Germplasm Enhancement in the United States: the Tropical Connection

James D. Kelly¹ and Phillip N. Miklas²

¹Department of Crop and Soil Sciences, Michigan State University, E. Lansing, MI; ²USDA-ARS, Prosser, WA 99350

The utilization of tropical germplasm in U.S. bean improvement programs is not well documented. The USDA-ARS project in Mayaguez, Puerto Rico, under the tutelage of Dr. Freytag made many significant contributions of enhanced tropical dry bean germplasm that was utilized as parents to improve architecture and disease resistance in temperate breeding programs. Results of these efforts included the development of the upright small seeded navy bean Mayflower, first upright pinto varieties Sierra and great northern Matterhorn, rust resistant B-190, L-226 and L-227 lines, and improved germplasm, possessing multiple disease resistance released by Miklas in later years. The Puerto Rican location provided an alternative selection site for broadening the adaptation of previously locally adapted Durango race beans.

A historical perspective of the utilization of tropical and exotic germplasm during cultivar development of two traditional U.S. dry bean market classes, small red and great northern, is described in detail (reviewed by Miklas, 2000). Both market classes originate from landraces that were grown by the Indians and early settlers. Plant breeders in the early part of the twentieth century made selections from these landraces, for instance the great northern cultivars UI-1, UI-59, and UI-123 derive from the great northern landrace. Crosses between the great northern landrace selections and the common red landrace gave rise to small red cultivars UI-3 and UI-34 in the 1930’s and the great northern cultivars UI-16 and UI-31 in the 1940’s (Coyne 1999; Dean 1994). Crosses between UI-34 and UI-31 or UI-59 gave rise to UI-35, UI-36, and UI-37 small reds in the 1960’s. Numerous crosses were made between these two market classes because the small red landrace possessed resistance to beet curly top virus (BCTV) but was susceptible to bean common mosaic virus resistance; whereas, the great northern landrace provided BCMV resistance but was susceptible to BCTV (Dean 1994). Both viral diseases were endemic to the Northwest region (ID, OR, WA) where small red and great northern beans were being grown at the time.

‘NW-63’ and ‘Rufus’ released in the 1970’s (Burke 1982a) represent the first small reds with introgression of exotic germplasm (PI 203958). The landrace PI 203958 from Mexico contributed root rot (Fusarium solani) resistance to these cultivars, and subsequently to pink and pinto cultivars as well (Burke 1982b; 1982c). Small reds UI-239 and UI-259 (Myers et al., 2001) released in the 1990’s with improved yield potential were derived from crosses conducted primarily among existing small red cultivars.

Recent small red cultivars LeBaron (Hang et al., 2000) and Merlot (Hosfield et al., 2004) developed by the ARS-MSU breeding program in E. Lansing, MI, derive from crosses among northwest small red cultivars, tropical small reds from Central America, and Sierra pinto (Kelly et al., 1990). The small red cultivars and germplasm lines emanating from ARS-MSU possess Ul-3 gene for resistance to rust (Uromyces appendiculatus), I and bc-1genes for resistance to BCMV, upright architecture, and better seed color. The development of these materials benefited from the shuttle-breeding program between MI and PR described above. Similarly ‘AC-Scarlet’ benefited from shuttle breeding between CIAT and Alberta, and likewise contains tropical germplasm.
'Emerson', released in 1971, was the first great northern cultivar with introgression of exotic germplasm (PI 165078). The PI 165078 from Turkey contributed bacterial wilt (Curtobacterium flaccumfaciens) resistance and improved seed quality. Aurora, a small white of tropical ancestry (Cornell 49-242 / Black Turtle Soup), contributed Ur-3 and I genes to the great northern cultivar Beryl (1980). 'Alpine' (Kelly et al., 1992) with rust resistance and upright architecture from Sierra pinto and 'Starlight' with upright architecture, I gene, and rust resistance from Tacaragua, a tropical black bean, represent the next significant introgression events for the great northern class. Alpine and the recent cultivar Matterhorn (1999) were products of the MSU-UPR shuttle-breeding program.

In summary, few introgressions of exotic germplasm were made in the small red or great northern market classes prior to the shuttle-breeding efforts initiated in the early 1990's. Historically, small red and great northern beans have been grown in specific regions, Pacific Northwest for small reds and Idaho and Nebraska for great northern. The cultivars derived from shuttle breeding are more widely adapted and possess better disease resistance and architecture, which essentially enables them to be grown across a wider geographic area. These recent materials contribute genetic diversity, which will facilitate breeding for improved yield potential in the small red and great northern market classes, and may reduce vulnerability of the market classes to emerging diseases. The pioneering effort of George Freytag and Wayne Adams for establishing the shuttle-breeding program, and subsequent efforts by Jim Beaver and Jim Kelly to improve and maintain it, should be recognized.