only one line showed severe response on the pods and leaves. Further observations in the seed increase plots did not uncover any line which expressed such severe disease symptoms.

Apparently, a combination of specific host genotype and a complementary environmental condition are needed to interact with a given strain of a pathogen, in order to produce symptom expressions which under abnormal conditions did not occur. The severe Anthracnose disease in the PI line 152 was due to unlikely combination of the above factors.

The highly susceptible Anthracnose accessions will be used, with other bean varieties, for differentiating Anthracnose races, for the study of C. lindemuthiarum races present in the lowland tropics.

Disease incidence, a limiting factor in seed increase of bean varieties used for differentiating strains of pathogens.

N. G. Vakili and W. Santiago

During the past season, it was necessary to increase seeds of bean differential varieties for CBMV and rust race studies in the greenhouse. However, rust incidence among these varieties was so severe that 1-1/2 months after planting some varieties were 100% defoliated. Repeated sprays of Dithane M-45, inter-spaced with foliar applications of 20-20-20 soluble fertilizer was required, in order to save the plots from complete loss.

A field trial was laid out to test fungicide control for the bean rust (Uromyces phaseoli var. typica). Toxicants included Dithane M-45, Daconil 2787 and Kilcop "53". Spray dosage was 3 lbs/100 gals/A of each fungicide. Control application was water spray treatment. Each treatment included four replications and each replication consisted of three 25-foot long rows of the highly susceptible bean variety "Blanca". Toxicants were applied at 5 to 7 day intervals.

Rust incidence was so severe that juvenile leaves were infected and pustules errupted by the time leaves were fully expanded. The only effect of the toxicants was to kill the uredial pustules which had covered 80 to 90% of the leaf surface.

Obviously, systemic fungicides are required if we were to grow susceptible bean varieties during the fall-spring growing season. Future fungicide trials will be conducted to find proper control of fungal diseases of bean foliage.

Increase of *Phaseolus vulgaris* accessions from Honduras.

N. G. Vakili and W. Santiago

According to previous arrangements with Dr. George F. Freytag, Head, Department of Agronomy, Escuela Agricola Panamericana, El Zamorano, Honduras, we received 472 lines of red beans, *Phaseolus vulgaris*. These accessions were part of the Central American bean collection presently maintained at Zamorano. Seeds of these accessions were increased during the fall, 1971.

Relationship between leaf webber (*Lamprosima indicata*) infestation and plant habit in *Phaseolus vulgaris*.

N. G. Vakili and H. Delpin

During the past 2 years of planting bean PI accessions for screening against diseases, it was noticed that a certain negative correlation existed between the height of a bean plant and severity of infestation by leaf webber caterpillars (*Lamprosima indicata*). The short internode and hence the close canopy of the bush beans provided an easy-to-reach and plentiful leaf surface for the caterpillars to work on. The long internodes separating leaves of vine type accessions made attaching of several distant leaves a difficult task. The only damage done by leaf webbers to vine-type beans was on the lower portion of plants, where the early semi-vine type growth with short internodes occurred. Leaf webber damage diminished as soon as branches began to extend and climb. The infestation of the semi-vine types was intermediate between the bush and the vine types.

In the early winter of 1971 an opportunity availed itself to record the effect of leaf webber damage in a PI accession population used for seed increase (Table 8). Among the 81 vine-type accessions observed there was no 90 or 100% leaf webbing observed, while many rows of bush beans were webbed into a solid canopy. The data summarized in Table 8 support impressions formed by field observations.

These observations led to a cooperative study of the leaf webber infestation with Dr. David W. Walker, Entomologist, Nuclear Center, UPR. A main purpose of this study is to find criteria by which resistance to leaf webber infestation could be measured. Characteristics other than internode length, are being studied in order to locate morphological markers. Also, relationships between plant habit, leaf webber infestation and yield are studied. The results of this cooperative work are being computerized by Mr. Peter Wilman, Nuclear Center, UPR, and will be presented in the next report.

Table 8.--Relationship between plant habit and leaf webber infestation, caused by *Lamprosima indicata* in *Phaseolus vulgaris* PI accessions.

Plant habit	Number of PI accessions and the percentage of leaf webber incidence										Total number of accessions
	10	20	30	40	50	60	70	80	90	100	
Bush	0	1	4	9	6	4	6	4	6	5	45
Semi-vine	1	4	5	8	5	2	6	2	2	0	35
Vine	7	20	22	20	5	3	3	1	0	0	81
Total	8	25	31	37	11	9	15	7	8	5	161

Screening *Vigna sinensis* PI accessions for field tolerance to powdery mildew *Erysiphe polygoni*.

N. G. Vakili and W. Santiago.

Five hundred and three *Vigna sinensis* PI accessions were grown during winter and spring 1970-71. Thirty-two lines remained relatively free from powdery mildew (*Erysiphe polygoni*) infection during this growing period. These 32 lines were selected and planted on December 4, 1970, in a complete randomized block with three replications. Each replicate consisted of a 25-foot row and 30 plants per row. Each block was bordered with two spreader rows of *Vigna* accessions highly susceptible to powdery mildew. Each spreader row was a different accession. This was done to reduce the possibility of screening against only one race of powdery mildew.

By February 12, 1971, powdery mildew had spread in the replicated blocks resulting in a severe infection on many of the previously selected lines (Table 9). Only three lines, VPR-70-R-R305, -R361, and -R482, proved to be resistant to powdery mildew incidence during this test. Six lines were partially resistant giving an average index of "2" to *E. polygoni* infections. Fifteen lines were moderately susceptible, and three lines were highly susceptible. The highly susceptible accessions were almost white with powdery mildew infection and defoliated prematurely. Table 9 gives the responses of three Southern pea lines representing a given reaction type. As data in the Table shows, there is some overlapping of reaction types. However, with two disease readings and three replications, the chances for insufficient observation before correct rating is greatly reduced.

Table 10 gives the data on six Southern pea accessions which were observed in three different plots during 1970-71 and their responses to powdery mildew were recorded. In this case also, more than one disease reading per line was carried out. However, these lines remained within a limited range of their reaction types.

Table 9.--Field response of *Vigna sinensis* PI accessions to powdery mildew (*Erysiphe polygoni*).

Source number	Powdery mildew index days after sowing						Average index for accession	Accession response
	Rep. I		Rep. II		Rep. III			
	50	70	50	70	50	70		
VPR-70-4-R361	0	1	1	1	1	2	1	Resistant
-R482	1	1	1	1	1	1	1	"
-R305	0	1	0	1	0	1	1	"
-R122	0	2	1	1	1-2	2	2	Port. resistant
-R476	1	1	2	2	1	2	2	" "
-R129	0-1	1	2	2	1	1	2	" "
-R362	0	3	2	2	2	3	3	Mod. Susc.
-R126	3	3	2	2	2	3	3	" "
-R125	2-3	3	1	3	2	2	3	" "
-R387	4	3	5	3	4	4	4	Susc.
-R55	2-3	2	4	4	4	5	4	Susc.
-R149	2	3	4	2	3	4	4	"
-R317	3	5	3	5	3	5	5	Highly susc.
-R495	3	4	3	5	3	5	5	" "
-R442	2	4	4	5	3	5	5	" "

Table 10.--Response of six *Vigna sinensis* accessions in three separate plantings during a year to powdery mildew (*Erysiphe polygoni*) incidence.

Source number	Response to powdery mildew		
	7/8/70	1/16/71	3/26/71
VPR-70-4-R8	1	0	0
-R46	3	2	2
-R224	2	1	0-1
-R369	2	2	2
-R469	3	1-2	1-2
-R289	1-2	3	0-1

No immune reaction to powdery mildew was observed in the field. Seedlings of highly resistant accessions when grown in the greenhouse became infected with E. polygoni. These observations suggest that multiple factors condition the tolerance of V. sinensis to E. polygoni infection. This reasoning concurs with results of Fennel (1948) which indicated that at least two factors conditioned resistance in V. sinensis.

Two of the parent varieties Fennel used for crossing, "Azul Grande" and "Chinegra", are moderately susceptible to powdery mildew under Puerto Rico conditions, while one of his hybrids, "Chitino", gave variable response.

The following is the summary of field screening method used for locating field resistance in V. sinensis to powdery mildew:

1) Plant single row per accession during the dry season. Record at least two field ratings for disease resistance.

2) Select disease free accessions. Plant in a replicated plot. Apply disease free accessions. Plant in a replicated plot. Apply disease pressure by planting spreader rows of highly susceptible varieties. Use several varieties in the spreader rows, to reduce the possibility of screening against a single race.

3) Plant selected varieties in different seasons, rainy and dry.

4) Plant selections at different locations.

The key to successful screening is repeated detailed observation on a large number of accessions. This is time consuming and laborious. But under tropical conditions where planting can be carried out 12 months out of the year, large numbers can be screened in a short period.

Screening Vigna sinensis PI accessions for field resistance to Puerto Rico cowpea mosaic.

