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INTERNATIONAL BEAN RUST NURSERY

COLECCION HISTORICA

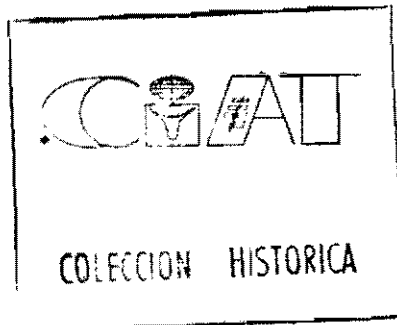
Results 1977~1978



INTERNATIONAL BEAN RUST NURSERY

Results 1977-1978

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Introduction

The international bean rust nursery (IBRN) was proposed and organized by participants at a bean rust workshop held at the Centro Internacional de Agricultura Tropical (CIAT) in October 1974. These potential IBRN collaborators established the internationally-distributed uniform nursery to test promising cultivars, parental accessions and breeding lines of *Phaseolus vulgaris* L. for resistance to race populations of the bean rust fungus [*Uromyces appendiculatus* (Pers.) Unger which is synonymous with *U. phaseoli* (Reben) Wint.] which exist in different bean growing regions of the world.

CIAT was requested to coordinate the shipment of nurseries and compilation of data collected by the collaborators. The results obtained with the 1975 - 1976 IBRN were previously summarized and distributed by CIAT in a 19 page bulletin entitled: "International Bean Rust Nursery, Results 1975 - 1976, series 20EB-1". This current bulletin summarizes the results obtained by the IBRN collaborators for the 1977 - 1978 IBRN, and compares these results to those of the 1975 - 1976 IBRN.

Objectives

The objectives of the international bean rust nursery are to:

- Identify cultivars and breeding lines resistant to a wide spectrum of the pathogenic potential inherent in the bean rust fungus.
- Determine the stability of different types of plant resistance by time and location.

c. Detect new and more virulent rust race complexes before they or bean cultivars susceptible to them become widely disseminated.

d. Obtain information on race patterns present in bean growing areas.

Format of the Nurseries

The 1975 - 1976 IBRN contained 132 entries, which included 28 potential rust race differentials which had been proposed by participants of the 1974 bean rust workshop. The 1977 - 1978 IBRN likewise contained these proposed differentials, 42 other entries which had been previously resistant or intermediate at most locations in the 1975 - 1976 IBRN, and 48 new introductions for a total of 118 materials.

A total of twenty six 1977-1978 IBRN trials were planted by more than 20 collaborators in 22 locations throughout Latin America, the United States, Europe, Africa, and Australia. However, data were obtained from and are reported for only 17 of these nurseries. Table 1 lists the locations and collaborators who participated in the trials reported in this bulletin. The geographic distribution of these nurseries is shown in Figure 1.

Management of the Nurseries

The suggested procedures for the 1977 - 1978 nurseries were similar to those recommended for the 1975 - 1976 IBRN trials. Fertilizer applications followed local recommendations and were designed to allow normal plant development free of nutrient deficiency problems. The following management suggestions and other agronomic practices were modified as required by collaborators to satisfy the agricultural practices existent at their trial locations.

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Figure 1. IBRN test locations in the Western Hemisphere, 1977 and 1978 trials.

Table 1. Test locations and collaborators for the 1977-1978 IBRN trials.

Location	Collaborators	Location code
Brazil (Goiânia)	Dulce Regina Nunes W. and Carlos A. Rava S.	BRAG
Colombia (CIAT-Palmira)	H.F. Schwartz and S.R. Temple (March)	COLA ¹
(CIAT-Palmira)	H.F. Schwartz and Fernando Correa (Sept.)	COLB ¹
(Manizales, Univ. de Caldas)	Alvaro Giraldo, Rodolfo López and Alberto Robledo M.	COLM
(Popayán)	H.F. Schwartz, S.P. Singh and Pablo Guzmán	COLP
(Río Negro)	H.F. Schwartz, S.R. Temple and Pablo Guzmán	COLR
Dominican Republic (Santiago)	Samuel Concepción and J.F. Rodríguez	DORE ²
Ecuador (Pallatanga)	Julio Delgado, Manuel Intriago and Fernando Armijos	ECUA
El Salvador (San Andrés)	René Villa, Nery Grejo and Víctor M. Rodríguez	ELSA
Guatemala (Chimaltenango)	Kazuhiro Yoshii	GUAT
Jamaica (Alexandria)	Meher Shaik	JAMA ²
Jamaica (Top Mountain)	Meher Shaik	JAMT ²
Perú (Chiclayo)	Elva Llontop C. and Guillermo Morales	PERU
Rep. of South Africa (Transvaal, Potchefstroom)	A.J. Liebenberg	RPSA ²
United States (Beltsville, Md.)	Jack P. Meiners	USB1 ¹
(Beltsville, Md.)	Jack P. Meiners	USB2 ^{1,2}
(Saginaw, Mich.)	A.W. Sattler	USAM

¹ Nurseries inoculated with mixture of local rust races. All other nurseries were naturally infected.

² Actually tested in early 1979.

Mixtures of two or more susceptible cultivars, plus other cultivars with varying levels of resistance, were sown as border/spreader rows around and within the plot 0-25 days before planting nursery entries (Fig. 2). IBRN entries were sown in rows perpendicular or parallel to the border/spreader rows. The 2 meter long rows were spaced 60-75 cm apart and 10-15 seeds were planted per meter length of row. Sufficient seed was provided to plant two replications. A susceptible and resistant local cultivar were planted systematically throughout the nursery. Nursery entries then became infected during naturally occurring epidemics of rust or after artificial inoculation with locally propagated isolates or purified races of the fungus.

Disease Reaction Classification

Evaluation of the entries for rust resistance 20-40 (pre-flowering to mid-flowering) and 40-60 (mid-flowering to pod formation) days after germination considered the following two criteria:

a. Intensity of infection, expressed as the percentage of leaf area (less than 1% to 100%) visibly covered by necrotic spots or sporulating pustules.

b. Type of pustule (Fig. 3), with the following five classes of development:

1. Immune: no evidence of infection.
2. Resistant: necrotic spots without sporulation, or minute pustules formed which are barely visible.
3. Moderately resistant: pustules formed having diameters less than 300 μ .
4. Moderately susceptible: pustules formed having diameters of 300 to 500 μ , possibly surrounded by chlorotic halos.
5. Susceptible: pustules formed having diameters greater than 500 μ and often surrounded by chlorotic halos.

Data obtained from collaborators were processed by compounding infection intensity and pustule type to define the categories of plant reaction, according to the tableau in Figure 4. In locations where two replicates were planted, the higher final rust rating was used to tabulate the final result reported. The plant reaction classification value obtained from the tableau was then

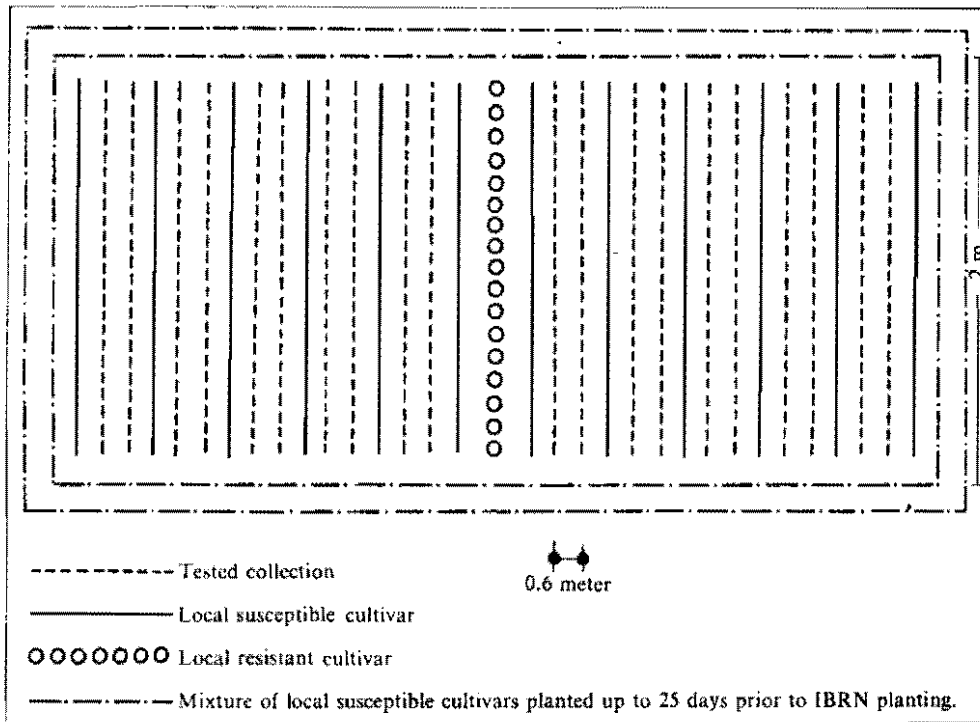


Figure 2. Suggested planting pattern for IBRN trials.

compounded with time of note taking (see Table 2) to obtain the final plant classification reported in subsequent Tables.

