RUST UREDINIOSPORE PRODUCTION AND RELEASE IN RELATION TO LEAF PUBESCENCE IN COMMON BEANS

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Partial resistance or reduced susceptibility also termed "low receptivity" to the bean rus pathogen Uromyces appendiculatus (Pers) Unger is recognized as a component of race-nonspecific resistance (J. Agr. Res. 21:385-404). Genotypes of Phaseolus vulgaris L. with long straight hairs or the abaxial leaf surfaces have reduced rust susceptibility characterized by reduced uredinia size and density on the upper trifoliolate leaves (BIC 33:61-62). Dense hairs on the abaxial leaf surface may interfere with deposition of urediniospores on the epidermis and therefore prevent germ tubes from reaching the leaf stomates and initiating infection (Phytopathology 75:478-81; Phytopathology 79:1036-42). We have observed trapping of urediniospores by dense leaf hairs, but the density of uredinia did not inversely correlate with leaf pubescence. Factors other than leaf pubescence may be responsible for the reduced susceptibility found in trifoliolate leaves. The objective of this study was to determine if the sporulation capacity and the release of urediniospores were involved in partial resistance and if this was related.

The nine genotypes used in this study represented different genetic and geographic origins. Pubescent genotypes were: Alubia 33-1 (A33-1), from an Argentinian landrace; Pompadour Checa 83-30 (PC83-30) and Pompadour Q-5 (PQ-5), from the Dominican Republic landrace; Jamaica Red (J-R) from the Jamaican landrace; Kabanima-5 (Kab-5), from Tanzania; and Diacol Calima (D-C) from Colombia. Glabrous genotypes were Pompadour Q-1 (PQ-1), a glabrous selection of PQ, Kabanima-1 (Kab-1), a glabrous selection of Kab; and Pinto U.I. 114 (P114). Bean plants were grown two per pot pure stand with each genotype in separate pots and as a mixed stand with P114. Primary leaves were spray inoculated with urediniospores from cultures NP10-1 from Nebraska and 87HP2-7#19 from Honduras in a 1:1 (v/v) mixture suspended at 5 μg/100 ml water with 40 mg/1 Tween-20 and incubated at 100% RH and 21 $\pm$ 1°C for 16 h. When 50% of the uredinia had turned brown, infected plants were moved to small growth cages 65 x 65 x 25 cm in size covered with clear plastic, one pot per cage. At 14 days after inoculation, all uredinia had opened and a current of cool air was blown through the leaves using a hair dryer. The air mixing in the cages lasted 3 min and released urediniospores into the atmosphere within each cage. A spore sample was collected on sticky slides placed in horizontal position within each cage. The process of spore release was repeated twice at 3 day intervals and after each occasion, plants were left undisturbed for 30 min. and then moved to incubation chamber to induce infection. The relative amounts of spores released were measured by the mean number of urediniospores on the slide and by the uredinia numbers formed in secondary infection of the upper leaves. Secondary infection was measured by the density and size of uredinia produced on the trifoliolate leaves. Uredinia data was taken on the primary leaves 14 days after inoculation and on the trifoliolate leaves 14 days after the last spore release.

The density of uredinia on the primary leaves was quite uniform across all genotypes, but PQ-1 and P114 had significantly larger uredinia of susceptible (S) category while all other genotypes had moderately susceptible (MS) reactions (Table 1). Secondary infection developed on trifoliolate leaves of all the genotypes, but the size and number of uredinia was significantly lower than in the primary leaves except in PQ-1 and P114. Even though plants grown with P114 stand had a slightly higher density of uredinia than pure stands, the difference was small and insignificant in A33-1, PC83-30, JR, PQ5, Kab-5, DC and Kab-1. Pompadour Q-1 and P114 had significantly higher infection intensity than

the other genotypes. Pompadour Q-1 in pure stand or in a mixture with P114 produced similar results. The amount of spores released by air turbulence was similar in pure stands of A33-1, PC83-30, JR, PQ-5, Kab-5, DC and Kab-1. However, when mixed with P114 the amount of spores released increased by more than 100% in most cases (Table 1). Since increasing the number of spores available for secondary leaf infection did not influence the density of infection in A33-1, PC83-30, JR, PQ-5, Kab-5, DC and Kab-1 reduced susceptibility may partially involve cellular or leaf surface mechanisms. These results indicate that the seven genotypes have several factors that operate together to confer rust resistance in the upper leaves including low sporulating capacity, reduced uredinia size and density and lower cellular susceptibility. All these characteristics are recognized as components of race-nonspecific resistance. It appears however that the resistance is not unique to pubescent genotypes since one of the seven genotypes, Kab-1, is glabrous yet showed reduced susceptibility similar to the pubescent genotypes. The role of leaf hairs in reduce infection intensity has been discussed (Phytopathology 75:478; 79:1036) but the relative significance of the hairs compared to the other resistance components needs to be determined.

TABLE 4. Release of rust urediniospores measured by spore counts on a sticky glass slide and subsequent trifoliolate leaf infection.

Genotype	Pureline (P) or mxied with P114 (M)	Primary leaf infection		Mean no. of spores on glass slide per 13.5 mm^2	Trifoliolate leaf infection-mean uredinia	
		Uredinia size µm	Uredinia No/9 cm^2		No/9 cm^2	Size
Alubia 33-1	P	525.0 bc	39 bc	15.0 ef	17 bcd	279.2 bc
	M	525.0 bc	27 bc	38.0 abc	23 ab	291.7 bc
PC83-30	P	537.5 bc	56 ab	21.2 cdef	4 cd	241.7 bc
	M	525.0 bc	39 abc	29.8 bcdef	9 bcd	216.7 bc
J-Red	P	500.0 c	42 abc	16.2 ef	6 cd	283.3 bc
	M	520.0 bc	45 abc	31.1 bcde	8 cd	250.0 bc
Pomp. Q5	P	550.0 b	24 c	10.4 f	3 cd	204.2 c
	M	500.0 c	4 abc	35.7 bcd	5 cd	291.7 bc
Kabanima 5	P	500.0 c	27 bc	24.8 cdef	16 bcd	300.0 b
	M	550.0 b	26 bc	56.7 a	6 cd	266.7 bc
D-Calima	P	525.0 bc	45 abc	15.5 ef	18 bcd	225.0 bc
	M	525.0 bc	26 bc	33.8 bcde	15 bcd	291.7 bc
Kabanima 1	P	550.0 b	29 bc	28.5 bcdef	5 cd	291.7 bc
	M	525.0 bc	41 abc	45.7 ab	16 bcd	291.7 bc
Pomp. Q1	P	725.0 a	54 abc	46.8 ab	52 a	595.8 a
	M	725.0 a	49 abc	49.0 ab	34 a	608.3 a
Pinto 114	P	700.0 a	54 a	48.5 ab	70 a	566.7 a

Numbers followed by different letters are statistically significant.