N. G. Vakili and W. Santiago

Observation of the 503 Vigna sinensis PI accessions during winter and spring planting, 1970, resulted in selecting 249 disease-free lines for further screening against Puerto Rico cowpea mosaic virus (PRCMV). The 249 Southern pea lines were planted on October 30, 1970. Each line consisted of 25 plants per row. Five Southern pea varieties, highly susceptible to PRCMV were planted as spreader rows at every 20 row intervals and on either end of the plot. Source of inoculum was infected volunteer plants growing in the previous plot. Leaf extract was obtained from the infected young leaves by placing equal weight leaf and distilled water in an electric blender and macerating for 2 minutes. The extract was diluted 1/5 in distilled water and after adding carborundum, the solution was sprayed on plants in field at 25 psi and a distance of 2 to 3 inches from the leaves.

The whole plot was inoculated on November 26, 1970. Three weeks later, leaves from infected spreader rows were used to re-inoculate the field on December 18, 1970. Also, after the first inoculation, insecticide spray was withheld to allow bean leaf beetle (Ceratoma ruficornis) to assist in the dissemination of the virus in the plot. On December 26, 1970, disease response in the field was recorded and the disease-free lines were selected for further screening test.

The above-mentioned screening trial resulted: 66 virus-free lines, 7 lines were slightly susceptible, 22 lines moderately susceptible, 111 lines susceptible, and 29 lines were highly susceptible to Puerto Rico cowpea mosaic virus disease.

On January 15, 1971, a new screening trial consisting of the 66 disease-free lines from the previous trial and six highly susceptible PI accessions, was planted in three replications. Each replicate consisted of 30 to 50 plants growing in a 22-foot long row. The six highly susceptible spreader varieties included: a) three varieties with bright yellow symptom, and b) three varieties with dull green (normal PRCMV response) mosaic. On February 5, 1971, replicate 1 was inoculated with the leaf extract from the dull green mosaic type and replicate II was inoculated with extract from the bright yellow leaves. The inoculum preparation and inoculation were made as before. Replicate III was uninoculated, but was not sprayed with insecticides.

Four types of symptom expressions were observed in the field (Table 11). These were:

a) Bright yellow mosaic. Virus inoculation caused a dull diffused yellow green response on leaves within a week. Vein chlorosis of the young leaves was followed by a bright yellow mosaic which often covered the whole leaflet. Yellow bands appear on green pods of highly susceptible accessions. Many infected pods failed to produce peas.

b) Dull green mosaic. The main difference between this virus symptom and the "bright yellow mosaic" symptom is the intensity of chlorotic lesions developed by the host plant. Vein discoloration in the young leaves is not pronounced and leaf mosaic consists of dark green island surrounded by dull yellow green background. There is a good deal of variation in symptom expression among the Vigna varieties tested. The six highly susceptible lines with distinct responses were used as standards for indexing disease reaction in the field.

c) Dwarfism. This symptom was an unexpected response of an accession to virus inoculation during the previous screening trial. In the present screening trial, the "Dwarfism" susceptible line was included as a standard and plants in the three replicates were indexed for dwarfism. There was a complete range of response to dwarfism in the accessions observed. The "dwarfism" or stunting symptoms are very impressive, especially when a row of minute deformed plants are located next to a row of bush and profusely growing plants.

d) Rugose symptoms. Wrinkled, brittle leaves with dull yellow green mosaic, reduction in plant size, reduction in pod set, and prolonging of vegetative growth are characteristics of this type of response. Plants displaying rugose symptoms are easily located in the field by their stiff overall appearance.

Table 11.--Summary of reaction types of 72 Vigna sinensis PI accessions as rated to different symptom expressions in the field.

Types of symptoms	Number of accessions per reaction type					Sum
	None	Slightly susc.	Moderately susc.	Susc.	Highly susc.	
Dull Mosaic	38	12	12	9	1	72
Yellow Mosaic	22	18	20	7	5	72
Dwarfism	19	12	32	7	2	72
Rugose	61	0	1	2	8	72

Results of inoculation data suggested that dull green and bright yellow mosaics were different genotypic expressions to the same virus diseases. Field observations and data also suggest that the bright yellow symptom is a response to infection by a more virulent strain of PRCMB than the strain causing the dull green response.

Dwarfism seemed to have spread in the replicated plots independently from the dull green and bright yellow inoculations. Whether dwarfism is a genotypic response to PRCMV infection or an entirely new virus could not be deduced from this work.

Ten Vigna sinensis accessions were found to be resistant in this screening trial. An accession was considered resistant when no disease symptom could be assigned to any of its plants in the three replications.

Greenhouse screening of Vigna sinensis PI accessions for resistance to Puerto Rico cowpea mosaic.

N. G. Vakili

Seeds of five field-resistant and five field-susceptible lines from the final field screening trial were selected for greenhouse inoculation tests. Table 12 gives the field responses of these 10 lines as indicated by their symptom expressions.

Table 12.--Field response of Vigna sinensis accessions to Puerto Rico cowpea mosaic virus.

Field Source	Field response to PRCMV		
	Dull Green	Bright Yellow	Dwarfism
Resistant			
VPR70-4R46	None	None	None
R108	"	"	"
R253	"	"	"
R256	"	"	"
R469	"	"	"
Susc. Testers			
VPR70-4R12	Severe	None	None
R16	None	Very severe	"
R203	"	Severe	"
R288	"	None	Severe
R289	"	"	Severe

Seeds of each line were planted in black plastic bags on March 30, 1971. Seedlings were inoculated on April 7, 1971, by means of rubbing sap on carborundum dusted primary leaves with a small wooden pot label.

Description of lines where inocula were obtained is as follows:

I. Bright Yellow symptom.--Line VPR70-10R65. Mostly bright yellow blotches on leaves, vein clearing, stiff or brittle leaves. Leaf surface smooth, no puckering or vein distortion. Growth was not suppressed. Pod set was not adversely affected.

II. Dull Green Mosaic.--Line VPR70-10R67. Dull green blotches on light green background. Slight rugosity-puckering and deformation of veins. Slight vein clearing. Normal plant growth.

III. Dwarfism.--Line VPR70-10R71. Plants dwarfed. No bright yellow or dull mosaic. Veins slightly deformed. No vein clearing. Leaves with normal color.

IV. Rugose.--VPR70-10R36. Leaves severely deformed, puckering, rugose, and stiff. Vein clearing and deformation. Growth moderately retarded, remain juvenile. No flowers or pods developed.

A single plant in each line was selected for its characteristic response and its young leaves were collected for sap extraction. Table 13 gives the response of the seedlings grown in the greenhouse at 6 days after inoculation.

Table 13.--Response of 10 Vigna sinensis accessions to mechanical inoculation of virus isolates selected from infected plants in the field.

Field Source	Inoculum source 1/				
	Bright I Yellow	Dull II Green	Dwarf III	Rugose IV	Water V
VPR70-4R46	None/4	1 pl Mos/5 2/	None/6	1 pl VC/6	None/5
R108	None/4	None/4	1 pl VC/7 3/	1 pl VC/4	None/7
R253	None/5	None/5	None/6	2 plVC/4	None/5
R256	5 pl Re/5 4/	None/5	None/6	2 pl Re/4	None/7
R469	None/4	None/4	None/6	5 pl VC/5	None/5
VPR70-4R12	3 pl VC/4	5 pl Mos/5	None/5	5 pl Re/5	None/7
R16	6 pl VC/6	7 pl VC/7	None/6	6 pl VN/6 5/	None/7
R203	5 pl VC/5	7 pl VC/7	None/6	6 pl VN/6	None/6
R288	4 pl Dw/4	4 pl Dw/4 6/	None/6	6 pl Dw/6	None/7
R289	5 pl Dw/5	5 pl Dw/5	None/6	6 pl Dw/6	None/7

1/ Recorded 6 days after inoculation
2/ Dull green mosaic
3/ Vein chlorosis
4/ Retarded = suppression of growth
5/ Vein necrosis
6/ Dwarf type

The inocula from sources I and II caused the same type of symptoms on inoculated seedlings. Vein clearing and mosaic appeared on the leaves of R12, R16, and R203 seedlings. An impressive symptom was the lethal effect of the two inocula on seedlings of R288 and R289. These seedlings wilted and died within 20 days after inoculation.

A month after the inoculation with sap from dwarf plant, seedlings began to show symptoms of deformation and retardation of growth at the shoot tips. Plants of lines R288 and 289 displayed severe deformation of growing branch tips. Except one seedling in Line R108, none showed any mosaic or vein clearing.

Inoculum number IV contains the most widely pathogenic virus. Symptoms caused by inoculum No. IV were very similar to those caused by the bright yellow and dull green inocula. There was a predominance of vein necrosis instead of vein chlorosis. Also, rugose inoculum did not cause mortality in seedlings or plants of R288 and R289 lines. Seedlings from R256 expressed the least susceptible response to the rugose inoculation.

In a second greenhouse inoculation, virus-infected leaves from line R16, inoculum #I; line R16, inoculum #II; line 288, inoculum #III, and the leaves from the single susceptible plant in line R108, inoculum #IV were used (Table 14).

