Spring 4-18-2020

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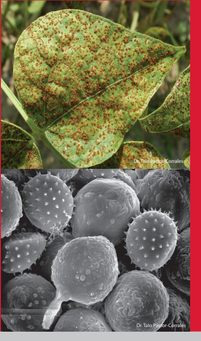
Santos Barrera Lemus

Prabin Tamang
USDA

Carlos A. Urrea
University of Nebraska Lincoln

Marcial A. Pastor-Corrales
USDA, Agricultural Research Service



Reaction of Tepary Beans to Eight Virulent Races of the Rust Pathogen that Overcomes All Known Common Bean Rust Resistance Genes

Santos Barrera[1], Prabin Taming[2], Carlos A. Urrea[1], and Marcial A. Pastor-Corrales[2]

1 University of Nebraska-Lincoln, Panhandle Research and Extension Center, Scottsbluff, NE,
2 USDA-ARS, Soybean Genomics and Improv. Lab., Beltsville Agricultural Res. Center, MD

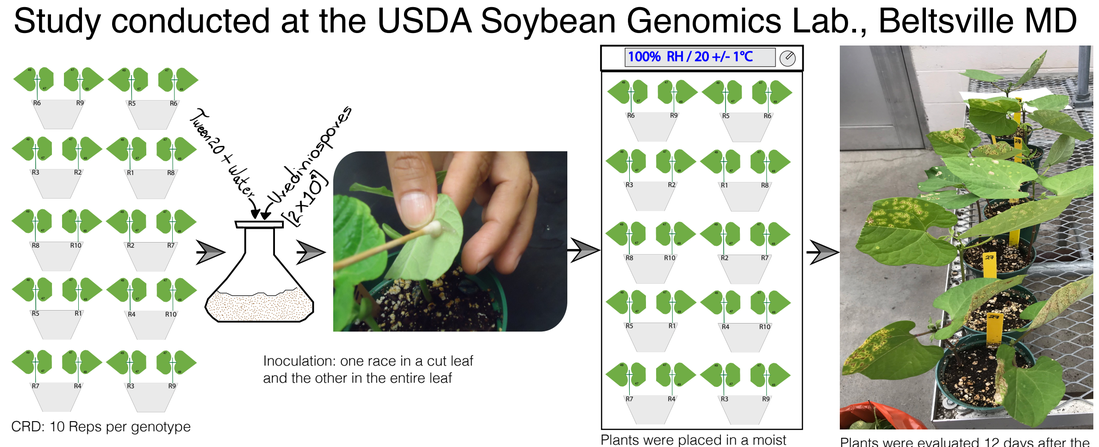
Nebraska Dry Bean Commission

INTRODUCTION AND OBJECTIVES

- Bean rust, caused by *Uromyces appendiculatus*, is a major disease of common and snap bean (*Phaseolus vulgaris*) worldwide (Stavely, 1984).
- Although host resistance is an important component of rust management (Mmbaga et al., 1996), populations of the rust pathogen comprise an extensive and shifting virulence diversity that could render susceptible all known rust resistance genes in common bean.
- Conversely, it has been suggested that certain tepary bean (*Phaseolus acutifolius*) accessions are broadly resistant to bean rust (Miklas & Stavely, 1998).
- The objectives of this study were to verify if tepary beans are resistant to eight races of the bean rust pathogen, which overcome all known rust resistance genes in common bean. Then, to select the resistant genotypes to cross with common beans without embryo rescue.

MATERIALS AND METHODS

- Genotypes: 22 tepary beans, 5 common bean lines, 5 interspecific common-tepary beans lines, and 5 checks
- Rust Races: 6 Mesoamerican and 2 Andean
- Study conducted at the USDA Soybean Genomics Lab., Beltsville MD



CRD: 10 Reps per genotype

Inoculation: one race in a cut leaf and the other in the entire leaf

Plants were placed in a moist chamber for 18 hours

Plants were evaluated 12 days after the inoculation, using Stavely et al. (1983) scale

Figure 1. Research methodology scheme

RESULTS

All common bean checks were susceptible to one or more than one of the bean rust races used in this study (**Table 1**). Conversely, six domesticated tepary beans were immune (1= no visible symptoms) to all eight races (**Fig. 2A**). The immune reaction exhibited by tepary beans is not known to occur in common bean. Two tepary beans and six interspecific (common bean-tepary) were resistant to at least six of eight rust races (**Table 1**). However, they showed typical common bean resistance reactions to rust (2, 2+, 2++=hypersensitive reaction, 3=tiny pustules, f2=faint chlorotic spots without sporulation) (**Fig. 2B, 2C**)

