Virulence Diversity

of *Pseudocercospora griseola* and its Implication for Breeding Common Bean for Resistance to Angular Leaf Spot

C. Jara[1], M. A. Pastor[2], G. Mahuku[3], and G. Mosquera[1]

[1]CIAT, International Center for Tropical Agriculture, Cali, Colombia; [2]ARS-USDA, Beltsville, Maryland, USA; [3]IITA, International Institute of Tropical Agriculture, Nigeria.

INTRODUCTION

Angular leaf spot (ALS), caused by the fungus *Pseudocercospora griseola*, is one of the most widely spread and damaging diseases of common bean (*Phaseolus vulgaris*) in tropical and subtropical countries (Correa-Victoria, 1988; Liebenberg & Pretorius,1997; Wortmann et al. ,1998).

The "First International Angular Leaf Spot (ALS) Workshop" of common bean was held in 1995 at the International Center for Tropical Agriculture (CIAT), Cali, Colombia, with participating researchers from Brazil, Bolivia, Colombia, Mexico, Costa Rica, and various African countries. At this workshop, the use of an international set of 12 common bean differential cultivars – six Andean and six Mesoamerican – and a binary system for identification of ALS races, proposed by CIAT's Bean Pathology program, was approved. We report the use of this system to characterize a global collection of *P. griseola* isolates and define the race structure of this pathogen.

MATERIALS AND METHODS

During the last 20 years, we have determined the virulence phenotype of 589 monosporic isolates of *P. griseola*, using the established international set of common bean differential cultivars. Nine seeds of each differential cultivar – three plants per pot and three pots per differential cultivar – were established in the greenhouse. The first trifoliate leaf of each plant was inoculated 17 days after planting, using 2 x 10^4 spores/ml of each isolate. Disease evaluations were conducted 10, 12, 14, and 17 days after inoculation, using a 1–9 disease severity scale (Van Schoonhoven & Pastor-Corrales, 1987). Scores of 1–3 were considered a resistance response, 4–6 intermediate, and 7–9 susceptible. The disease reaction scores recorded 17 days after infection were used to determine isolate × cultivar compatibility or incompatibility. Rating scores of 1–3 were considered incompatible or resistant, while ratings greater than 3 were considered compatible or susceptible. Race designation was estimated by summing the binary values of the differential varieties that had a compatible interaction. **Table 1.**

TABLE 1

	DIFFERENTIAL VARIETIES												
	DON TIMOTEO	G 11796	BOLÓN RAYO	MONTCALM	AMENDOIN	G 5686	PAN 72	G 2858	FLOR DE MAYO	MEXICO 54	BAT 332	CORNELL 49242	
	A*	B	C	D	E	F	G	H	I	J	K	L	
ISOLATES	1**	2	4	8	16	32	1	2	4	8	16	32	RACE
Pg11MWI		b***	c	d									14-0
Pg15MWI	a	b	c				g	h	i		k		7-23

*Differential varieties.
**Binary value to determinate race.
***The lowercase letter indicates differential cultivar compatible with isolate.

The first isolate Pg11MWI is considered an Andean isolate of *P. griseola* (Race 14-0) because it can only infect common bean of Andean origin; whereas the second isolate Pg15MWI is a Mesoamerican isolate (race 7-23), which infect both Andean and Mesoamerican bean varieties.

RESULTS

Of the 589 isolates tested, there are 160 Andean and 426 Mesoamerican. Of these, 184 isolates are from Africa; 158 from Central America, and 247 from South America. The distribution of the number of isolates per country is shown in **Table 2**.