Table 14.--Greenhouse inoculation, April 27, 1971, of *Vigna sinensis* seedlings and response of their primary leaves after 6 days

Field Source	Response to inoculum source				
	Inoc. #I Plant R16	Inoc. #II Plant R16	Inoc. #III Plant R288	Inoc.#IV Plant R108	Water Control
Resistant					
VPR70-4R254	None[1/]	None	None	None	None
R256	"	"	"	"	"
R46	"	"	"	"	"
R187	"	"	"	"	"
R108	"	"	"	"	"
R253	"	"	"	"	"
R369	Sli.chlorosis[2/]	Sli.chlorosis	VN & chl.[3/]	"	"
Susceptible					
VPR70-4R288	Ring spot & VN	VN moderate	Severe necrosis	Ring spot	"
R289	" " "		Chlorosis	" "	"
R16	Chlorotic mottle	Chlor.mottle	Severe necrosis	Very sli. chlor.	"
R71	Chlorisis	Sli. chlor.	Ring spot & chlor.	None	"
R12	VN & chlor.	VN	" " "	Ring spot	"
R203	Ring spot & VN	Ring spot & chlor.	Chlorosis	Ring spot	"

1/ Seven plants per accession
2/ Slight
3/ Vein necrosis

The PI lines which had proved resistant in the field were free from virus infection symptoms except for line R369, which was susceptible to inocula #I, #II and #III, but showed no symptoms against #IV. The field susceptible varieties displayed susceptible symptoms to all inoculations, except line R71, which gave no response to #IV inoculum. The susceptible plant in line R108, source of inoculum #IV, was apparently an off-type or a hybrid.

The greenhouse inoculation results indicated that:

1. As Dr. Perez had indicated in his serological studies, the bright yellow and the dull green mosaic symptoms were different varietal responses to the same virus infection.

2. Accessions which remained disease free after passage through three field inoculation and screening trials, also retain their resistance in greenhouse inoculations.

3. The dwarf and rugose symptom expressions could have been due to varietal response to strains of PRCMV. On the other hand these symptoms could have been caused by other virus sources.

Serological tests of Vigna sinensis extract for reaction to Puerto Rico cowpea mosaic virus.

J. E. Perez (University of Puerto Rico, Rio Piedras), and N. G. Vakili.

Two distinct responses to virus infection were observed among the Vigna sinensis PI accessions screened for resistance to Puerto Rico Cowpea Mosaic (PRCM). These were: a) a bright yellow mottle sometimes covering the entire leaf and bright irregular blotches on the green pods, and b) severe mosaic, coarse dull green mottle of older leaves, wrinkling and blistering of the young trifoliate leaves. In order to find out whether one or more viruses were involved, serological tests were carried out at the Rio Piedras Experiment Station by Dr. J. Enrique Perez.

For serological tests, sap of each field or greenhouse sample was extracted by grinding leaves in separate sterile mortars and pestles. The crude sap was then clarified by centrifuging at 3,000 rpm in an International model U. V. centrifuge, using a No. 813 angle head. Clarified saps were decanted and tested undiluted and diluted up to 1/32 in a saline with various viral antisera.

Two lines, one representing the field response type (a), and the other (b) were selected from the October 30, 1970, Vigna plot used for PRCMV screening. These were UPR-71-3-R21 and UPR-71-3-R84, the former displaying yellow mottle leaf symptoms and the latter the dull green mottle symptom characteristic of PRCMV. Serological tests showed that both R21 and R84 reacted positively up to a dilution of 1/2 only with PRCMV and Arkansas cowpea mosaic virus antisera. No reactions

were observed between the two saps and antisera to tobacco mosaic, pepper mosaic, and VPLLT viruses nor with normal rabbit serum.

On February 17, 1971, the same test was carried on samples of UPR-71-r-R7, UPR-11-R62 and UPR-11-R63. This time, only the sap from the last sample was positive again with the PRCMV antiserum. All other reactions were negative.

Seedling leaves of a highly susceptible PI accession 294380 were inoculated: (a) with sap from leaves of a yellow mottle infected line, and (b) with the sap from leaves displaying normal PRCMV symptoms. Infected seedlings developed exactly the same symptoms for both inoculum sources. On April 15, 1971, tests were repeated with both sets of infected seedlings. Saps from both inoculum sources were only positive with antiserum of PRCMV and negative withthe rest of antisera. This time cowpea chlorotic mottle virus antiserum was also included in the tests. The precipitation tests were repeated with cowpea chlorotic mottle with negative results.

The serological tests indicated that isolates tested were similar in reaction to PRCMV. The varied symptoms observed in the field are apparently due to varietal expressions.

Field screening of Vigna sinensis accessions for resistance to bacterial blight caused by Xanthomonas vignicola.

N. G. Vakili and W. Santiago

Responses of 500 PI accessions, in four previous field trials, to bacterial blight disease caused by Xanthomonas vignicola were compared. Two hundred and ninety-five lines were selected for their bacterial blight response. These PI accessions were planted at Isabela on May 4, 1971, and final data were recorded September 3, 1971.

Several PI accessions highly susceptible to bacterial blight were used as spreader rows. Spreader rows were planted at 25 feet distance from each other for the length of the field (230 feet), while PI accessions to be tested were planted perpendicular to the spreader rows on rows 33 inches apart.

Inoculum was provided by bacterial blight infected leaves from other V. sinensis plots. One pound of infected leaf was macerated in two liters of water, then filtered. Carborundum was added to the filtrate and the spreader rows were inoculated by means of pneumatic pressure gun at 30 PSI. The gun nozzle was maintained at approximately 2-inch distance from the leaves. Spreader rows were inoculated on June 9, 1971. On july 9, 1971, the whole plot was inoculated by the same method mentioned above.

Only 32 PI lines developed light bacterial lesions while 263 PI lines were free from infection. This trial will be repeated with the addition of overhead sprinklers in the field for the duration of the trial and sand blasting will replace carborundum inclusion into the inoculum.

Twenty-one PI accessions were selected out of the 295 tested for their overall foliage disease resistance in the field. These accessions retained 80 to 100% foliage up to 5 months after sowing. The May to September is the high rainfall period in the area.

In an adjacent trial where 218 PI accessions were being screened, at the same period, for Cercospora leaf spot resistance, 53% of the PI accessions were affected by bacterial blight disease. Since neither of these accessions were selected for their bacterial blight resistance nor were they inoculated, the high resistance incident among the PI accessions used in the bacterial blight resistant trial may suggest prevalence of a factor for bacterial blight resistance in V. sinensis.

Screening for Cercospora leaf spot resistance in PI accessions of Vigna sinensis.

N. G. Vakili and W. Santiago

Two hundred eighteen PI accessions were selected from previous trials for their lack of field response to Cercospora leaf spot disease caused by Cercospora cruenta.

Twenty-foot rows of each selected PI accession was planted perpendicular to the spreader rows. Spreader rows were 230 feet long and planted at 25-feet distances from each other. PI accessions were planted at 33-inch distance from each other. Seeds were sown on May 5, 1971, and the last record was taken on September 3, 1971.

Inoculum was provided by bringing many sackfulls of Cercospora leaf spot-infected leaves from an older planting and spreading them within the screening plot and then applying overhead irrigation. This inoculation technique was repeated eight times at 2- to 4-day intervals.

Twenty-one PI accessions out of 218 selected remained free from Cercospora leaf spot lesions during the trial. These PI accessions will be subjected to screening in a replicated complete randomized block trial to further ascertain field resistance. Afterwards, the resistant lines will be inoculated in the greenhouse under controlled conditions.

Comparison of responses of 31 Vigna sinensis PI accessions to field diseases in El Salvador and Puerto Rico.

N. G. Vakili, B. Patiño and R. Cristales

In May 1970, 31 black seed Vigna sinensis accessions which had performed well in the field were sent to El Salvador for a preliminary adaptability trial. These seeds were planted at San Andrés Experiment Station on January 19, 1971. Dr. Jack P. Meiners and I had an opportunity to record their disease incidence on April 20, 1971 (Table 15).

Table 15. Comparison of responses of 31 *Vigna sinensis* PI accessions to field diseases occurring at San Andres, El Salvador, and in Puerto Rico

Origin	Earliness		Mosaic virus		Powdery mildew		Bacterial blight		Cercospora leaf spot	
	P.R.[1]	El Sal.[2]	P.R.	El Sal.	P.R.	El Sal.	P.R.	El Sal.	P.R.	El Sal.
PI 293527	Early	Early	--	--	5	3	Susc.	Susc.	Susc.	Susc.
293518	Early	Early	Susc.	--	4	4	--	Susc.	--	Mod.
270066	Early	Early	Susc.		5	5	--	Susc.	--	Susc.
291140	Late	Late	--	None	3	0	Sli.	None	--	None
195417	Very late	Late	0	Sli.	2	0	Susc.	None	Susc.	Susc.
195416	Very late	Very late	Susc.	None	3	2	--	None	0	Sli.
189230	Very early	Early	Susc.	--	3	4	--	Susc.	Susc.	Susc.
115674	Mod. late	Late	Susc.	None	2	1	--	None	Susc.	Sli.
115683	Early	Med. early	Susc.	--	3	3	--	Med. Susc.	Susc.	Sli.
174965	Early	Early	--	--	4	0-1	--	Susc.	--	Mod.
189099	Late	V. late	Susc.	Hi. Susc.	2	0	--	Susc.	Susc.	None
293531	V. early	Med. early	--	None	5	4	Susc.	Susc.	Susc.	Susc.
293538	Early	Early	Susc.	Susc.	4	5	--	Susc.	Susc.	Sli.
PR 70-1-392	V. early	Early	Susc.	None	3	5	--	Susc.	Susc.	Susc.
PI 339597	V. early	Early	--	None	3	4-5	--	Med. susc.	--	Mod.
197056	V. late	V. late	Susc.	None	2	0	--	Slight	Sli.	Mod.
292907	V. early	V. early	Susc.	None	4	3	--	Mod.	Susc.	0
269664	V. early	Late	--	CP mosaic	2	5	--	None	Susc.	Sli.
255792	Mod. late	V. late	--	None	2	0-1	Susc.	None	--	0
208845	V. early	Mod. late	--	None	4	0-1	Hi. susc.	Mod.	Susc.	Mod.
292897	Early	Mod. early	--	Sli.	2	4	Susc.	Susc.	--	None
292910	V. early	Late	--	--	3	1-2	H. susc.	Susc.	--	None
293464	Early	Mod. early	--	None	3	3	Hi. susc.	Susc.	Susc.	None
PR 70-1-383	V. early	Mod. early	Susc.	None	3	5	--	Susc.	Susc.	None
PI 293456	Early	Mod. early	Susc.	--	3	1	--	Hi. susc. defol.	--	Mod.
293455	V. early	Late	--	None	2	5	--	Sli.	Mod. susc.	None
292898	V. early	Early	--	--	2	0-1	--	Susc. defol.	--	Sli.
293481	Early	Early	--	None	3	3-4	Hi. susc.	Susc.	Mod. susc.	None
115679	Mod. late	Late	Susc.	None	3	0	--	V. sli.	Susc.	None
115681	Mod. late	Late	Susc.	None	3	0	--	Mod.	Susc.	None
271258	Early	Mod. late	--	--	2	0	--	Susc. Hi.	Hi. susc.	None

