Rust Reaction and Pubescence in Alubia Beans

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Abstract. Sixteen Alubia lines (15 with long, straight hairs and one with short, hooked hairs on trifoliolate leaves) derived from single-plant selections made in an Alubia landrace (Argentine) were used to evaluate the relation of abaxial leaf pubescence to reaction to rust in a greenhouse experiment. The pinto cultivar UI-114 (short, hooked hairs) was used as a susceptible check. One plant per pot, replicated six times, in a randomized complete-block design was used. The primary leaves and the sixth trifoliolates of all plants from 12- and 50-day-old plants, respectively, were inoculated with a water suspension of urediniospores (10^5 cells/ml) of rust isolate US-NP85-10-1. Pustule size and rust intensity were assessed 14 days later. No rust pustules were observed on the sixth trifoliolate leaves of the pubescent (long, straight hairs) Alubia lines, but large pustules were observed on the primary leaves (short, hooked hairs) of all Alubia lines and pinto 'UI-114', as well as on the sixth trifoliolate leaf of A-07-2 and pinto 'UI-144' (the latter two with short, hooked hairs).

Some U.S. great northern and pinto bean (*Phaseolus vulgaris* L.) cultivars possess race-specific genes for resistance to *Uromyces appendiculatus* and have glabrous leaves. This type of resistance persists for only a few years. Since the rust pathogen readily overcomes race-specific resistance (Coyne and Schuster, 1975), there is a need to explore alternative types of resistance, particularly those types that operate against all the races of the fungus. A relationship between pubescence and nonspecific rust resistance (Shaik, 1985; Steadman and Shaik, 1988) has been reported in the 'Jamaica Red' and 'Pompadour Checa' bean cultivars. Our objective was to look for additional sources of dense pubescence for use in rust-resistance breeding programs.

Sixteen Alubia lines, derived from bean common mosaic-resistant (NY-15 strain) single-plant selections made in an Alubia landrace (Argentine origin) in 1988 (Coyne, unpublished), were used to evaluate their pubescence in relation to rust intensity. Six plants

of each line were grown in 1.8-liter pots filled with equal parts by volume of vermiculite/sand/Sharpsburg silty clay loam soil potting mixture. Seeds were nicked and planted, one per pot, and pots were arranged in a completely randomized design. Plants were watered daily. A 23 to 26°C temperature regime and 12 hr day/night photoperiod were maintained. All plants were evaluated for abaxial leaf pubescence and reaction to rust. The nodes and the nodal leaves of the 16 lines were numbered sequentially from the bottom to the top of plants. Thus, the primary leaves at node 1 were both considered as leaf 0, the first trifoliolate leaf as leaf 1, and the subsequent trifoliolate leaves as leaves 2, 3, 4, 5, and 6. Only leaves at the 0 and 6 sites on each plant were studied. A 1 to 5 rating scale, on which 1 = glabrous, 2 to 5 = increasing degrees of pubescence, was used to describe hair density (unaided eye assessments). Pubescence ratings were evaluated on fully expanded leaves to eliminate density errors due to degree of leaf expansion.

Primary leaves and the sixth trifoliolates of the 16 lines and pinto 'UI-114' (glabrous susceptible check) from 12- and 50-day-old plants, respectively, were inoculated using a modified crown sprayer (Stavely, 1984) with a water suspension of urediniospores of strain US-NP85-10-1 of *U. appendiculatus* (10^5 cells/ml). The plants were placed in a 100% RH chamber for 18 hr (overnight) in a 23 to 26°C greenhouse. Pustule size and rust intensity were assessed after 14 days of incubation in the greenhouse. Rust intensity was measured as the percentage of leaf area with obviously diseased tissue, including any disease-associated chlorosis and necrosis.

Significant differences were observed among means of pustule size and rust intensity on primary leaves of the Alubia lines (Table 1). The Alubia lines exhibited less-

dramatic increase in hair densities with increasing leaf position than the cultivars Pompadour Checa and Jamaica Red, studied by Shaik and Steadman (1988). All leaves except leaf 0 were covered with long, straight hairs, and no rust pustules were observed on these densely pubescent lines (Table 1), while others found rust pustules with low intensity on 'Pompadour Checa' and 'Jamaica Red' (Shaik and Steadman, 1988), indicating that these Alubia lines are a better source of non-specific resistance to rust. A-07-2 line was an exception, where all leaves including leaf 0 were covered with short, hooked hairs and rust pustules were observed on leaf 6 (Table 1). The primary (leaf 0) glabrous leaves were susceptible to rust (Table 1).

Shaik (1985) first reported negative correlations between leaf pubescence and low intensity of rust pustules on 'Jamaica Red'. Steadman and Shaik (1988) later reported a negative correlation of long, straight hairs on the abaxial leaves of adult plants with rust intensity. The protection offered by the long hairs is greatest when the leaves have not expanded fully. At such early stages, the leaf hairs are close enough to form a mat over the abaxial surfaces on which droplets of water rest without making contact with the leaf epidermis. This phenomenon of water droplets condensing first on the leaf hairs and later forming a water layer was demonstrated by Burrage (1969). Thus, on hairy leaves the rust germ tubes would be unable to make contact with the leaf epidermis (von Alten, 1983).

Since all of the presently grown great northern and pinto cultivars are glabrous and thus probably lack nonspecific resistance to rust, it would be useful to use these Alubia lines in breeding programs to develop great northern and pinto dry beans with nonspecific resistance to rust.

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Table 1. Intraspecific variation of Alubia bean lines (extracted from a landrace) for abaxial leaf surface hairs and for reaction to rust isolate US-NP85-10-1.

Cultivars/lines	Leaf position ^z	Long, straight hairs ^y					Short, hooked hairs ^y					Rust pustule size ^x (µm)	Rust intensity ^w (%)
		1	2	3	4	5	1	2	3	4	5		
Pinto UI-114 (susceptible check to rust)	0	All							All			800	40
	6	All							All			800	40
A-04-1	0	All							All			400	5
	6					All	All					0	0
A-06-1	0	All							All			480	10
	6					All	All					0	0
A-07-2	0	All									All	400	10
	6	All									All	400	5
A-08-2	0	All							All			500	13
	6					All	All					0	0
A-10-2	0	All							All			530	16
	6					All	All					0	0
A-15-1	0	All							All			500	23
	6				All		All					0	0
A-16-2	0	All							All			450	10
	6				All		All					0	0
A-18-1	0	All							All			520	8
	6					All	All					0	0
A-22-1	0	All							All			400	6
	6					All	All					0	0
A-23-2	0	All							All			470	10
	6					All	All					0	0
A-25-2	0	All							All			500	10
	6					All	All					0	0
A-31-1	0	All							All			480	25
	6					All	All					0	0
A-33-1	0	All							All			580	10
	6					All	All					0	0
A-34-1	0	All							All			570	8
	6					All	All					0	0
A-37-1	0	All							All			520	6
	6					All	All					0	0
A-42-2	0	All							All			530	13
	6				All		All					0	0

^zThe primary leaves at node 1 were both considered as leaf 0, the first trifoliolate leaf as leaf 1, and the subsequent trifoliolate leaves as leaves 2, 3, 4, 5, and 6.

^ySee text for description of rating scales for hairs.

^xLSD 0.05 value to compare means of rust pustule size within leaf position 0 for different cultivars/lines = 44.

^wLSD 0.05 value to compare means of rust intensity within leaf position 0 for different cultivars/lines = 4.