Results — Plant Resistance

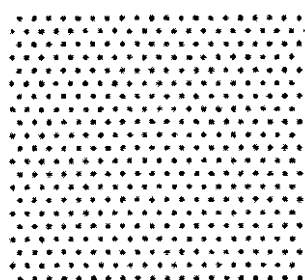
The final plant reactions of each IBRN entry at each testing location are presented in Table 3, and Table 4 summarizes each entry's overall reaction to rust infection during 1977-1978.

These tables demonstrate that nearly every entry was susceptible at one or more locations. Some entries such as Cocacho (Entry No. 4), Cuilapa 72 (No. 26),

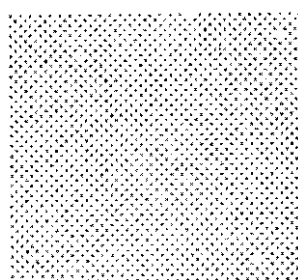
Redlands Pioneer (No. 28), Redlands Greenleaf B (No. 44), Redlands Greenleaf C (No. 46) and Puebla 87 (No. 88) were not susceptible at any location. A selection of Jamapa (No. 38) was not susceptible at any location, however, was intermediate at most sites.

The 1977-1978 IBRN entries were also evaluated in the glasshouse at Beltsville for resistance to four U.S. strains of rust, including one strain from Michigan that attacks Aurora¹. Only 19 of the entries were resistant as seedlings to these strains in the glasshouse, while more than 50 entries were reported resistant as older plants in the field (Refer to results for USB1, USB2 and USAM).

¹ Meiners, J. P. 1979. Sources of resistance to U. S. bean rust—Update. Annual Rept. Bean Improvement Coop. 22: 62-63.



Approximately 500 μ



Approximately 300 μ

Figure 3. Guide to pustule size utilized in the IBRN rust classification. Davison & Vaughan, Bean Rust Grading Scale.

Immune 1	Resistant 2						
1- 0%							
2- 1%	2- 5%	2- 10%	2- 30%	2- 40%	2- 65%	2- 100%	
3- 1%	3- 5%	3- 10%	3- 30%	3- 40%	3- 65%	3- 100%	
4- 1%	4- 5%	4- 10%	4- 30%	4- 40%	4- 65%	4- 100%	
5- 1%	5- 5%	5- 10%	5- 30%	5- 40%	5- 65%	5- 100%	
	Intermediate 3			Susceptible 4			

Figure 4. Plant reaction classifications determined by field observations of rust infection type and intensity. The number is a rating of the pustule size on a scale of 1-5 with the infection intensity given as a percentage.

Table 5 summarizes the reactions of the most widely resistant entries in the 1977-1978 IBRN, as well as in the previous 1975-1976 IBRN. All entries were, however, susceptible at one or more locations during one or more years. Puebla 87 was not evaluated in the 1975-1976 IBRN, but has now been observed to be susceptible to rust at CIAT, and therefore was not included in Table 5.

Many of the entries listed in Table 5 are widely resistant to the rust races present within Latin America and other regions of the world, and could provide useful sources of rust resistance for bean improvement programs. However, additional research and nurseries are required to identify new and possibly more widely resistant germplasm within the IBRN testing network.

Results — Pathogenic Variability

Table 6 summarizes the 1977-1978 IBRN rust classification by location, and reveals that scientists from CIAT, the Dominican Republic, El Salvador and Beltsville, Maryland reported the highest proportion of susceptible entries.

Entry numbers 43-70 contain the 28 rust differential cultivars that were proposed by participants at the 1974 CIAT bean rust workshop. No attempt has been made to interpret the specific data reported for these differential cultivars, since mixtures or populations of rust races were inoculated to or perpetuated in the field nurseries. Therefore specific race identification was not possible since the differentials had not been inoculated with purified isolates under strict quarantine conditions in the glasshouse.

The IBRN format represents a more practical and efficient attempt to monitor the overall race patterns and pathogenic variability displayed by the race or

races comprising the population of rust endemic at each location. Therefore, the IBRN testing system is actually designed to measure the combined interaction between the group of IBRN entries and the population of rust races. This system still allows collaborators to monitor the change in resistance expressed by specific entries (as presented in the previous section), and to monitor the pathogenic variability expressed by bean rust populations at specific locations and over time. Of course this variability may also be influenced by date of planting and the environmental conditions.

This variability can be demonstrated by selecting a fixed group of cultivars and/or breeding entries to

Table 2. Method for final classification of IBRN entries.

Classification 20-40 days after germination	Classification 40-60 days after germination	Final classification
1 ¹	1	1
1	2	2
1	3	3
1	4	4
2	1	2
2	2	2
2	3	3
2	4	4
3	1	3
3	2	2
3	3	3
3	4	4
4	1	3
4	2	2
4	3	3
4	4	4

¹ Classification values obtained from Figure 4: 1= immune; 2= resistant; 3= intermediate; 4= susceptible.

serve as a standard monitor of the pathogenicity displayed by the rust population present at each location. The entire set of IBRN entries could be used for this purpose to compare rust populations in the 1975-1976 IBRN or in the 1977-1978 IBRN. However, the varietal composition of these two IBRN's has differed, therefore it was necessary to select a fixed group of 41 entries (refer to Table 3 for their identity) which had been evaluated in both IBRN's and which are also being evaluated in the 1979-1980 IBRN. Table 7 summarizes the final plant reaction classifications reported for these entries at each location in 1975, 1976 and 1977-1978, and which were used to later construct the frequency distribution figures. Table 8 is included to help identify the location codes utilized in the 1975-1976 IBRN, and Table 1 identifies the 1977-1978 IBRN locations.

Data from Table 7 were utilized to calculate the frequency distribution of each plant reaction class (i.e., immune, resistant, intermediate, susceptible) at each testing location during 1975-1978. This frequency value was obtained by dividing the number of entries in each reaction class (Table 7) by the total number of the 41 monitoring entries actually evaluated at each location. Since the monitoring entries are standard, it is possible to compare the frequency distributions in Figures 5, 6 and 7 between locations and/or between years.

The frequency distributions clearly illustrate those locations at which more monitoring entries were susceptible during a specific year. For example, this occurred at CIAT (CI10) and Puerto Rico-Limani (PURL) in Figure 5; at Celaya, México (MEXC) and

Santiago, Dominican Republic (DORE) in Figure 6; and at Santiago, Dominican Republic (DORE) and San Andrés, El Salvador (ELSA) in Figure 7.

The rust populations varied between planting seasons at one location such as Palmira as demonstrated in Figure 5 (CI02, CI04 and CI10), and between years when compared to Figure 6 (CIAT) and Figure 7 (COLA and COLB). Location-specific differences in rust populations within one region or country are also illustrated by the Colombian data, as shown in Figure 7 by comparing the susceptible frequency distribution of COLA and COLB at Palmira, to that of COLM at Manizales, to that of COLP at Popayán, and finally to that of COLR at Río Negro.

Although the rust populations at these latter three locations infected fewer entries than the rust populations at Palmira, they infected different entries than the rust populations at Palmira (Table 3). This indicates that race differences did exist between and within sites quantitatively as well as qualitatively.

Therefore, these contrasting sites and seasons form a complementary germplasm-testing network capable of identifying entries widely resistant to all the rust populations present within these regions of the country.

The preceding comparisons were made to illustrate the utility of IBRN data to study the pathogenic variability inherent in the rust fungus. Similar comparisons can readily be made between locations and years for the other IBRN reporting sites from Latin America and other regions of the world.

Table 3. Final plant classifications for the 1977-1978 IBRN entries (0 = no data; 1 = immune; 2 = resistant; 3 = intermediate; 4 = susceptible).