TABLE 2

COUNTRY	ISOLATES: ANDEAN	MESOAMERICAN	TOTAL
ARGENTINA	0	2	2
BOLIVIA	0	38	38
BRASIL	1	70	71
BURUNDI	2	0	2
COLOMBIA	78	52	130
COSTA RICA	0	45	45
ECUADOR	6	0	6
EL SALVADOR	0	19	19
ETHIOPIA	1	9	10
GUATEMALA	0	2	2
HAITI	0	19	19
HONDURAS	0	25	25
KENYA	7	20	27
MADAGASCAR	3	0	3
MALAWI	9	27	36
MEXICO	0	14	14
NICARAGUA	0	24	24
PANAMA	0	3	3
PUERTO RICO	0	7	7
R SUR AR	28	9	37
RD CONGO	4	5	9
RWANDA	4	7	11
SWAZILAND	1	0	1
TANZANIA	3	5	8
UGANDA	6	27	33
ZAMBIA	5	0	5
ZIMBABWE	2	0	2
TOTAL	**160**	**429**	**589**

FIG. 1 Figure 1 shows percent compatibility of isolates with differential varieties. The Andean varieties are more susceptible than Mesoamerican varieties.

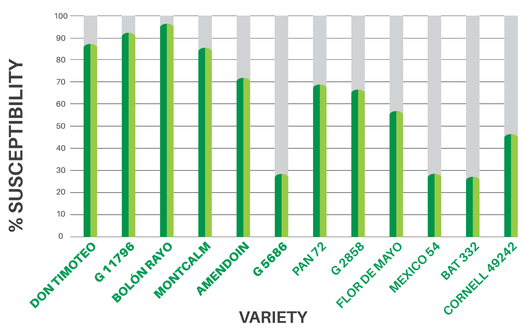


TABLE 3 These isolates (589) originated 134 races worldwide. Only 14 races were Andean and 120 Mesoamerican. The distribution of common and unique races by gene pool and continent is shown in Table 3.

DISTRIBUTION OF 134 RACES OF AFRICA AND AMERICA

	MESOS	ANDEAN	# RACES
AFRICA	29	2	31
AMERICA	75	5	80
BOTH CONTINENTS	16	7	23
	120	**14**	**134**

The race structure of P. griseola from Africa was different from those found in the Americas. The 184 isolates were divided into 54 pathotypes (races), of which 4 were Mesoamerican, 1 Andean and 1 Afro-Andean. Figure 2.

The isolates from South America were divided into 63 races, and these clustered into 6 groups, 1 group contained all Andean races, while the Mesoamerican races were divided into 5 clusters. Figure 3.

These results reveal that Mesoamerican races are more diverse compared to Andean isolates, reflecting the genetic diversity existing within the bean germplasm. Most of the diversity was found in isolates from Central America, and these were clustered into 6 groups. Figure 4.

Figures 2, 3, 4. Three-dimensional graphs based on multiple-correspondence analysis of pathogenicity data from the interaction of *P. griseola* isolates on 12 differential bean genotypes and plotted using the spin platform of the JMP program in SAS. Symbols indicate positions of strains within each cluster.