1/ Summary of several field recordings during 1970-71.

2/ Planted on January 9, 1971.

Agronomically, PI accessions behaved very similar to the growth habit observed in Puerto Rico. However, it seemed that San Andrés had much better soil than is available in Puerto Rico which resulted in a very lush growth.

In the previous visits to El Salvador and in the same visit but in different locations, no virus-infected Southern peas were encountered. The January 9 planting provided the first cases. The observed virus had symptoms similar to those encountered in Puerto Rico cowpea mosaic-infected plants in Isabela, Puerto Rico.

Bacterial blight incidence (Xanthomonas vignicola) appears more prevalent at San Andrés than in Isabela. Some accessions such as PI 115674, 269664, and 293455 seemed to possess a good deal of tolerance to bacterial blight.

On the average, powdery mildew, (Erysiphe polygoni) races in Puerto Rico appear more virulent than those attacking Vigna accessions at San Andrés. However, all combinations of disease responses were observed for both locations (Table 15). From responses presented in Table 15, it appears that two races of E. polygoni were involved in these readings. One, a Puerto Rican race which is virulent to PI 270066, 174965 and 208845, but avirulent to PI 292897, 293455, and 197056. A second race, present in San Andrés, which is virulent to PI 270066, 292897, and 293455, but avirulent to PI 174965, 208845, and 197056. The dry season had provided optimum condition for powdery mildew incidence.

Dry weather had suppressed Cercospora leaf spot incidence at San Andrés. However, PI accession 270066 showed susceptible response at San Andrés, while in our plots in Puerto Rico, this accession has been free from infection.

Studies on field infestation of 32 Vigna sinensis PI accessions by pea weevil (Acanthoscelides).

N. G. Vakili, D. W. Walker, and P. Willman (Walker and Willman, Nuclear Center, UPR, Mayaguez, P. R.)

The Vigna sinensis planting described in the powdery mildew tolerance study (see above) was used also for the evaluation of weevil infestation of pods and peas.

In the Vigna screening plots, the experience of the past 2 years has shown that if insecticide spray is withheld, especially at flowering and pod setting period, pods and peas of majority of lines become so severely infested that few good seeds are available at harvest. The weevil attacking the pods is one of the Acanthoscelides species.

On February 1, insecticide spray of the plot was discontinued and on February 10, 1971, the pod weevil experiment was started. During this day, five to seven young peduncles per replicate were tagged. Each tagged peduncle contained one

flower that had opened on the same day and two to four younger flowers. The purpose of tagging flower of the same day was to ensure that pods sampled for infestation studies were all of the same relative age and had developed during the same period.

Thirty days after the flower tagging, pods were harvested, on March 12, 1971. Pods were placed in brown bags and marked for block and replication number and removed to a refrigerator room. Thus, the three replicates in each of the 32 PI accessions were sampled.

The following data were gathered for processing: A) Number of pods sampled; B) Number of weevil punctures per sample; C) Number damaged peas per sample; and D) Total number of peas per replicate sample. Hence, 32 accessions x 3 replicates x 4 groups of data = 384 separate values, were gathered for calculation. Mr. Peter Willman, Nuclear Center, programmed these data to be calculated according to the Duncan Multiple Range Test. The computer program was written for an IBM 360 Mod. 40. The data gathered and its calculation are available on computer print-out.

The results of the analysis indicate that the number of punctures per pod does not necessarily indicate the corresponding infestation of peas in that pod. Perhaps the average number of peas infested is a better criterion than the average number of punctures per pod for measuring feeding preference. A factor that affects the puncture counts is the length of a pod. The longer the pod, the higher is the count for feeding punctures. Average number of punctures per unit length should be a better criterion than the total number per pod. In future tests, PI accessions at the two extremes of ranges will be tested for feeding preference and pea infestation.

Disease response and yield of Southern peas (Vigna sinensis), acquired from Southern Pea Conference, in a preliminary yield trial.

N. G. Vakili and W. Santiago.

This preliminary yield trial includes 23 Southern pea varieties acquired from Southern Pea Conference through Dr. Blake B. Brantly, Jr., Head, Department of Horticulture and Forestry, Georgia Agricultural Experiment Station at Experiment, Georgia. The local selection MZ-4R-482 was used as the local standard. The yield trial consisted of four replications laid out in randomized complete blocks. Each variety was represented by a 17-foot row of plants in each replication. Rows were placed 33 inches apart.

Table 16 gives the summary of results as indicated by the averages of data gathered for agronomic and disease resistance characteristics of each Southern pea variety. The trial planted on April 30 and the final harvest were done on July 26, 1971.

Early varieties included: G 70-59-1 with 62 to 69 days for harvest; 69 F-99-100 with 62 to 73 days to harvest; and VB 70-302 with 68 to 73 days to harvest. The late varieties were: 68 F-3, 68 F-477, and 70 F-151, which required 73 to 87 days for harvest. The rest were intermediate in nature, requiring 68 to 87 days for harvest.

Five of the 23 lines were field resistant to the Puerto Rico cowpea mosaic virus (PRCMV). This was a high frequency for resistance to PRCMV since only seven resistant PI accessions were obtained from screening 500 lines. The varieties indicating field resistance (Table 16) will be subjected to greenhouse inoculation to verify resistance.

Table 16.--Summary of agronomic and disease resistance characteristics of advanced breeding lines of Southern peas grown in a preliminary yield trial at Isabela.

Variety	Harvest period (in days)	Seed size 1/	Response 2/ to foliage diseases 3/				Yield lbs/a 4/
			PRCMV	Bact. blt.	C.L.S.	P.M.	
Ala 9-3-1-2	68-87	S	S	MS	SS	MS	1,200
Ala 9-2-4	68-87	VS	HS	MS	SS	S	1,400
Ala 3-1-3-2	68-76	S	HS	NL	MS	MS	990
Ala 3-1-2	61-87	S	HS	NL	R	SS	2,200
Va 67-11	68-87	M	MS	NL	HS	S	1,355
Va 67-30	68-87	S	S	NL	S	S	858
Va 69-11	68-76	VS	MS	S	SS	S	1,639
Va 69-13	68-76	VS	R	NS	Vari.	S	2,240
Va 69-286	68-87	S	S	NL	S	S	1,812
68 F-3	73-87	S	HS	HS	R	S	1,285
68 F-477	73-87	M	R	HS	SS	MS	1,685
68 F-491	69-87	M	S	S	SS	HS	2,357
68 F-41	69-87	M	R	S	HS	HS	2,118
69 F-99-100	62-73	S	S	NL	SS	S	1,398
70 F-47	69-87	M	SS	NL	MS	MS	2,958
70 F-51	68-87	L	R	NL	S	SS	2,532
70 F-151	73-87	L	S	NL	SS	HS	1,342
VB 70-302	68-73	M	MS	S	MS	HS	1,620
M 67-522	68-87	S	S	MS	MS	S	2,546
G 60-15-1B	68-76	S	S	MS	MS	S	1,436
G 70-59-1	62-69	M	MS	NL	MS	S	1,081
G 70-90-B	68-87	M	R	S	S	S	2,221
M 70-319	69-76	S	S	NL	MS	S	1,224
MZ 4R-482	68-87	S	MS	MS	R	MS	2,260

1/ Seed size: VS=very small; M=Medium; L=large.
2/ Response: S = susceptible; SS = slightly susceptible; MS = moderately susceptible; HS = highly susceptible; NL = no lesions; R = resistant; and Vari = variable response.
3/ Diseases: PRCMV = Puerto Rico cowpea mosaic virus; Bact. blt. = Bacterial blight; C.L.S. = Cercospora leaf spot; and P.M. = powdery mildew.
4/ Calculated for 50,000 plants per acre.