IBRN entry No.	Identification	Location Code																
		BRAG	COLA	COLB	COLM	COLP	COLR	DORE	ECUA	ELSA	GUAT	JAMA	JAMT	PERU	RPSA	USB1	USB2	USAM
1	V.I. 1013	0	2	3	0	0	4	1	2	0	3	2	2	0	1	1	2	2
2	Wis. Hyb. 72	3	0	0	0	0	1	3	2	3	4	2	2	0	3	2	2	2
3	Canario Divex 8120 (G 5704) ¹	3	2	3	1	0	1	2	3	4	2	2	4	3	3	4	4	2
4 ²	Cocacho	3	3	3	2	2	1	3	2	2	2	3	3	3	2	1	2	2
5	Bayo Camana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
6	Bonita (G 6733)	0	3	3	3	2	1	4	2	0	3	4	2	1	3	3	3	2
7	Caballero	4	3	2	0	1	1	3	1	4	2	2	4	4	3	3	2	2
8	Canario L.M.	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2	2
9	México 142-N	4	3	3	2	1	1	1	1	4	2	3	2	1	3	0	3	1
10	Negro de Chíncha	3	0	3	0	1	1	1	2	3	2	2	4	0	0	2	2	3
11 ²	Ormiston	2	2	3	0	1	1	1	4	2	2	3	4	0	3	4	4	2
12	Pinto Serrano	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
13	P.R.-2	4	4	4	4	4	1	4	4	2	4	4	2	2	3	2	2	1
14	P.R.-7	3	4	4	4	3	1	4	4	4	0	4	2	0	1	3	2	1
15	Diacol Calima (G 4494)	0	1	3	2	3	3	4	2	0	2	3	4	0	0	4	2	3
16 ²	Compuesto Chimalteco 3 (G 5712)	2	2	2	0	2	3	3	1	4	3	2	2	1	3	2	2	2
17 ²	México 309 (G 5652)	2	2	1	2	2	1	1	1	4	3	2	2	1	1	1	2	1
18 ²	Turrialba 1 (G 4485)	2	3	4	3	2	1	4	1	2	3	4	2	0	1	2	2	3
19 ²	Ecuador 299 (G 5653)	3	2	2	2	2	1	3	1	4	4	3	2	0	3	1	2	1
20 ²	México 235	3	2	2	2	1	1	4	1	0	4	2	2	0	3	1	2	1
21	Portugal	0	0	3	0	3	2	2	4	2	3	3	3	0	3	2	2	2
22 ²	Compuesto Chimalteco 2 (G 5711)	0	0	2	0	1	0	1	1	3	3	2	2	1	1	1	2	2
23	Cacahuete 72 (G 5481)	2	2	3	0	1	2	3	4	2	2	3	4	0	3	4	4	2
24	27-R (G 4458)	4	1	3	1	3	3	3	4	2	3	3	4	0	4	4	4	3
25	ICA-Pijao (G 4525)	2	4	4	1	3	1	4	2	2	2	3	2	2	1	4	3	3
26 ²	Cuilapa 72 (G 4489)	3	2	1	2	1	1	2	2	2	3	3	2	1	1	1	2	1
27 ²	Turrialba 4 (G 4465)	3	4	4	1	1	1	3	1	2	3	2	2	1	1	1	3	1
28 ²	Redlands Pioneer	2	2	2	2	1	1	3	1	2	2	2	0	3	2	2	2	2
29	4691-54-1	3	4	4	2	4	4	4	2	4	3	3	3	2	4	3	3	3
30 ²	Negro Jalpatagua	0	3	3	4	1	3	4	1	2	0	3	2	1	3	1	2	1
31	Porrillo 70 (G 4142)	2	4	4	0	3	3	4	1	3	4	3	2	1	3	4	3	3
32 ²	P.R.-5	3	2	3	3	0	4	4	1	4	4	2	2	1	1	3	2	2
33	P.R.-3	4	4	4	3	4	3	4	3	3	4	3	2	3	3	1	2	2
34 ²	Cornell 49-242 (G 5694)	3	3	4	2	3	1	4	3	3	4	3	2	2	3	2	2	2
35	Nep-2 (G 4459)	3	4	4	3	3	1	4	2	2	2	4	2	2	1	2	2	2
36	Rico 23 (G 3827)	4	4	4	2	3	1	4	3	4	3	3	2	1	3	1	3	1
37	Rico Bayo 1014	3	1	2	2	1	3	3	1	4	3	2	2	4	1	4	2	3
38	Jamapa	3	3	3	3	3	3	3	2	3	3	2	2	2	2	2	2	2
39	P.I. 226883	3	2	3	2	2	3	4	4	3	2	3	4	0	3	4	4	3
40	P.I. 226895 (G 1423)	4	2	3	2	1	3	4	2	3	3	2	3	0	3	4	3	3

(Continued)

Table 3. Continued.

IBRN entry No.	Identification	Location Code																
		BRAG	COLA	COLB	COLM	COLP	COLR	DORE	ECUA	ELSA	GUAT	JAMA	JAMT	PERU	RPSA	USB1	USB2	USAM
41	Miss Kelly	4	4	4	3	3	1	3	2	2	2	4	2	3	3	1	2	1
42	Mountaineer White Half Runner	4	4	4	4	3	2	4	2	3	4	3	2	4	3	4	4	3
43 ²	Redlands Autumn Crop	2	1	3	2	3	2	3	4	2	2	3	4	0	3	4	4	2
44 ²	Redlands Green Leaf B	2	1	2	2	2	1	3	2	2	2	1	2	0	2	2	3	2
45 ²	Cuva 168-N	2	2	3	3	4	1	4	1	3	4	3	2	1	1	1	2	1
46 ²	Redlands Green Leaf C	2	1	3	1	2	1	3	1	2	2	2	2	0	2	3	3	2
47 ²	Bountiful No. 181	3	2	3	0	4	0	4	4	0	2	3	4	0	4	4	4	2
48 ²	Brown Beauty	3	2	3	0	3	3	4	4	4	2	3	4	0	4	4	4	2
49 ²	Canario 101	2	1	3	0	3	2	0	4	2	2	2	4	0	3	4	4	2
50 ²	California Small White No. 643 (G 5693)	3	4	2	2	3	1	4	1	2	2	3	2	2	3	4	2	3
51 ²	C.C.G.B. 44 (G 3607)	3	4	4	2	4	3	4	1	4	3	3	1	1	3	2	2	1
52	Dade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	2
53 ²	Epicure	4	4	4	3	4	2	4	3	4	4	4	2	2	4	4	4	4
54 ²	Golden Gate Wax	4	4	2	0	2	1	4	2	4	2	2	3	0	4	3	3	2
55 ²	Kentucky Wonder No. 765	3	3	2	2	3	4	4	2	3	2	2	2	2	3	4	3	3
56 ²	Kentucky Wonder No. 780	3	4	4	0	3	1	4	3	0	0	4	2	3	4	4	4	3
57 ²	Kentucky Wonder No. 814	3	4	4	1	3	1	4	3	2	4	3	2	2	3	4	3	3
58 ²	Mulatinho	3	4	4	4	4	3	4	3	4	3	3	2	0	3	2	2	1
59 ²	Pinto No. 650	4	4	4	3	3	2	4	3	0	0	4	4	4	4	4	4	4
60 ²	U.S. No. 3	4	4	4	2	4	1	4	2	0	4	4	2	0	3	4	4	4
61 ²	Veracruz 1-A-6	4	4	4	2	2	3	4	2	4	3	2	2	1	3	3	3	4
62 ²	Aguascalientes 13	4	4	4	2	4	4	4	3	4	4	3	3	0	4	4	4	4
63 ²	Guerrero 6	3	4	4	3	3	1	4	2	3	3	3	2	1	1	3	2	1
64 ²	Guerrero 9	4	3	3	1	2	1	4	1	4	2	3	2	1	3	4	3	2
65 ²	Guanajuato 10-A-5	3	0	3	3	3	4	4	3	4	4	4	2	2	1	3	3	1
66 ²	Jalisco 33	2	3	2	3	3	1	4	1	4	2	2	2	0	4	4	3	3
67 ²	México 6	3	2	2	2	3	1	4	1	3	3	2	2	0	1	3	2	2
68 ²	México 12	4	2	3	0	4	2	3	2	3	3	2	2	2	3	4	3	2
69 ²	Negro 150	4	0	4	0	4	1	4	2	3	4	3	2	0	3	4	3	4
70 ²	Veracruz 10	4	4	4	3	4	0	4	2	4	3	4	2	0	3	4	4	4
71	P.I. 150941 (G 0091)	2	1	2	1	1	1	1	1	4	2	0	0	2	4	4	2	3
72	P.I. 165915 (G 0176)	2	2	2	0	2	3	1	2	4	2	0	0	1	3	3	2	1
73	P.I. 165928 (G 0177)	3	1	2	0	2	1	4	2	3	2	0	0	1	0	2	2	2
74	P.I. 165948 (G 0179)	2	4	3	0	2	1	1	4	2	2	0	0	0	0	0	0	3
75	P.I. 169855 (G 0310)	3	2	4	0	2	2	1	4	3	3	0	0	0	0	4	4	3
76	P.I. 172028 (G 0406)	0	0	4	0	1	0	0	4	3	0	0	0	0	0	4	4	2
77	P.I. 182011 (G 0686)	0	1	2	0	1	3	4	2	3	4	0	0	2	0	3	2	1
78	P.I. 186492 (G 0716)	3	0	3	0	1	1	1	2	2	2	0	0	0	0	4	2	2
79	P.I. 197970 (G 0818)	0	0	3	0	1	0	3	1	3	2	0	0	2	0	4	3	4
80	P.I. 282086 (G 1101)	3	1	3	4	3	1	4	4	3	2	0	0	3	0	4	4	2

(Continued)

Table 3. Continued.