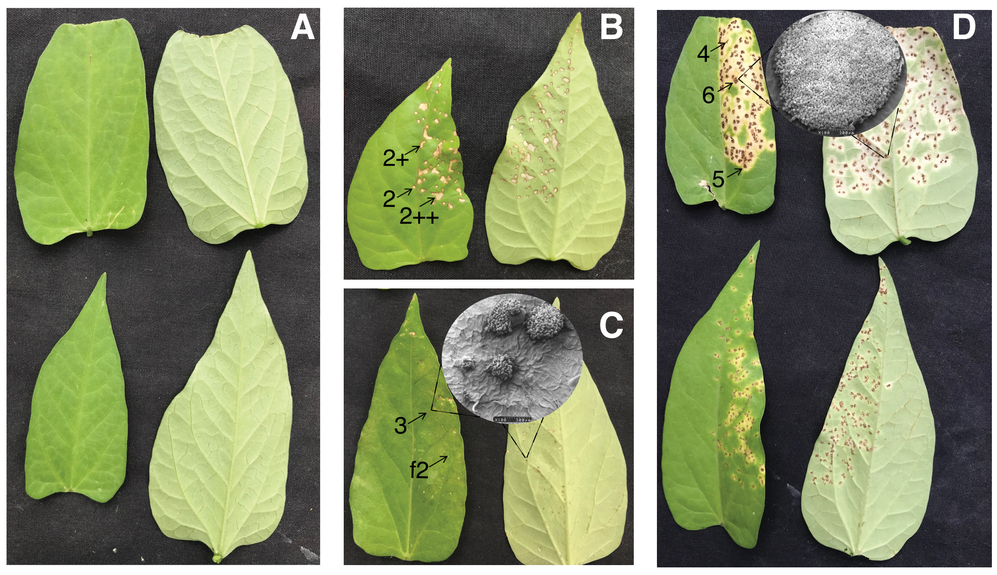
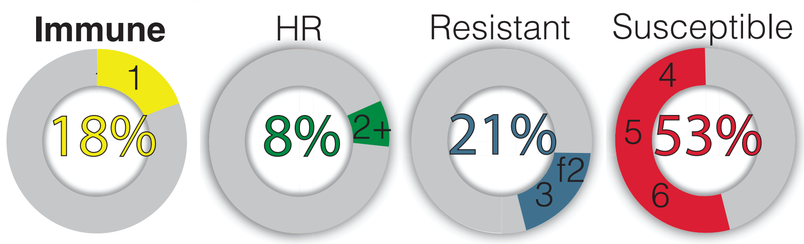


Figure 2. Rust reaction of tepary genotypes: (A) Immune reaction; (B) Resistant hypersensitive reaction (HR); (C) Resistant tiny pustules and faint chlorotic spots without sporulation; (D) Susceptible reaction large pustules

Twelve tepary and four common beans were susceptible to several of the evaluated Mesoamerican bean rust races (**Fig. 2D**). However, most of the evaluated genotypes were resistant to the two Andean rust races, indicating resistance due to the genetic pool.

In sum:



All resistant tepary beans were used in crosses with common bean.

Table 1. Reaction of tepary and common bean genotypes to 6 Mesoamerican and 2 Andean races of bean rust