Two of the varieties were highly susceptible to bacterial blight (Xanthomonas vignicola) while 11 of the varieties showed no leaf lesions. These bacterial blight-free varieties will be subjected to field inoculation for further screening.

Varieties Ala. 3-1-2 and 68 F-3 were as resistant to Cercospora leaf spot disease as the local selection MZ-4R-482. These varieties showed no leaf lesions while the highly susceptible varieties Va 67-11 and 68 F-41 were defoliated.

Variety Ala. 3-1-2 and 70 F-47 were the only lines which displayed slight susceptibility (SS) to powdery mildew (Erysiphe polygoni) infection during the trial period. The (SS) response is rated as resistant, since up to date, no immune reaction to powdery mildew infection has been detected.

The yield of three varieties was higher than that of the local selection, while five varieties yielded approximately the same. That is, about 2200 pounds of dry peas (from 50,000 plants) per acre. No fresh pea yields were obtained.

The preliminary yield trial of the advanced hybrid progenies produced by Southern pea breeders in the Southern states indicated that a number of these lines could be selected for high yield and adaptability to tropical environment.

Disease response and yield of Southern pea (Vigna sinensis) varieties, acquired from the Southern Pea Conference, in an advanced yield trial.

N. G. Vakili and W. Santiago

Six Southern pea varieties: Va. 67-3, Va. 67-6, 68 F-12, 68 F-51, Ark. 67-542 and G. 60-5-3A, and a local selection MZ-4R-482 were planted at Isabela farm in an advanced yield trial during May 3 to July 27, 1971. There were four replications in this trial. Each replication per variety consisted of a four-row plot with 17-foot-long rows placed at 33 inches apart.

All the six varieties had cream color seeds, varied between low-bush to high-bush in plant habit while the local standard had speckled purple seed and had prostrate habit. Table 17 gives the summary of data on some agronomic traits, disease resistance in field, and yield.

Varieties 68 F-12 and G 60-5-3A were highest yielders and displayed a good deal of field resistance (Table 17). Especially, variety G. 60-5-3A was resistant to field inoculation by Puerto Rico Cowpea Mosaic, displayed no leaf lesions of Xanthomonas vignicola; had moderate susceptible response to Cercospora sp., and was resistant to powdery mildew, caused by Erysiphe polygoni. The variety Va. 67-3 had the earliest maturing pods, from 60 to 67 days, while variety 68 F-5 had the latest-maturing pods, which started at about 78 days after sowing.

Table 17.--Summary of agronomic and disease resistance characteristics of Southern pea varieties grown in an advanced yield trial at Isabela

Variety	Days to mature	Seed Size[2/]	Response[2/] to Foliage Diseases[3/] PRCMV	Bact. Blt.	C.L.S.	P.M.	Percent seed damage	Yield per acre (in Kg)[4/]
Va. 67-3	67	S	SS	S	HS	HS	7.0	568.0
Va. 67-6	72	S	S	S	S	HS	23.0	665.0
68 F-5	78	S	S	S	NL	S	40.0	887.0
68 F-12	75	M	SS	S	SS	MS	10.0	1,300.0
Ark. 67-542	75	S	SS	S	MS	HS	23.0	850.5
G.60-5-3A	75	L	R	NL	MS	R	14.0	1,230.0
MZ-4R-482 (check)	76	S	MS	S	NL	MS	27.0	1,076.0

1/ Seed size: S = small; M = medium; L = large

2/ Disease response: S = susceptible; SS = slightly susceptible, MS = moderately susceptible; HS = highly susceptible; NL = no lesions

3/ PRCMV = Puerto Rico Cowpea Mosaic Virus. Bact. Blt. = bacterial blight; C.L.S. = Cercospora Leaf Spot; P.M. = powdery mildew

4/ Calculated for 50,000 plants per acre.

Varieties Va. 67-3, 68 F-12, and G.60-5-3A had a very low percentage of seed damage. Seed damaged consisted of seed rotted by fungus or bacterial infection (which often followed insect damage), worm or caterpillar damage, and weevil damage. No rotted peas were encountered in the Va. 67-3 replicates while peas of variety G. 60-5-3A were free from weevil puncture and those of the variety 68 F-12 contained only 1% weevil damaged seeds.

Varieties 68 F-12 and G.60-5-3A will be subjected to further field tests before recommending them for cultivation in tropical regions.

Florida hybrid progenies of Southern peas.

N. G. Vakili and W. Santiago

At the Grain Legume Improvement meetings which were held in Panama City during March 2 to 6, 1971, Dr. Albert P. Lorz, Horticulturist, University of Florida, provided the Mayaguez Pulse Program with 158 lines of black-seeded *Vigna sinensis* hybrids. The same hybrid seeds were also distributed to interested persons in Costa Rica, El Salvador, and Panama for selection and adaptability tests.

A 17-foot row of each hybrid line was planted at Isabela on May 3, 1971. After 15 rows of hybrid lines, one row each of the varieties Floricream, Snapea and Zipper Cream were planted for agronomic and disease resistance comparisons. Selected seeds were harvested between 67 to 85 days after sowing.

Field selection was made for earliness, plant habit, pod location, curve and color, and seed shape (bean type seed). Also, selection was made for resistance to virus and foliage diseases. Dried seeds were weighed for seed size selection. One hundred and forty single plant selections were chosen and were planted on September 21, 1971. These included:

Seed Color	Seed Shape	No. of Selections
Black	Crowder	44
Black	Semi-crowder	29
Black	Bean type	29
Holstain	Semi-crowder	3
Black-eye	Bean type	5
Brown	Crowder	20
Brown	Bean type	6
Cream	Crowder	8
Cream	Bean type	2

These F_5 hybrid lines are being increased for further selection and inoculations with PRCMV and bacterial blight.

Hybridization of Vigna sinensis for study of inheritance of resistance to Puerto Rico Cowpea Mosaic Virus.

N. G. Vakili and J. Santiago.

During August to December 1971, a total of 78 crosses of Vigna sinensis PI accessions were made for the study of inheritance of resistance to Puerto Rico Cowpea Mosaic Virus (PRCMV) disease. All plants used in these crosses were grown in an insect-free screenhouse, in order to eliminate the possibility of cross pollination by Carpenter bee (Xylocopa brasilianum).

Only 44 pods or 56% of the cross set seed. The total number F_1 hybrids produced by these crosses were 363 seeds.

Each seedling to be used for hybridization was inoculated with PRCMV at its primary leaf stage. Response to virus infection was rated up to the fourth trifoliolate leaf stage. F_1 hybrid seeds were obtained from the following crosses:

Resistant x susceptible and reciprocal; resistant x slightly susceptible and reciprocal; resistant x moderately susceptible and reciprocal.

F_1 seeds from each of the four virus resistance response types were obtained for comparison with the segregating hybrids.

APPENDIX B

List of Publications and Oral Presentations, and Participation in Technical Conferences

Iran

Kaiser, W. J., K. E. Mueller, and D. Danesh. 1967. An outbreak of broadbean diseases in Iran. Plant Dis. Reptr. 51:595-599.

Kaiser, W. J., D. Danesh, M. Okhovat, and H. Mossahebi. 1968. Diseases of pulse crops (edible legumes) in Iran. Plant Dis. Reptr. 52:687-691.

Kaiser, W. J. 1970. Rhizoctonia stem canker disease of mungbean (*Phaseolus aureus*) in Iran. Plant Dis. Reptr. 54:246-250.

Kaiser, W. J., M. Okhovat, and G. H. Mossahebi. 1970. Mungbean (*Phaseolus aureus*) damping-off and stem canker (*Rhizoctonia solani*). Fungicide and Nematicide Tests, Volume 26.

Kaiser, W. J. and F. Escandari. 1970. Bean yellow mosaic virus in Iran. Iranian J. Plant Path. 6:11-17.

Kaiser, W. J. and Louise Kaiser. 1968. The challenge of overseas work. Phytopathology News 2(7):1,4: (8):4.

Danesh, D. and W. J. Kaiser. 1969. Virus diseases of chickpea (*Cicer arietinum*)in Iran. Iranian J. Plant Path. 5:50-56. (In Farsi with an English summary.)

Kaiser, W. J. and D. Danesh. 1971. Biology of four viruses affecting *Cicer arietinum* in Iran. Phytopathology 61:372-375.

Kaiser, W. J. and D. Danesh. 1971. Etiology of virus-induced wilt of *Cicer arietinum*. Phytopathology 61:453-457.

Kaiser, W. J., M. Okhovat, and G. H. Mossahebi. 1971. Etiology and control of damping-off and root rot of pea (*Pisum sativum*) in Iran. Plant Dis. Reptr. 55:244-248.

Kaiser, W. J., M. Okhovat, and G. H. Mossahebi. 1971. *Pythium aphanidermatum*, an important pathogen of peas (*Pisum sativum*) in Khuzestan, Iran. Iran J. Plant Path. 7(1):1-2.

Kaiser, W. J. Biology of bean yellow mosaic and pea leaf roll viruses affecting *Vicia faba* in Iran. Received Division approval 10-12-71. Submitted to Can. J. Bot. 4-11-72.

Kaiser, W. J. Occurrence of three fungus diseases of chickpea (*Cicer arietinum*) in Iran. Received Division approval 8-12-71. Submitted to FAO Plant Portection Bulletin 9-22-71.