IBRN entry No.	Identification	Location Code																
		BRAG	COLA	COLB	COLM	COLP	COLR	DORE	ECUA	ELSA	GUAT	JAMA	JAMT	PERU	RPSA	USBI	USB2	USAM
81	P.I. 310842 (G 2084)	4	4	4	3	3	4	4	1	3	4	0	0	2	1	2	3	4
82	P.I. 313652 (G 2539)	3	2	3	2	3	1	4	1	4	4	0	0	2	1	2	2	2
83	Brazil 2 (G 3807)	3	2	4	2	3	3	4	1	3	3	0	0	1	0	4	3	4
84	Negro 321 (G 3128)	3	4	4	2	3	1	4	1	3	3	0	0	2	0	2	2	4
85	Huila 14 (G 3619)	3	4	3	2	4	1	4	1	3	0	0	0	1	0	3	2	1
86	Mexico 114 (G 4354)	0	0	4	0	1	0	4	1	4	3	0	0	0	0	4	2	3
87	Puebla 3-A-2 (G 4302)	3	1	3	3	3	3	1	2	4	4	0	0	2	1	2	2	1
88	Puebla 87 (G 3341)	2	1	3	1	3	1	1	2	3	2	0	0	1	0	1	2	1
89	S-166 (G 4122)	3	2	3	0	3	1	4	1	3	3	0	0	1	0	3	2	2
90	S-434 (G 3913)	3	2	3	2	2	1	1	1	3	0	0	0	1	0	1	2	2
91	51.051 (G 3834)	0	1	2	2	1	3	1	1	3	3	0	0	1	1	1	3	2
92	P.R. 5, PR-S-70-15-RTS-B-K (G 5479)	4	2	2	2	1	4	3	1	3	4	0	0	2	3	1	2	2
93	P.I. 313624 (G 2525)	3	1	4	3	2	4	3	1	3	0	0	0	2	0	3	2	2
94	Línea 17 (G 4523)	3	1	2	0	3	1	1	1	2	2	0	0	0	3	4	2	3
95	Red Kidney Shell (G 3601)	0	2	4	3	3	3	4	4	3	0	0	0	0	0	4	4	0
96	Colorado (G 4059)	2	2	3	0	3	3	4	1	4	3	0	0	1	1	2	2	2
97	Great Northern #1 Sel. 27 (G 5477)	3	3	2	2	1	1	4	1	4	0	0	0	2	4	4	4	3
98	Rojo 70 (G 5701)	0	0	4	0	1	0	4	1	4	3	0	0	3	3	3	2	3
99	51.052 (G 4792)	3	4	2	1	1	1	3	1	2	2	0	0	2	3	4	3	1
100	10.233 (G 5709)	3	3	4	1	2	1	3	1	2	2	0	0	1	1	2	2	3
101	Master Piece (G 4509)	3	2	2	2	1	1	0	2	4	0	0	0	0	3	2	2	2
102	Paraná (G 4829)	2	2	3	0	1	1	1	2	3	2	0	0	1	1	2	2	2
103	Pirata 2 (G 4823)	2	4	4	1	1	4	3	1	3	4	0	0	3	1	4	3	1
104	Rio Tibagi (G 4830)	2	4	4	3	3	1	4	3	2	3	0	0	2	0	4	4	3
105	Zamorano 2 (G 4482)	3	2	4	0	3	1	3	1	3	3	0	0	2	1	2	2	2
106	Great Northern 1140 (G 5051)	3	3	3	4	2	1	4	1	4	2	0	0	2	3	4	4	3
107	Puebla 152 (G 4446)	3	4	4	2	4	3	4	2	4	3	0	0	2	1	2	2	1
108	Diacol Nutibara (G 4831)	2	0	2	0	3	1	1	1	2	2	0	0	0	0	4	2	2
109	Kaboon (G 6380)	0	3	3	0	3	1	0	2	4	2	0	0	0	3	3	3	3
110	Per 257 (G 6038)	3	2	2	3	2	1	1	4	2	2	0	0	2	3	2	4	3
111	P.I. 284703 (G 1540)	4	2	3	0	3	1	4	1	4	4	0	0	0	3	4	3	3
112	Flor de Mayo (G 5897)	2	3	4	0	1	4	1	1	2	3	0	0	2	1	2	2	1
113	Tacarigua (G 4790)	0	0	4	0	1	0	4	2	2	3	0	0	1	0	2	2	1
114	P.I. 298105 (G 1640)	0	0	4	0	0	1	4	3	3	0	0	0	1	0	4	4	3
115	15-R-55 (G 6651)	3	4	4	4	4	1	4	2	2	4	0	0	2	3	4	3	2
116	Desarrolla Vaina Roja (G 5445)	0	0	4	0	1	0	4	3	0	4	0	0	1	0	4	3	0
117	Retinto Dulce Nombre Copan (G 7136)	0	0	4	0	1	0	4	3	0	4	0	0	1	0	4	4	3
118	Rojo Gentry No. 21566 (G 7131)	0	0	4	0	1	0	4	4	0	3	0	0	2	0	4	4	1

¹ The G code numbers refer to the CIAT Genetic Resources accession number.

² Entry selected to monitor pathogenic variability of bean rust at different locations and over time (see Figures 5, 6 and 7).

Table 4. Summary of plant classifications for each IBRN entry during 1977-1978.

IBRN Entry No.	Identification	No. of locations where the entry was classified as:				
		Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
1	V.I. 1013	3	6	2	1	5
2	Wis. Hyb. 72	1	6	4	1	5
3	Canario Divex 8120 (G 5704) ¹	2	5	5	4	1
4	Cocacho	2	7	8	0	0
5	Bayo Camana	0	0	0	1	16
6	Bonita (G 6733)	2	4	7	2	2
7	Caballero	3	5	4	4	1
8	Canario L.M.	0	1	1	1	14
9	México 142-N	6	3	5	2	1
10	Negro de Chincha	3	5	4	1	4
11	Ormiston	3	5	3	4	2
12	Pinto Serrano	0	1	0	0	16
13	P.R.-2	2	5	1	9	0
14	P.R.-7	3	2	3	7	2
15	Diacol Calima (G 4494)	1	4	5	3	4
16	Compuesto Chimalteco 3 (G 5712)	2	9	4	1	1
17	México 309 (G 5652)	8	7	1	1	0
18	Turrialba 1 (G 4485)	3	6	4	3	1
19	Ecuador 299 (G 5653)	4	6	4	2	1
20	México 235	5	6	2	2	2
21	Portugal	0	6	6	1	4
22	Compuesto Chimalteco 2 (G 5711)	5	6	2	0	4
23	Cacahuate 72 (G 5481)	1	6	4	4	2
24	27-R (G 4458)	2	1	7	6	1
25	ICA-Pijao (G 4525)	3	6	4	4	0
26	Cuitapa 72 (G 4489)	7	7	3	0	0
27	Turrialba 4 (G 4465)	8	3	4	2	0
28	Redlands Pioneer	3	11	2	0	1
29	4691-54-1	0	3	7	7	0
30	Negro Jalpatagua	5	3	5	2	2
31	Porrillo 70 (G 4142)	2	2	7	5	1
32	P.R.-5	3	5	4	4	1
33	P.R.-3	1	3	7	6	0
34	Cornell 49-242 (G 5694)	1	6	7	3	0
35	Nep-2 (G 4459)	2	8	3	4	0
36	Rico 23 (G 3827)	4	2	6	5	0
37	Rico Bayo 1014	4	5	5	3	0
38	Jamapa	0	8	9	0	0

(Continued)

Table 4. Continued.