FIG 2 54 *P. griseola* races were identified from Africa

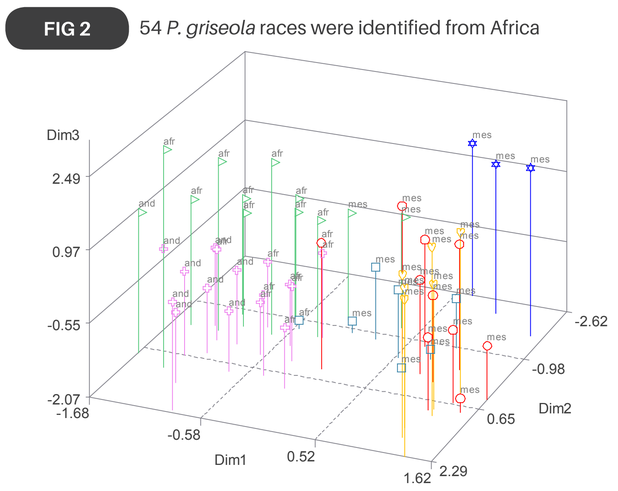


FIG 3 63 *P. griseola* races were identified from South America

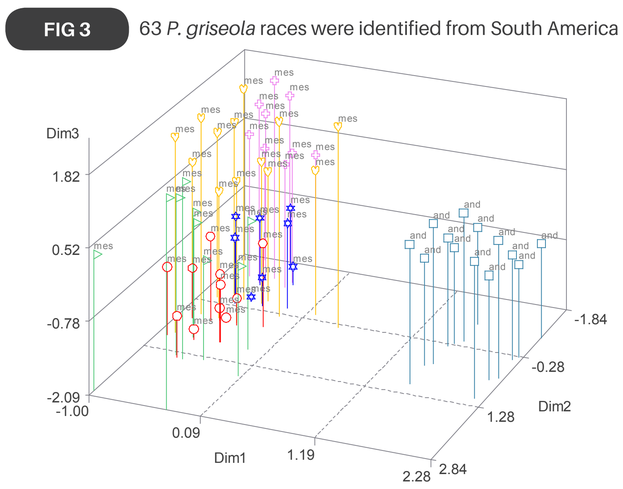
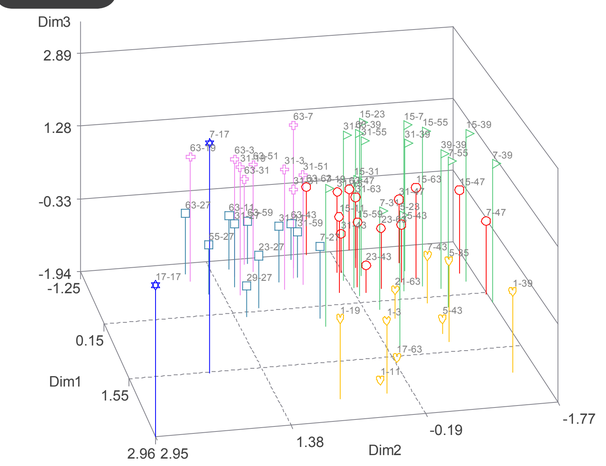


FIG 4 60 *P. griseola* races were identified from Central America



CONCLUSIONS

In total 134 *P. griseola* races were identified worldwide. Of these races, 31 were unique to Africa, and 80 unique to the Americas. The rest (23) were identified in the two continents.

54 *P. griseola* races were identified from Africa, 60 *P. griseola* races from Central America, and 63 *P. griseola* races from South America.

The inoculation of the international set of differential cultivars with 589 isolates of *P. griseola* revealed great diversity of this pathogen in many countries of Central and South America and in Eastern and Southern Africa.

The majority of the Andean differential cultivars are susceptible to the Mesoamerican races of the ALS pathogen from Central America and Brazil. Conversely, the Mesoamerican differential cultivar Mexico 54 is outstanding for its resistance to many races of the *P. griseola* in the world, and most particularly in Africa.

Many races found appear only in a given location, country, or region.

This information has been used to better target the deployment of ALS resistance genes and prolong the usefulness of these genes in the regions where ALS is an important disease.

References

Correa-Victoria FJ. 1988. Pathogenic Variation, Production of Toxic Metabolites, and Isoenzyme Analysis in *Phaeoisariopsis griseola* (Sacc) Fer. PhD thesis. Michigan, USA: Michigan State University.
Liebenberg MM; Pretorius ZA. 1997. A review of angular leaf spot of common bean (*Phaseolus vulgaris* L.). African Plant Protection 3:81–106.
Wortmann CS; Kirkby RA; Eledu CA; Allen DJ. 1998. Atlas of Common Bean (*Phaseolus vulgaris* L.) Production in Africa. Cali, Colombia: CIAT.
Van Schoonhoven A; Pastor-Corrales MA. 1987. Standard System for the Evaluation of Bean Germplasm. Cali, Colombia: Centro Internacional de Agricultura Tropical.

CONTACT Carlos Jara, M.Sc.
Research Associate, Bean Pathology
Agrobiodiversity Research Area
c.jara@cgiar.org

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change