Kaiser, W. J. Diseases of food legumes caused by pea leaf roll virus in Iran. Received Division approval 10-27-71. Submitted to FAO Plant Protection Bulletin 12-8-71.

Kaiser, W. J. Etiology and biology of viruses affecting lentils (Lens esculenta) in Iran. Will submit for Division approval by June 1972.

Gibson, K. E. 1967. Possible incidence of curly top in Iran--a new record. Plant Dis. Reptr. 51:976-977.

Gibson, K. E. 1971. The incidence of curly top virus on sugar beets in Iran--1966 to 1969. Plant Dis. Reptr. 55:85-86.

Horner, G. M. and M. Mojtehedi. 1970. Yield of grain legumes as affected by irrigation and fertilizer regimes. Agr. J. 62:449-450.

Puerto Rico

Vakili, N. G. and J. E. Perez. Resistance of Vigna sinensis to Puerto Rico Cowpea Mosaic Virus. Abst. Phytopathology (in press).

Vakili, N. G. Resistance of Vigna sinensis to powdery mildew (Erysiphe polygoni) in Puerto Rico. Abst. Phytopathology (in press).

Vakili, N. G. and J. Bird. Resistance of beans (Phaseolus vulgaris) to Rhynchosia mosaic in Puerto Rico. Abst. Phytopathology (in press).

Bird, J., Josefina Sanchez and N. G. Vakili. Golden yellow mosaic of beans (Phaseolus vulgaris) in Puerto Rico. Abst. Phytopathology (in press).

Bird, J., Josefina Sanchez, N. G. Vakili and R. Woodbury. Host Range of Rhynchosia mosaic virus in Puerto Rico. Abst. Phytopathology (in press).

These were abstracts presented by N. G. Vakili at the 1971 Caribbean Division Meeting of the American Phytopathological Society held in San Salvador from November 14-20, 1971. These abstracts will be published during 1972 in Phytopathology.

Bird, J., J. E. Perez, R. Alconero, N. G. Vakili and P. L. Melendez. 1972. A whitefly-transmitted golden-yellow mosaic virus of Phaseolus lunatus in Puerto Rico. J. Agr. Univ. P. R. 56(1):64-74.

Oral Presentations

"Diseases of Pulse Crops in Iran", presented to scientists working with pulse crops in New Delhi, India, January 3, 1967.

"Agriculture in Iran", presented to newly arrived Peace Corps volunteers, Tehran, Iran, October 25, 1967.

"Plant Viruses and Virus Diseases," presented to agriculture students in the College of Agriculture, University of Tehran, Karaj, Iran, May 15, 1968.

"The Importance of Viruses in the Cultivation of Pulse Crops (Edible Legumes) in Iran", presented at the Third Meeting of the International Working Group on Legume Viruses, London, England, July 26, 1968.

"Study of Plant Virology", was the title of a course in Plant Virology that Dr. Kaiser was invited to give to students working on their Master's Degree in plant pest control at the College of Agriculture, University of Tehran, Karaj, Iran, from October 1968 to January 1969.

"Diseases of Pulse Crops in Southwestern Iran", presented to staff of the Agricultural Experiment Station, Khuzestan Water and Power Authority, Safiabad, Dezful, Iran, May 13, 1969.

"Viruses and Their Importance in Crop Production in Iran", presented to faculty and students, College of Agriculture, Jundi Shapur University, Molla Sani, Ahwax, Iran, May 17, 1969.

"Studies with Pea Leaf Roll Virus in Iran", presented to delegates of the 2nd Congress of Plant Medicine of Iran, Tehran, Iran, September 13, 1969.

"Virus Diseases of Chickpea (*Cicer arietinum*) in Iran", presented to the 3rd Annual Conference on Pulse Crops, New Delhi, India, February 1969.

"*Pythium aphanidermatum*, an Important Pathogen of Peas (*Pisum sativum*) in Iran", presented to delegates of the 3rd Congress of Plant Medicine of Iran, Shiraz, Iran, September 15, 1970.

"Biology of *Ascochyta rabiei* in Iran", presented at the Second International Symposium on Plant Pathology, New Delhi, India, February 1, 1971.

Participation in Technical Conferences, Workshops, etc.

Pulse Project Workshop, College of Agriculture, University of Tehran, Karaj, Iran, August 8-12, 1966.

International Symposium on Plant Pathology, New Delhi, India, December 27, 1966, to January 1, 1967.

Pulse Project Workshop, College of Agriculture, University of Tehran, Karaj, Iran, July 17-20, 1967.

Agricultural Planning Seminar, College of Agriculture, University of Tehran, Karaj, Iran, January 8, 1968.

First International Congress of Plant Pathology, London, England, July 14-26, 1968.

Third Meeting of the International Working Group on Legume Viruses, London, England, July 26, 1968.

Seminar on Pulse Production, College of Agriculture, University of Tehran, Karaj, Iran, January 7-9, 1969.

Workshop in Scientific Writing, U. S. Commission for Cultural Exchange with Iran (Fulbright Commission), the School of Public Health, University of Tehran, and the Cancer Research Institute, Pahlavi Hospital, University of Tehran, Tehran, Iran, January 18-23, 1969.

Second Pulse Conference, All India Coordinated Pulse Project, New Delhi, India, February 3-5, 1969.

Second Plant Medicine Congress of Iran, Tehran, Iran, September 13-16, 1969.

Pulse Project Workshop, College of Agriculture, University of Tehran, Karaj, Iran, February 1-3, 1970.

Third Plant Medicine Congress of Iran, Shiraz, Iran, September 12-16, 1970.

Pulse Project Workshop, College of Agriculture, University of Tehran, Karaj, Iran, January 1971.

Second International Symposium on Plant Pathology, New Delhi, India, January 27 to February 3, 1971.

Puerto Rico

Project personnel have participated in Cooperative Central American Program for Improvement of Food Crops (PCCMCA) held in Panama City, March 1971 and Managua, March 1972.

Caribbean Division Meetings of the American Phytopathological Society, San Salvador, November 1971. Dr. N. G. Vakili presented five papers at this meeting. Titles of papers are listed under publications.

Workshops for the National Bean Program, El Salvador, May 1971; National Bean Program, Guatemala, June 1971; and National Bean Nematode Investigations, El Salvador, November 1971.

Information obtained on disease symptoms and occurrence in Puerto Rico and Central America has been used in presentations and discussions at the PCCMCA Meetings in Panama City, 1971, and Managua, 1972, and in Bean Improvement Workshops in El Salvador and Guatemala.

Information from trip reports has been used by Americans and Latin Americans in Central American countries where the disease surveys were made.

APPENDIX C

Dissemination of Germ Plasm During 1971

Iran

1. Thirty large-seeded broadbean (Vicia faba) lines were sent to the University of London, London, England, for studies on Favism--a disease which affects the blood of some humans, especially certain genotypes who eat the seed of this plant.

2. Ninety-five lentil (Lens esculenta) and broadbean lines were sent to FAO in Egypt for agronomic and disease resistance studies.

3. Thirty-five lines of urid bean (Phaseolus mungo), mungbean (Phaseolus aureus) and cowpea (Vigna sinensis) were sent to the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, to include in their germ plasm collection and to be observed for agronomic characteristics and resistance to diseases and pests.

4. Ten lines of cowpea, 20 of mungbean and 20 of dry bean (Phaseolus vulgaris) were sent to each of the following in Kabul, Afghanistan: Ministry of Agriculture; Faculty of Agriculture, Kabul University; and Mr. John Wilson, USAID, to be included in yield trials in various regions of the country. Twelve broadbean lines were also sent to the Ministry of Agriculture and Kabul University.

5. Sixty lentil, dry bean and chickpea (Cicer arietinum) lines were sent to the Ministry of Agriculture and Ankara University, Ankara, Turkey, for incorporation in their breeding program and to be evaluated for agronomic characteristics and disease resistance.

6. Eighty-three broadbean lines, 44 dry and snap bean varieties, and 20 cowpea types were sent to Dr. Takumo Izuno, CIMMYT, Ford Foundation, West Pakistan, for testing in various parts of the country.

7. Over 1000 lines of mungbeans, beans and cowpeas were sent to the Ministry of Agriculture, Philippines, to be included in their germ plasm collection and to test for agronomic and disease resistance characteristics.

8. Seed of approximately 7000 lines of bean, cowpea, mungbean, chickpea, broadbean and lentil were sent to the National Seed Laboratory in Fort Collins, Colorado, for storage. Emphasis was placed on sending germ plasm lines originating outside the U. S. Field data concerning growth characteristics of these lines were put on punch cards and tape for computer analyses and these records were sent along with the seeds.

Puerto Rico

1. Five hundred and three cowpea lines from the Legume Project's germ plasm bank were sent to the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, for agronomic and disease resistance studies.

2. Forty-six black shiny hybrid beans (F_4 to F_5) were specially developed for commercial acçeptance in El Salvador, and contained field resistance to rust, Fusarium wilt and bean common mosaic virus. One of these hybrid lines has proved to be highly desirable in El Salvador and is being increased for further testing and release.

3. Seed of 223 PI Accessions of cowpea were sent to Dr. W. R. Langford, Coordinator, Regional Project S-9, Regional Plant Introduction Station, Experiment Georgia, to refurnish his supply of these PI Accessions.