IBRN entry No.	Identification	No. of locations where the entry was classified as:				
		Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
39	P.I. 226883	0	4	7	5	1
40	P.I. 226895 (G 1423)	1	4	8	3	1
41	Miss Kelly	3	5	5	4	0
42	Mountaineer White Half Runner	0	3	5	9	0
43	Redlands Autumn Crop	1	6	5	4	1
44	Redlands Green Leaf B	3	11	2	0	1
45	Cuva 168-N	6	4	4	3	0
46	Redlands Green Leaf C	4	8	4	0	1
47	Bountiful No. 181	0	3	3	7	4
48	Brown Beauty	0	3	5	7	2
49	Canario 101	1	6	3	4	3
50	California Small White No. 643 (G 5693)	2	7	5	3	0
51	C.C.G.B. 44 (G 3607)	4	3	5	5	0
52	Dade	0	1	1	1	14
53	Epicure	0	3	2	12	0
54	Golden Gate Wax	1	6	3	5	2
55	Kentucky Wonder No. 765	0	7	7	3	0
56	Kentucky Wonder No. 780	1	1	5	7	3
57	Kentucky Wonder No. 814	2	3	7	5	0
58	Mulatinho	1	3	6	6	1
59	Pinto No. 650	0	1	3	11	2
60	U.S. No. 3	1	3	1	10	2
61	Veracruz 1-A-6	1	6	4	6	0
62	Aguascalientes 13	0	1	3	12	1
63	Guerrero 6	4	3	7	3	0
64	Guerrero 9	4	4	5	4	0
65	Guanajuato 10-A-5	2	2	7	5	1
66	Jalisco 33	2	5	5	4	1
67	México 6	3	7	5	1	1
68	México 12	0	7	6	3	1
69	Negro 150	1	2	4	7	3
70	Veracruz 10	0	2	3	10	2
71	P.I. 150941 (G 0091)	6	5	1	3	2
72	P.I. 165915 (G 0176)	3	7	3	1	3
73	P.I. 165928 (G 0177)	3	7	2	1	4
74	P.I. 165948 (G 0179)	2	4	2	2	7
75	P.I. 169855 (G 0310)	1	3	4	4	5
76	P.I. 172028 (G 0406)	1	1	1	4	10
77	P.I. 182011 (G 0686)	3	4	3	2	5

(Continued)

Table 4. Continued.

IBRN entry No.	Identification	No. of locations where the entry was classified as:				
		Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
78	P.I. 186492 (G 0716)	3	5	2	1	6
79	P.L. 197970 (G 0818)	2	2	4	2	7
80	P.I. 282086 (G 1101)	2	2	5	5	3
81	P.I. 310842 (G 2084)	2	2	4	7	2
82	P.I. 313652 (G 2539)	3	6	3	3	2
83	Brazil 2 (G 3807)	2	2	6	4	3
84	Negro 321 (G 3128)	2	4	4	4	3
85	Huila 14 (G 3619)	4	2	4	3	4
86	Mexico 114 (G 4354)	2	1	2	4	8
87	Puebla 3-A-2 (G 4302)	4	4	5	2	2
88	Puebla 87 (G 3341)	7	4	3	0	3
89	S-166 (G 4122)	3	3	6	1	4
90	S-434 (G 3913)	5	5	3	0	4
91	51.051 (G 3834)	7	3	4	0	3
92	P.R. 5, PR-S-70-15-RTS-B-K (G 5479)	3	6	3	3	2
93	P.I. 313624 (G 2525)	2	4	5	2	4
94	Linea 17 (G 4523)	4	4	4	1	4
95	Red Kidney Shell (G 3601)	0	1	4	5	7
96	Colorado (G 4059)	3	5	4	2	3
97	Great Northern #1 Sel. 27 (G 5477)	3	3	3	5	3
98	Rojo 70 (G 5701)	2	1	5	3	6
99	51.052 (G 4792)	5	4	4	2	2
100	10.233 (G 5709)	5	5	4	1	2
101	Master Piece (G 4509)	2	7	2	1	5
102	Paraná (G 4829)	5	7	2	0	3
103	Pirata 2 (G 4823)	5	1	4	5	2
104	Rio Tibagi (G 4830)	1	3	5	5	3
105	Zamorano 2 (G 4482)	3	5	5	1	3
106	Great Northern 1140 (G 5051)	2	3	5	5	2
107	Puebla 152 (G 4446)	2	5	3	5	2
108	Diacol Nutibara (G 4831)	3	6	1	1	6
109	Kaboon (G 6380)	1	2	7	1	6
110	Per 257 (G 6038)	2	7	4	2	2
111	P.I. 284703 (G 1540)	2	1	5	5	4
112	Flor de Mayo (G 5897)	5	5	2	2	3
113	Tacarigua (G 4790)	3	4	1	2	7
114	P.I. 298105 (G 1640)	2	0	3	4	8
115	15-R-55 (G 6651)	1	4	3	7	2
116	Desarrural Vaina Roja (G 5445)	2	0	2	4	9
117	Retinto Dulce Nombre Copan (G 7136)	2	0	2	5	8
118	Rojo Gentry No. 21566 (G 7131)	2	1	1	5	8

¹ CIAT Genetic Resources Accession Number.

Table 5. Reactions of the most widely resistant entries reported in the 1975-1976 and/or 1977-1978 IBRN.

IBRN entry			Number of nurseries where the entry was classified as:														
			1975					1976					1977 - 1978				
			Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)	Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)	Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
1977-1978 IBRN No.	1975-1976 IBRN No.	Identification															
4 ¹	31	Cocacho	5	4	0	1	5	0	5	2	2	8	2	7	8	0	0
16 ¹	7	Compuesto Chimalteco 3 (G 5712)	4	3	2	1	5	5	9	2	1	0	2	9	4	1	1
17 ¹	13	México 309 (G 5652)	6	5	1	0	3	8	4	3	2	0	8	7	1	1	0
18	14	Turrialba 1 (G 4485)	4	3	2	3	3	3	7	6	1	0	3	6	4	3	1
19	26	Ecuador 299 (G 5653)	5	7	1	0	2	3	6	6	2	0	4	6	4	2	1
20	82	México 235	2	1	2	0	10	6	4	4	2	1	5	6	2	2	2
25	52	ICA-Pijao (G 4525)	3	1	4	3	4	3	6	7	1	0	3	6	4	4	0
26 ¹	9	Cuilapa 72 (G 4489)	4	7	1	0	3	8	3	3	3	0	7	7	3	0	0
28 ¹	2	Redlands Pioneer	0	0	0	0	15	2	7	5	2	1	3	11	2	0	1
34	44	Cornell 49-242 (G 5694)	3	5	4	1	2	2	4	9	2	0	1	6	7	3	0
38 ¹	58	Jamapa	3	5	2	3	2	2	3	5	7	0	0	8	9	0	0
40	63	P.I. 226895 (G 1423)	4	6	2	0	3	1	5	7	2	2	1	4	8	3	1
44 ¹	108	Redlands Greenleaf B	7	3	2	0	3	2	8	5	2	0	3	11	2	0	1
46 ¹	106	Redlands Greenleaf C	1	2	2	0	10	1	7	6	2	1	4	8	4	0	1
67 ¹	129	México 6	0	0	0	0	15	1	2	2	1	11	3	7	5	1	1

¹ Most widely resistant entries in the 1977 - 1978 IBRN, in addition to Puebla 87 (No. 88).

Table 6. Summary of 1977-1978 IBRN rust classifications by location.

Location ¹ code	No. of entries classified as:				
	Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
BRAG	0	24	49	22	23
COLA	16	32	16	33	21
COLB	2	25	40	46 ²	5
COLM	12	33	20	8	45
COLP	32	21	40	16	9
COLR	61	9	22	11	15
DORE	20	3	23	64 ²	8
ECUA	46	35	15	18	4
ELSA	0	31	37	35 ²	15
GUAT	0	40	36	26	16
JAMA	1	23	30	12	52
JAMT	1	46	6	13	52
PERU	28	35	8	4	43
RPSA	27	3	45	12	31
USB1	17	27	19	51 ²	4
USB2	1	56	31	29	1
USAM	27	45	31	11	4

¹ See Table 1 for location identity.

² Locations with the highest proportion of susceptible entries.