Genotype	Species	*Uromyces appendiculatus* Races							
		13-3	15-3	22-6	31-1	31-22	22-52	21-0	37-1
Pinto 114	*P. vulgaris*	4, 5	5, 6	4, 5	5, 6	4, 5	4, 5	5, 6	5, 6
Aurora (Ur-3)	*P. vulgaris*	4, 5	5, 4	5, 4	2	4,5	2	2	2
Early Gallatin (Ur-4)	*P. vulgaris*	4, 5	4, 5	2, 2++	4	4	2, 2++	4, 5	5, 6
Golden Gate Wax (Ur-6)	*P. vulgaris*	2,2+, 2++	2, 2++	4	4, 5	4, 5	4, 5	4, 5	2, 2++
PI 181996 (Ur-11)	*P. vulgaris*	f2	f2	f2	f2	f2, 3	5,4	f2	f2
G 40142	*P. acutifolius*	1	1	1	1	1	1	1	1
G 40148	*P. acutifolius*	1	1	1	1	1	1	1	1
G 40161	*P. acutifolius*	1	1	1	1	1	1	1	1
G 40237A	*P. acutifolius*	1	1	1	1	1	1	1	1
TEP 22	*P. acutifolius*	1	1	1	1	1	1	1	1
TEP 23	*P. acutifolius*	1	1	1	1	1	1	1	1
G 40264	*P. parvifolius*	2	3	3	2+	2	3	3	2++
G 40274	*P. acutifolius*	2++	2++	2++	2+	f2, 3	2++	2++	2++
G 40279	*P. acutifolius*	f2	f2	f2	f2	1	1	f2	f2
G 40019	*P. acutifolius*	3	3	f2; 3	3	4	4, 5	f2	2+
INB 834	interspecific	3, f2	3, f2	3, f2	3	4,5	5, 4	f2	f2, 3
INB 841	interspecific	3, f2	3, f2	3, f2	3	5, 4	5, 4	f2	f2
SEF 10	*P. vulgaris*	3, f2	3, f2	3, f2	3, f2	5, 4	6, 5, 4	f2	f2, 3
VAP 1	interspecific	3, f2	3, f2	3, f2	3	5, 6	5, 6	f2	f2, 3
VAP 2	interspecific	3, f2	3, f2	3, f2	3	4, 5	4, 5	f2	f2
VAP 3	interspecific	3, f2	3, f2	3, f2	3	4, 5	4, 5	f2	f2, 3
G 40084	*P. acutifolius*	4, 5	4, 5	4, 5	2	3, f2	3, f2	2	2++
G 40001	*P. acutifolius*	4, 5	4, 5	4, 5	4, 5	f2, 3	f2, 3	f2	3
SMR 139	*P. vulgaris*	4	4	3, f2	3, f2	4, 5	4, 5	3, f2	3, f2
G 40036	*P. acutifolius*	4	4, 5	4, 5	3, f2	4	4, 5	2, 2+	f2, 3
G 40119	*P. acutifolius*	4, 5	4, 5	4, 5	3, f2	4	4	2	2
G 40200	*P. acutifolius*	4, 5	4, 5	4, 5	4, 5	3, f2	4	f2	3
G 40284	*P. acutifolius*	4, 5	4, 5	4, 5	3	4	4	f2	3
SMR 155	*P. vulgaris*	4, 5	4, 5	3, f2	4	4, 5	4,5	3, f2	3
G 40022	*P. acutifolius*	4, 5	4, 5	4, 5	5, 4	4, 5	4, 5	3	3
G 40068	*P. acutifolius*	4, 5	4, 5	4	4, 5	4, 5	4, 5	2	2
TEP 29	*P. acutifolius*	4	4	4	4	4, 5	5	f2	2
SMC 214	*P. vulgaris*	5, 4	4, 5	4	4, 5	5, 4	5, 4	f2	3, f2
SEN 118	*P. vulgaris*	4, 5	4, 5	4, 5	4, 5	5, 4	4, 5	3	3, f2
G 40111	*P. acutifolius*	4, 5	4, 5	4, 5	5, 6	4, 5	4, 5	2	4
G 40173A	*P. acutifolius*	4, 5	4, 5	4, 5	5, 4	4, 5	4, 5	3	4
TEP 32	*P. acutifolius*	4, 5	4, 5	4, 3	4, 5	5, 4	5, 4	4, 3	3

Races 31-22, 22-52, 31-1, 13-3, 15-3, 22-6, are Mesoameican
Races 21-0 and 37-1 are considered Andea

1 = Immune No visible symptoms	Resistant 2, 2+, 2++ = Hypersensitive reaction (HR)
Resistant f2=faint chlorotic spots; 3=tiny pustules	Susceptible 4, 5 and 6 = Large pustules

CONCLUSIONS

- The immune response to bean rust showed by tepary beans confirms its high value as resistant genetic sources for improving common bean
- These results show the presence of new and unique rust resistance reactions in tepary beans that maybe are conferred from different resistance genes.

REFERENCES

- Mmbaga et al. (1996). *Journal of Phytopathology* 144: 533-541
- Miklas & Stavely, (1998). *HortScience* 33: 143-145
- Stavely et al. (1983). *Ann. Rep. Bean Improv. Coop (BIC)*. 26: 4-6.
- Stavely, (1984). *Phytopathology* 74: 339-344

ACKNOWLEDGMENTS

The authors want to express special thanks of gratitude to the Nebraska Dry Bean Commission for the financial support in this research. Also, the authors want to thank Dr. Steve Beebe form the International Center for Tropical Agriculture (CIAT) and Dr. Tim Porch from the USDA for providing the genotypes for this study.