4. Ten bean lines were sent to Dr. B. J. Ballantine, Biology Department, N.S.W. Department of Agriculture, Rydalmere, New South Wales, Australia, for disease resistance trials.

5. Five cowpea lines resistant to beetle-transmitted viruses in Puerto Rico were sent to Dr. Rodrigo Gamez, University of Costa Rica, San José, Costa Rica,for testing against beetle-transmitted cowpea viruses in Central America.

6. Due to requests from USAID/Nicaragua and Dr. Rolando Lasso G., Plant Breeder, Ministry of Agriculture, Divisa, Panama, one set of 17 pigeon pea (*Cajanus cajan*) varieties and hybrids were obtained from Dr. Raul Abrams, Head, Department of Agronomy, University of Puerto Rico, Mayaguez, and delivered to each of the parties requesting the seed.

APPENDIX D

Examples of The Use of Findings

Iran

1. In Iran, three bean, two cowpea, and two chickpea lines which were selected by the pulse project are being increased by the Ministry of Agriculture for release.

2. One black-seeded chickpea line in the Iran Pulse Project Germ Plasm collection which was found from greenhouse and field testing to be highly resistant to Ascochyta blight (A. rabiei) has been sent to India, West Pakistan and Turkey for additional testing against this important disease.

3. A culture media developed by the Iran Pulse Project for increased sporulation of A. rabiei is being used in India by scientists at the Indian Agricultural Research Institute, Pusa, New Delhi, working with this pathogen.

4. Several B.S. and M.S. students in the College of Agriculture, University of Tehran, Karaj, Iran, did their thesis work with the pulse project and the results of these studies have been published by some of the students in Iranian scientific journals.

5. A syllabus of plant virology and virus diseases prepared by the American plant pathologist of the Pulse Project is being used in plant pathology courses taught at several Iranian universities, including the University of Tehran, University of Tabriz and the Jundi Shapoor University.

6. More than 120 requests have been received for reprints of 10 research papers on diseases of edible legumes published in various scientific journals, including Phytopathology, Plant Disease Reporter and the Iranian Journal of Plant Pathology. These requests have come from scientists in many countries, including those in the Less Developed Countries where these crops are cultivated.

Puerto Rico

1. Bean and cowpea lines developed by the Pulse Project in Puerto Rico were sent to Ing. Bernardo Patino, Head, Bean Project, Ministry of Agriculture, Santa Tecla, El Salvador, for field testing. Of 46 shiny black bean lines resistant to rust, Fusarium wilt and bean common mosaic virus which were sent to Ing. Patino, one F_5 line was selected for its outstanding agronomic and disease resistant characteristics, and the seed is being increased for release to the farmers.

Out of 34 black-seeded cowpea selections sent to Ing. Patino, five were selected in El Salvador for their high yielding and disease resistance characteristics, and seed is being multiplied for possible release to the farmers.

2. In visits to Central American countries by Pulse Project personnel, several bean research technicians from each country have been trained in field diagnosis of diseases affecting beans and cowpeas. Also, suggestions have been made on methods of designing experiments for screening and selection of breeding material against plant diseases and insect pests. These suggestions have been used by technicians in some of these countries in the design and execution of their legume experiments. "On-the-Job-Training" is an important aspect of the Legume Project's work.

3. Bean lines from Puerto Rico Legume Project which were found to be resistant to the whitefly-transmitted Rhynchosia mosaic virus are being tested in several Central American countries. Lines resistant to the virus in Puerto Rico are also resistant to the virus in Central America.

AID-2-3 (6-64)

PASA BUDGET PLAN By Object Class

PARTICIPATING AGENCY SERVICE AGREEMENT
WITH:
U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BUDGET PLAN FOR FY 1972

AMOUNT:
APPROPRIATION 72-2101004
ALLOTMENT 254-31-099-00-22-21

PASA CONTROL NO. RA(AJ)3-00-A16
PIO/T NO. 931-17-130-029-72-3127552
931-17-130-029-72-3127553

Position	Class. Grade	FC Grade	Rate	Man ~~Years~~ Months	Salary	Differential	11 TOTAL	12 Personnel Benefits	21 Int'l.* Travel	22 Transportation of Things	TOTAL	Puerto Rico Total
IRAN												
Soil Scientist												
Horner, Glen M. a/		11/5	24,910	7	13,878	--	13,878	1,117	1,700	5,500	22,195	
Horner's lump-sum payment for 691 hrs. or $8,278. 8/38 payable from PASA (146 hrs.)					1,747	--	1,747	--	--	--	1,747	
Plant Pathologist												
Kaiser, Walter, J.	FC-11/1;GS13/6		21,862	12	21,349	586	21,935	1,774	3,200 b/	6,000	32,909	23,194
Plant Geneticist												
Evans, Kenneth H.		10/3	19,987	6 3/4	14,752 c/	--	14,752	923	3,000	6,250	24,925	
Evans' lump sum payment for 318 hrs.					3,133						3,133	
Entomologist												
Schalk, James M.		9/3	15,875	6	7,592	--	7,592	673	2,346	6,435	17,046	

a/Retired 1/29/72.

b/Vakili's and Kaiser's travel to Central America (3 trips), Brazil and the United States, including home leave in the case of Vakili (Pg. 2) and transfer for Kaiser.

c/Includes $3,076 final severance payment.

TOTAL _____

23 Rent, Communications, Utilities _____

26 Supplies and Materials _____

31 Equipment _____

Overhead _____ % _____

GRAND TOTAL _____

*Estimated Per Diem:

ARS/IPD Revised 5/12/72

AID-2-3 (6-64)

PASA BUDGET PLAN By Object Class

PARTICIPATING AGENCY SERVICE AGREEMENT
WITH:
U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BUDGET PLAN FOR FY 1972

AMOUNT:
APPROPRIATION 72-2101004
ALLOTMENT 254-31-099-00-22-21

PASA CONTROL NO. RA(AJ)3-00

PIO/T NO.
931-17-130-029-72-3127552
931-17-130-029-72-3127553

Position	Class. Grade	FC Grade	Rate	Man ~~xxxx~~ Months	Salary	Differential	11 TOTAL	12 Personnel Benefits	21 Int'l.* Travel	22 Transportation of Things	TOTAL	PUERTO RICO
PUERTO RICO												
Plant Pathologist												
Vakili, Nader G.	GS	12/10	20,627	12	20,223	1,015	21,238	1,729	5,400b/		28,367	28,367
Research Technician												
Santiago-Medina		5/4	8,051	12	7,886	408	8,294	823	--		9,117	9,117
Tech. Ass't (Biology)												
Santiago-Rosado, J. A.		4/1	6,544	10½	5,534	280	5,814	302	--		6,116	6,116
Crop Research Helper												
Torres-Soto		1/1 WB	2.00 ph	11	3,677	--	3,677	191			3,868	3,868
Crop Research Helper												
Diaz, Ismael		1/1 WB	2.00 ph	6½	2,174		2,174	131			2,305	2,305
Clerk Typist		2/2	5,060	2 wks.	194		194	17			211	211
L/A Labor					3,895		3,895	203			4,098	4,098
Inspection Travel d/									2,400		2,400	650

d/ Two trips. One trip of pathologist to Puerto Rico and one to Iran.

e/Includes cost of supplies, materials and equipment of specialized nature available from limited USDA procurement sources.

f/Excludes local budget for Iran (separate Budget attached) in amount of 46,050 and PASA program support, $9,300.

TOTAL	158,437	77,926
21 Tran. of things	1,580	1,300
23 Rent, Communications, Utilities	300	300
25 Other Services	5,500	5,500
26 Supplies and Materials	e/ 3,878	3,578
31 Equipment	7,044	7,044
Sub-total	176,739	95,648
Overhead 15 %	26,511	14,347
Total	f/ 203,250	
Add local budget	46,050	109,995
Grand Total	249,300	109,995

*Estimated Per Diem:

ARS/IPD Revised 5/12/72

FY-1972 BUDGET
FOR
SERVICES, SUPPLIES AND EQUIPMENT

REGIONAL PULSE IMPROVEMENT PROJECT
FEDERAL EXPERIMENT STATION, MAYAGUEZ, P. R.