Table 7. Summary of rust classifications for the 41 IBRN monitoring entries at each testing location during 1975-1978.

Location	No. of 41 entries classified as:				
	Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
<u>1975¹</u>					
BRAV	4	8	8	2	19
CI 02	5	10	6	2	18
CI 04	12	7	2	4	16
CI 10	1	9	5	11	15
CORI	5	1	12	3	20
ECUA	1	10	1	2	27
GUAT	14	7	0	0	20
PERU	13	2	0	4	22
PURI	4	7	5	5	20
PURL	7	1	4	8	21
USAB	3	15	5	8	9
USAF	13	2	5	0	21
USAM	15	6	3	0	17
<u>1976²</u>					
AUST	14	0	10	8	9
BRAG	1	9	4	7	20
CIAT	9	8	8	16	0
CORI	0	10	7	13	11
ECUA	0	5	12	12	12
ELSA	1	7	15	7	11
GUAT	0	12	11	7	11
MEXC	4	1	8	25	3
PERU	22	3	0	5	11
PURI	5	7	8	10	11
PURL	4	6	10	10	11
USAB	3	16	12	10	0
USAM	17	13	9	1	1
BRAV	4	9	12	4	12
BR77	1	9	20	8	3
DORE	5	2	7	16	11
EL77	0	20	11	7	3
<u>1977-1978³</u>					
BRAG	0	11	18	10	2
COLA	4	13	7	14	3
COLB	2	11	13	15	0
COLM	4	16	9	2	10
COLP	7	10	13	10	1
COLR	23	5	6	4	3
DORE	3	1	9	27	1
ECUA	17	11	8	5	0
ELSA	0	13	8	15	5

(Continued)

Table 7. Continued.

Location	No. of 41 entries classified as:				
	Immune (1)	Resistant (2)	Intermediate (3)	Susceptible (4)	No data (0)
(1977-1978 ¹ , cont.)					
GUAT	0	14	13	11	3
JAMA	1	15	18	7	0
JAMT	1	31	3	6	0
PERU	9	10	2	1	19
RPSA	11	2	20	8	0
USBI	9	8	6	18	0
USB2	1	16	13	11	0
USAM	11	17	6	7	0

¹ See Figure 5.² See Figure 6.³ See Figure 7.

Table 8. Test locations and codes utilized for the 1975-1976 IBRN data depicted in the following series of figures (see Table 1 for the 1977-1978 location codes).

1975 location code	Identity	1976 location code	Identity
BRAV	Vigosa, Brazil	AUST	Castle Hill, Australia
CI 02	Palmira, Colombia (February)	BRAG	Goiânia, Brazil
CI 04	Palmira, Colombia (April)	CIAT	Palmira, Colombia
CI 10	Palmira, Colombia (October)	CORI	Alajuela, Costa Rica
CORI	Alajuela, Costa Rica	ECUA	Pallatanga, Ecuador
ECUA	Pallatanga, Ecuador	ELSA	Santa Tecla, El Salvador
GUAT	Monjas, Guatemala	GUAT	Chimaltenango, Guatemala
PFRU	La Molina, Perú	MEXC	Celaya, Gto., México
PURI	Isabela, Puerto Rico	PERU	La Molina, Perú
PURL	Limani, Puerto Rico	PURI	Isabela, Puerto Rico
USAB	Beltsville, Maryland, U.S.A.	PURL	Limani, Puerto Rico
USAF	Fargo, North Dakota, U.S.A.	USAB	Beltsville, Maryland, U.S.A.
USAM	East Lansing, Michigan, U.S.A.	USAM	East Lansing, Michigan, U.S.A.
		BRAV ²	Vigosa, Brazil
		BR77 ²	Goiânia, Brazil
		DORE ²	Santiago, Dominican Republic
		EL77 ²	Santa Tecla, El Salvador

² Actually tested in early 1977

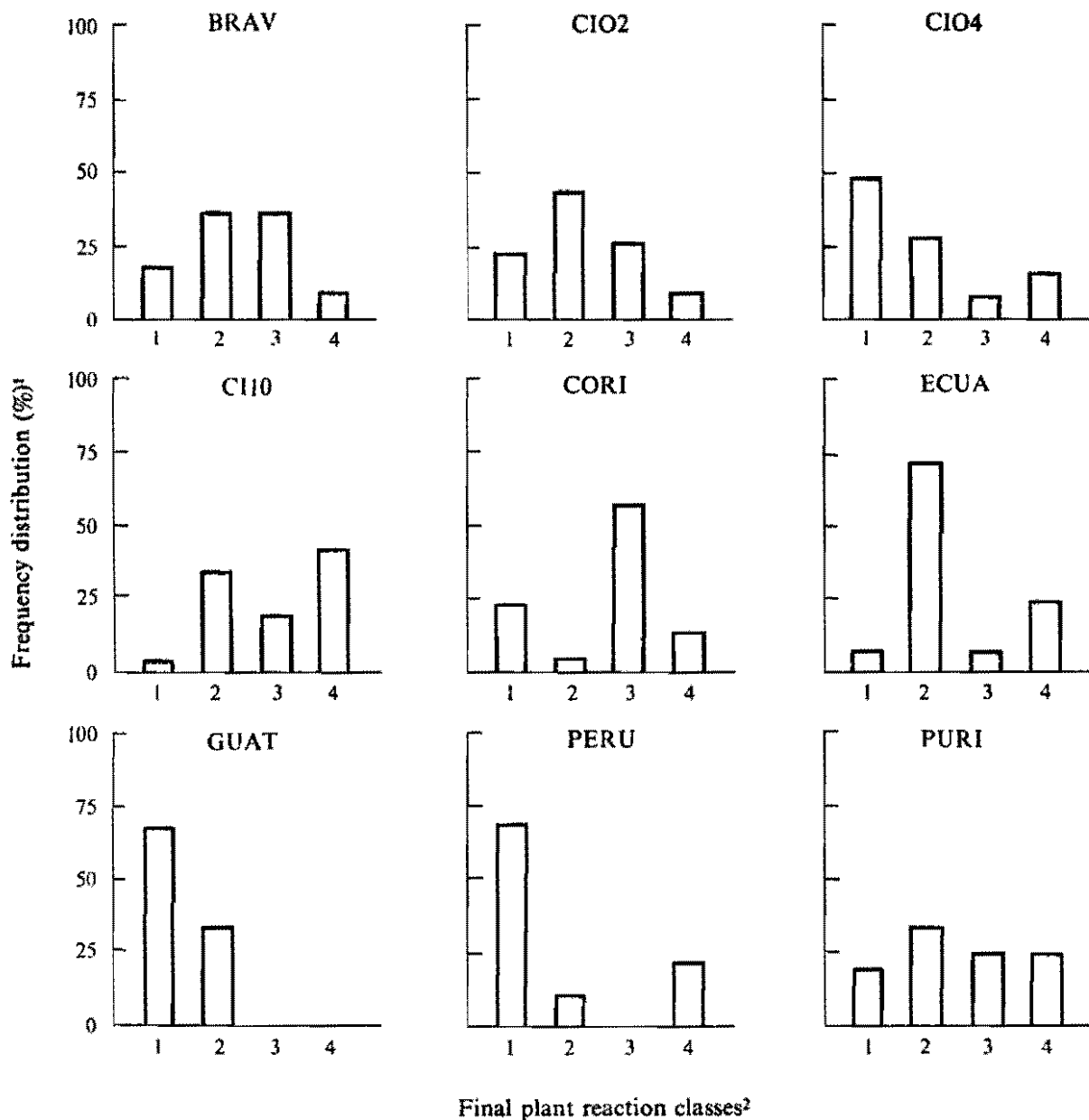
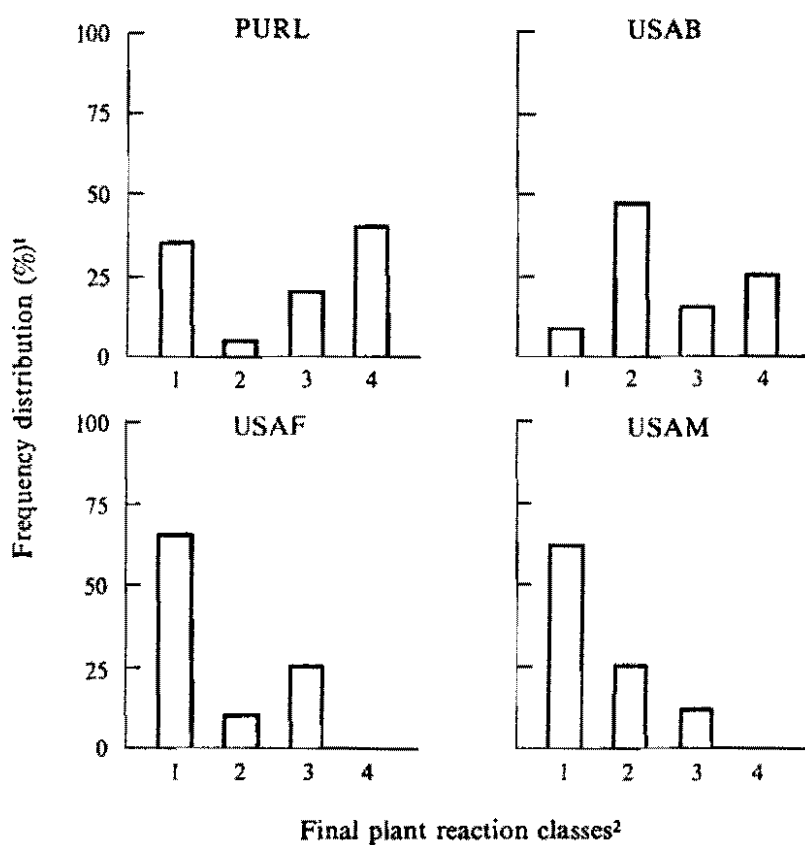


Figure 5. Frequency distribution of the final plant reaction classification values reported for the 41 monitoring entries in 1975.

Figure 5. Continued.



¹ Frequency distribution calculated by dividing the number of entries in each reaction class (refer to Table 7) by the total number of the 41 monitoring entries actually evaluated at each location and multiplying this value by 100%.

² Final plant reaction classes: 1= immune; 2= resistant; 3= intermediate; 4= susceptible. Refer to Table 8 for explanation of location codes.

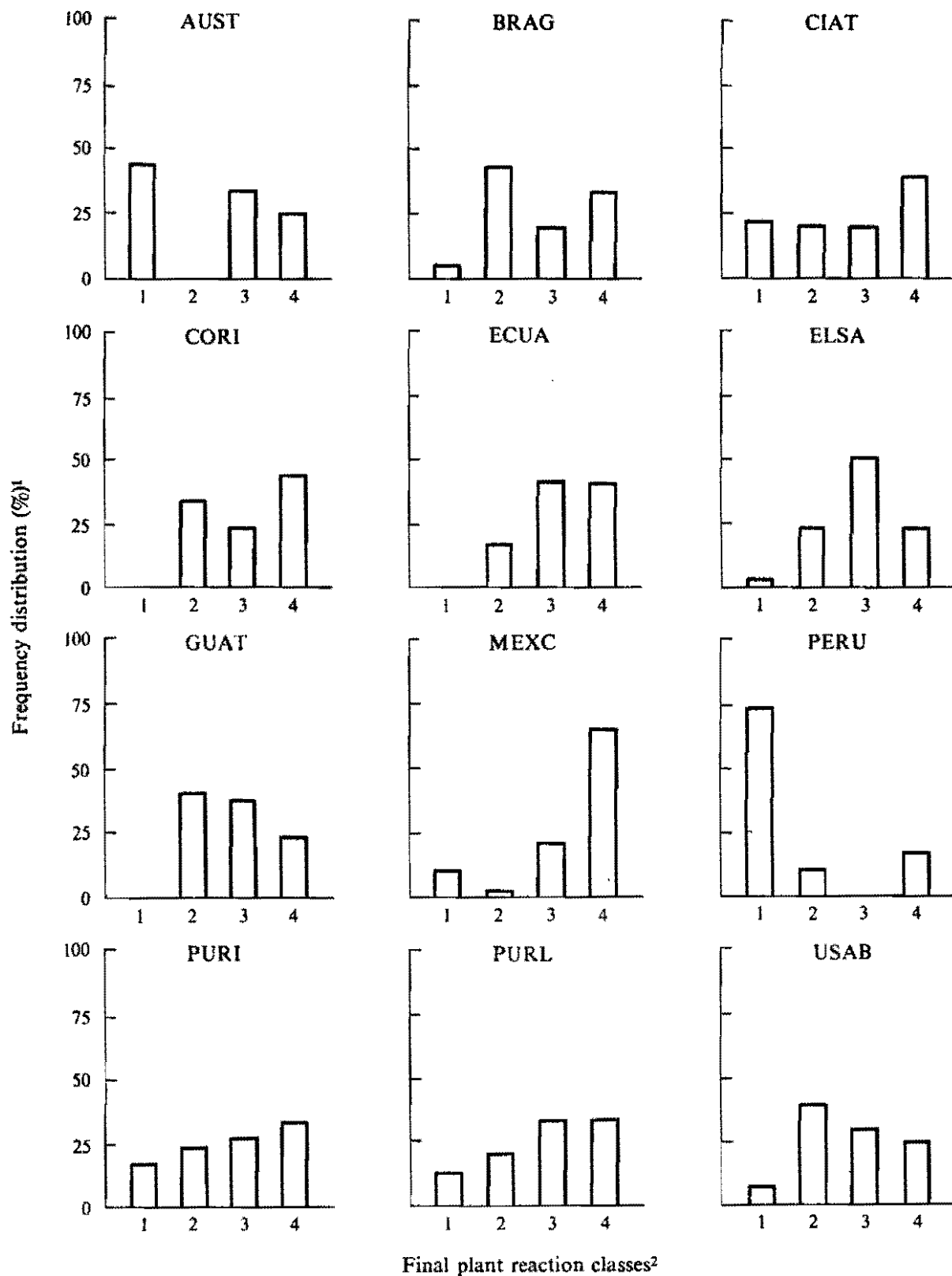
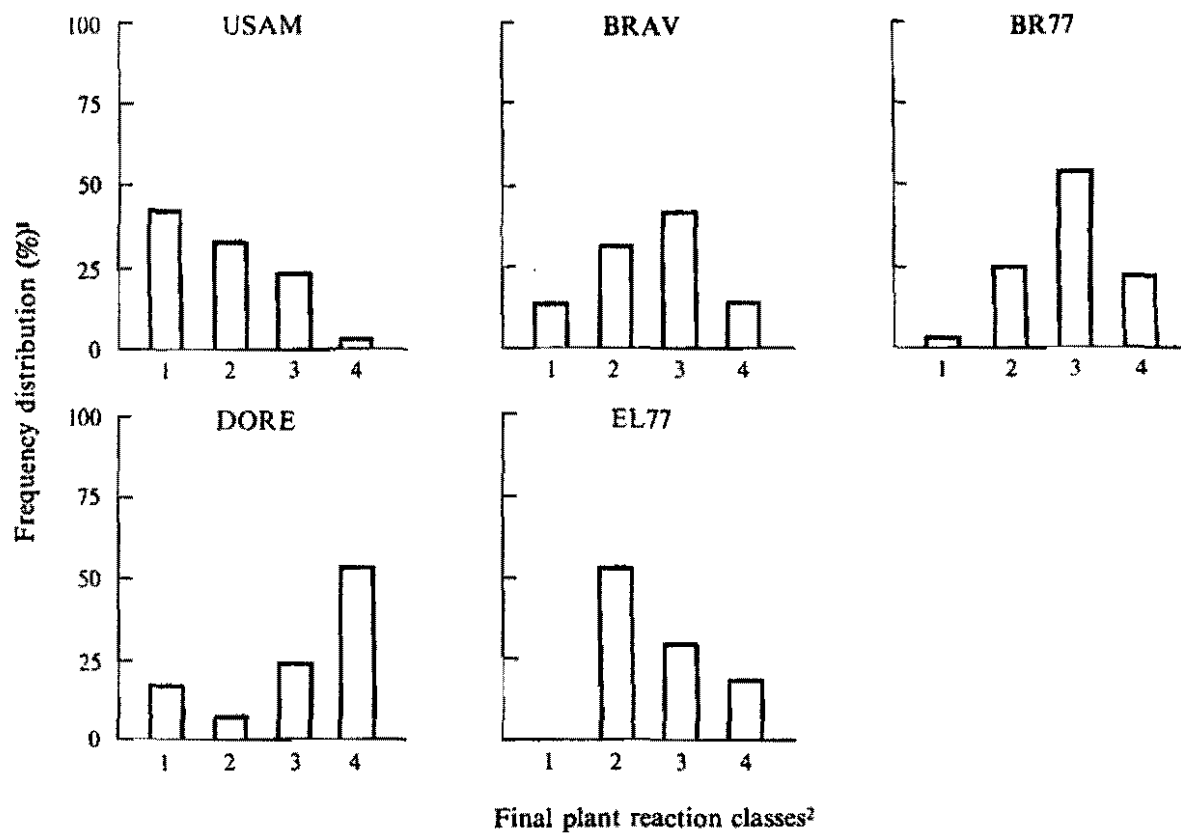


Figure 6. Frequency distribution of the final plant reaction classification values reported for the 41 IBRN monitoring entries in 1976.