Other Services (Operation & Maintenance)		
Vehicles - cost of gas, oil, servicing and maintenance of vehicles. The plot land is some 30 miles away from the Mayaguez Station so considerable travel is involved.	$ 600	
Land preparation and cultivation and insect and weed control including charges for tractors, implements, and operating personnel. Several acres of experimental beans and cowpeas are grown three times each year.	600	
Irrigation water and facilities including cost of personnel to apply the water. The bean plantings must be irrigated during the growing seasons in fall and spring.	500	
Greenhouse, office and laboratory facilities, pro-rata cost of maintenance, repair, and utilities, etc.	3,800	$5,500
Equipment		
Mist sprayer for treating seed with fungicides and insecticides. Now this must be done by slow hand methods since no sprayer is available. Not needed until seed building is finished; however, fungicide sprayer is required.	326	
Irrigation tubing, valving & sprinklers that can be permanently assigned to the project. At present, the same equipment is used for several crops and it is necessary to move it frequently from one field to another and to delay the irrigating of the beans and cowpeas while the equipment is in use on another crop. Station purchased part of this requirement.	925	
Microscope - Transfer a microscope from Beltsville for Dr. Vakili's and Dr. Kaiser's use.	0	
Plot cultivator - For use in cultivating beans for weed control - to be used in addition to tractor-mounted equipment to cultivate where tractor cannot go, such as alleys, individual rows, etc. Purchased by Station.	0	

1/2-ton, 2 dr. pick-up truck to use for transporting crew, equipment, seed, etc., from station to field plantings.	2,600	
Two vehicles are needed to allow independent mobility of Drs. Vakili and Kaiser and their crews. In fact, they will need 3 or 4 vehicles but possibly can continue to get some transportation from the Federal Experiment Station motor pool. Present motor pool is such that there are times when vehicles are not available to the RPIP program. For the present, one vehicle will be acquired.		
Camera and attachments. Needed to document research activities. At the present time no Govt. camera is available. Attachments are essential and it is better to purchase them with camera as a purchase under $500 does not qualify for the Govt. discount.	557	
Refrigerator - Commerical type, 41 cu. ft. Essential to preserve large quantities of valuable fungal and bacterial pathogens as they are collected.	2,000	
Laboratory sink unit - 8 foot. Station has furnished a lab. for use of the project, but is not able to provide this sink unit, nor base slide cabinet.	636	7,044
Supplies		
Seed Storage Trays - needed to facilitate the handling of seed envelopes and storage of seed. Purchased by station.	0	
Fertilizers, weed control chemicals, insecticides, hand tools, seed envelopes, paper and plastic bags, chemical laboratory chemicals, glassware, and other innumerable items necessary for the project.	3,578	3,578
TOTAL		$16,122

FY-1972 BUDGET
FOR
SERVICES, SUPPLIES AND EQUIPMENT

REGIONAL PULSE IMPROVEMENT PROJECT
FEDERAL EXPERIMENT STATION, MAYAGUEZ, P. R.

Other Services (Maintenance)		
Vehicles	1,200	
Irrigation and water facilities	500	
Greenhouse and other facilities housing supplies and equipment for project	3,800	5,500
Expendible Supplies and Materials		3,578
Equipment		
Irrigation tubing, valving & sprinklers	925	
Camera	557	
Sprayer, fungicide	326	
Slide cabinet	241	
1/2-ton, 2 dr. pick-up truck	2,600	
Refrigerator	2,000	
Laboratory sink	395	7,044
		16,122

ARS/IPD
Revised 5/12/72

AID/ARS
REGIONAL FOOD LEGUME (PULSE) IMPROVEMENT PROJECT
LOCAL BUDGET ESTIMATE FY 1972 (IRAN)
BY: OBJECT CLASS
Revised February 3, 1972

11.	Personnel Compensation (Education Allowances)	$ 2,000
12.	Personnel Benefits (Housing Allowances)	6,000
21.	Travel	200 1/
22.	Transportation of Things	2,000
23.	Rent, Communications and Utilities	50
25.	Other Services	23,000 2/
	Services to Other Agencies (SAS)	10,000 3/
26.	Supplies and Materials	2,800
		$46,050

1/Local travel in Iran.

2/Includes $14,200 for reimbursement to host country cooperating institutions for labor, as agreed by cooperative agreement, and additional labor or contractural services to process germ plasm for shipment to the U.S.; to punching field data of germ plasm collection on punch cards and tapes and like treatment of data previously acquired in India on pigeon peas and chickpeas. Latter data processing services are recently reported by Dr. Horner to have cost $4,550.

3/Shared administrative costs and services payable to the Embassy.

ARS/IPD
Revised 5/12/72

APPENDIX F

AID-2-3 (6-64)

PASA BUDGET PLAN By Object Class

PARTICIPATING AGENCY SERVICE AGREEMENT
WITH:
U.S. Department of Agriculture
Agricultural Research Service (Grain Legumes)
BUDGET PLAN FOR FY 1973

AMOUNT:
APPROPRIATION
ALLOTMENT

PASA CONTROL NO. RA(AJ)3-00
PIO/T NO.

Position	Class. Grade	GS ~~RX~~ Grade	Rate	Man ~~XXXX~~ Months	Salary	Differential	11 TOTAL	12 Personnel Benefits	21 Int'l.* Travel	22 Transportation of Things	TOTAL
Plant Pathologist Kaiser, Walter J.		13/6	21,862	12	21,862	1,093	22,955	1,860	2,000 a/		26,815
Plant Pathologist Vakili, Nader G.		12/10	20,627	12	20,634	1,031	21,665	1,755	5,900 b/		29,320
Research Technician Santiago-Medina, Wm.		5/4	8,051	12	8,051	403	8,484	681	--		9,165
Technical Asst.(biology) Santiago-Rosado, J. A.		4/2	6,762	12	6,732	327	7,059	571	--		7,630
Crop Research Helper Torres-Soto		3/1 WB	4,318	12	4,318	--	4,318	367	--		4,685
Crop Research Helper Diaz, Ismael		3/1 WB	4,318	12	4,318	--	4,318	367	--		4,685
Technical Asst. (Biology)		5/1	7,319	9	5,576	279	5,855	474			6,329
Clerk Typist		3/1	5,828	9	4,435	222	4,657	377	--		5,034
Inspection Travel									2,450 c/		2,450

a/Home leave, including travel within U.S. (states of Washington, Nebraska, Idaho, New York, and Michigan)to visit bean breeders and pathologists and consultations in Washington/Beltsville to consult with AID/USDA officials.

b/For either Vakili or Kaiser: local travel within Puerto Rico; travel to Mexico to attend American Phytopathological meetings from August 6-12, 1972, and to visit bean growing areas in Southern Mexico to complete the disease survey of pulse growing regions in tropical Central America. One trip to central America during the course of fiscal year for continuation of work with PCCMCA in connection with Central American bean and cowpea improvement programs; another such trip to extend into South America for contacts with scientists working in pulse programs and visit CIAT.

*Estimated Per Diem: $3,500

Footnote c on page 2

TOTAL	96,113
23 Rent, Communications, Utilities	
26 Supplies and Materials	
31 Equipment	
Overhead ____ %	
GRAND TOTAL	

ARS/IPD 5/23/72

AID-2-3 (6-64)

PASA BUDGET PLAN By Object Class

PARTICIPATING AGENCY SERVICE AGREEMENT
WITH:
U.S. Department of Agriculture
Agricultural Research Service (Grain Legumes)
BUDGET PLAN FOR FY 1973

AMOUNT:
APPROPRIATION
ALLOTMENT

PASA CONTROL NO. RA(AJ)3-00
PIO/T NO.

Position	Class. Grade	FC Grade	Rate	Man ~~XXXXX~~ Months	Salary	Differential	11 TOTAL	12 Personnel Benefits	21 Int'l.* Travel	22 Transportation of Things	TOTAL
L/A Labor				6	2,100		2,100				2,100

c/Two trips. One trip from Beltsville and one from Pullman, Washington. One of these trips to extend into Central and South America to accompany Kaiser or Vakili.

d/Includes cost of supplies, materials, and equipment of specialized nature available from limited USDA Procurement sources.

f/Excludes PASA Program support in the amount of $7,050.

TOTAL	98,213
22 Trans. of Things	6,000
23 Rent, Communications, Utilities	350
25 Other Services	6,800
26 Supplies and Materials	4,000 d/
31 Equipment	37,200
Sub-Total	152,563
Overhead 15 %	22,884
GRAND TOTAL	175,447 f/

*Estimated Per Diem: $3,500

AR/IPD 5/23/72

FY-1973 BUDGET
FOR
SERVICES, SUPPLIES AND EQUIPMENT

REGIONAL PULSE IMPROVEMENT PROJECT
FEDERAL EXPERIMENT STATION, MAYAGUEZ, P. R.

Other Services (Maintenance)		
Vehicles, tractors, and other machines	1,800	
Irrigation and water facilities	500	
Greenhouse and other facilities (housing and other equipment for project)	4,500	6,800
Supplies		
Glassware, laboratory chemicals and supplies, fungicides, insecticides, fertilizers, seed envelopes, paper and plastic bags, etc.	4,000	4,000
Equipment		
4-door delivery truck	3,700	

Four vehicles are needed to allow independent mobility of Kaiser and Vakili and their crews. At present we do not have sufficient, reliable vehicles to carry out our pulse research activities. Possibly, we can continue to get some transportation from the Federal Experiment Station motor pool. Present motor pool is such that there are times when vehicles are not available to the RPIP program. For the present, one vehicle is being requested, to augment vehicle ordered in FY-1972 which will not be received until FY-1973.

Compound microscope with apochromatic lenses and camera attachments.	3,000

We lack a compound microscope in our laboratory, and we need a well-equipped instrument which can be used for critical studies involving chromosome counting, observation of bacterial and fungal spores and cells, as well as being equipped to take photo micrographs.

Two constant temperature and humidity growth chambers.	14,000	
These are needed to study various aspects of resistance of newly developed bean and cowpea lines to various pathogens, and to investigate the effects of temperature, light, and humidity to growth, sporulation and survival of pathogenic fungi and bacteria.		
Cold Storage Facility	15,000	
Cold storage space very inadequate for volume of bean and cowpea seed in the pulse project collection. Additional space is also needed for the numerous hybrids and slections that are being made each growing season with these two pulse crops.		
Non-expendable equipment such as hot plates, stirrers, ph meters, constant temperature baths, etc. needed in the laboratory.	1,500	
		37,200
		$48,000