Figure 6. Continued.



¹ Frequency distribution calculated by dividing the number of entries in each reaction class (refer to Table 7) by the total number of the 41 monitoring entries actually evaluated at each location and multiplying this value by 100%.

² Final plant reaction classes: 1=immune; 2=resistant; 3=intermediate; 4=susceptible. Refer to Table 8 for explanation of location codes.



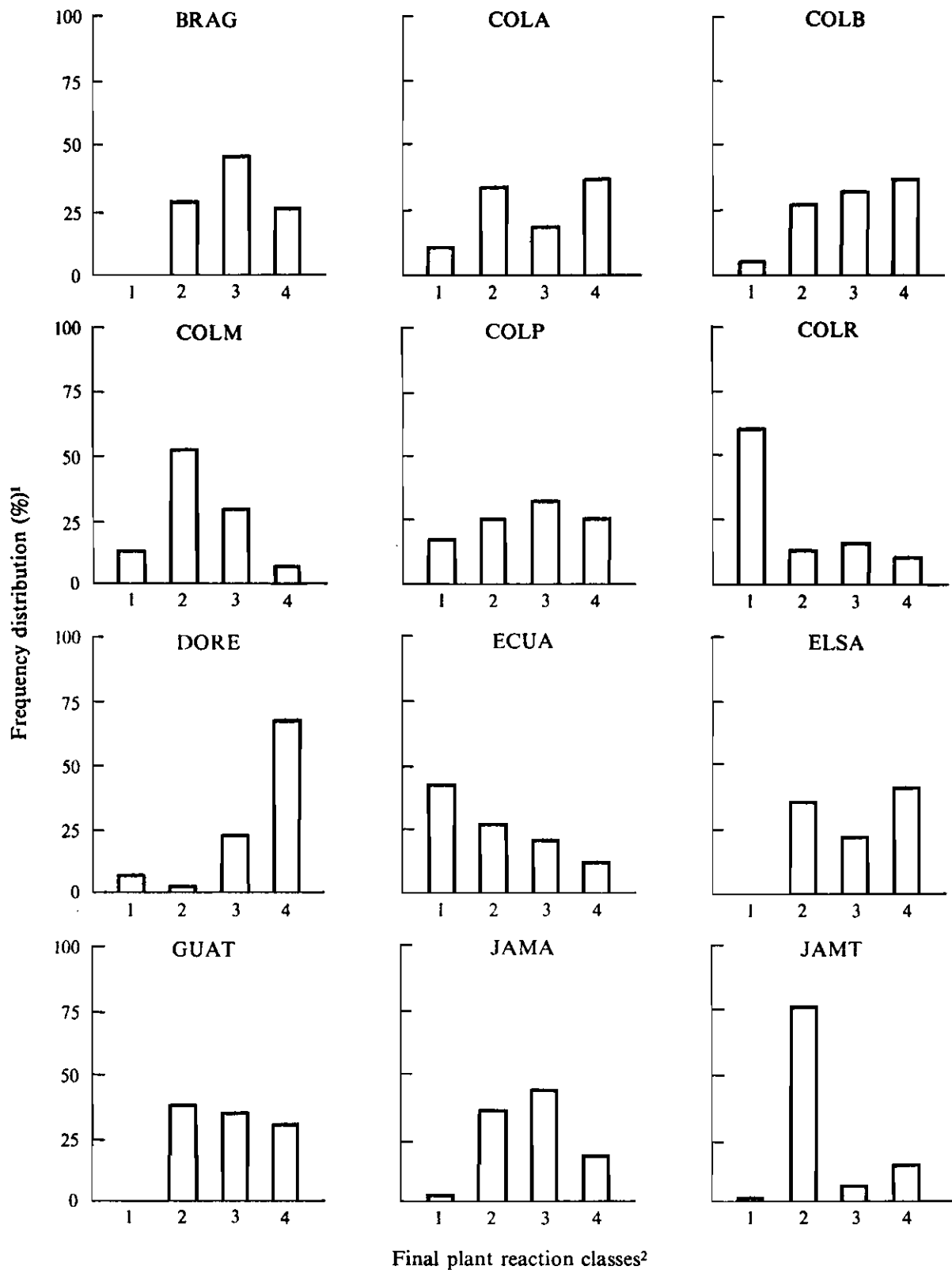
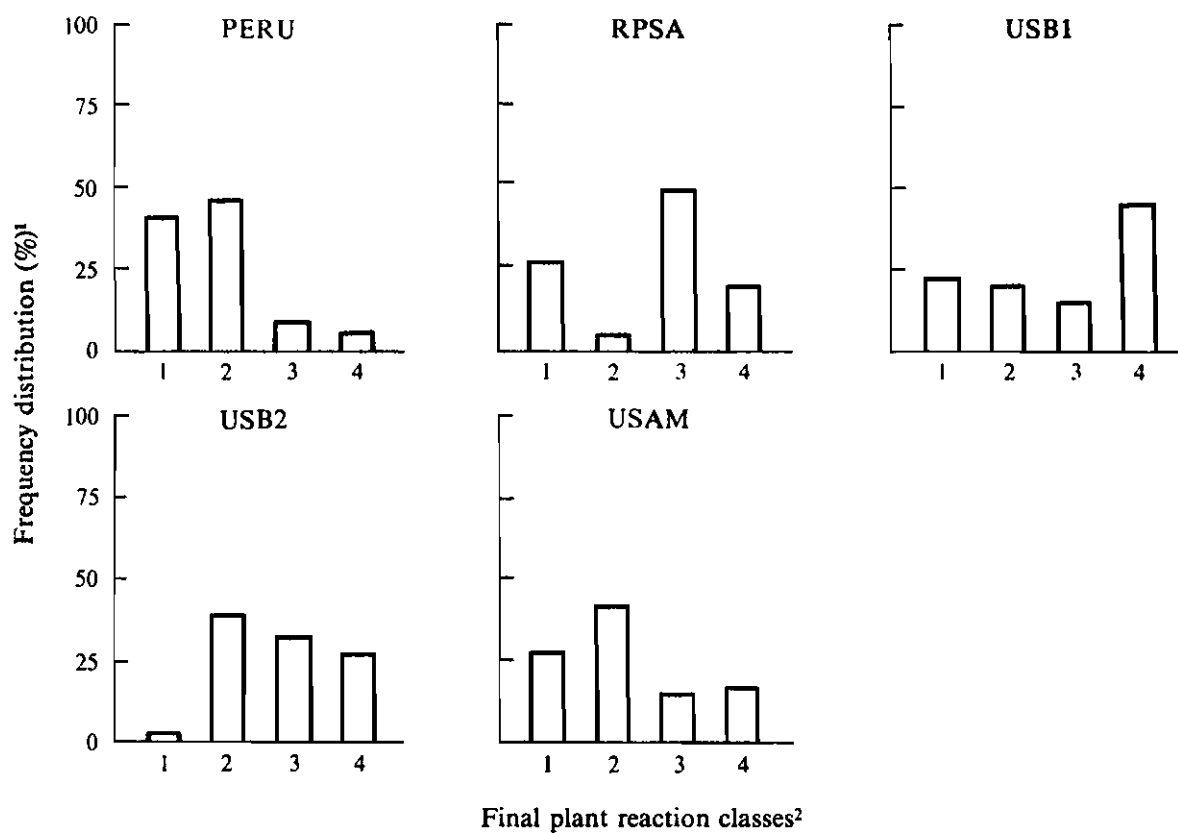


Figure 7. Frequency distribution of the final plant reaction classification values reported for the 41 IBRN monitoring entries in 1977-1978.

Figure 7. Continued.



¹ Frequency distribution calculated by dividing the number of entries in each reaction class (refer to Table 7) by the total number of the 41 monitoring entries actually evaluated at each location and multiplying this value by 100%.

² Final plant reaction classes: 1=immune; 2=resistant; 3=intermediate; 4=susceptible. Refer to Table 1 for explanation of location codes.