Is There More Than One Source of the 'I' Gene?

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The inhibitor I gene is a single dominant gene which conditions resistance to all strains of bean common mosaic virus (BCMV). It conditions an immune response to certain BCMV strains but when challenged with a group of necrosis-inducing strains it produces a hypersensitive reaction within the host referred to as top necrosis or black root which usually results in the death of the plant. The gene was first identified and described by Ali (1) in 1950 in the garden bean Corbett Refugee and its derivatives. Since its discovery, the I gene has been utilized extensively by breeders interested in incorporating adequate BCMV resistance into new varieties.

The interesting aspect of this gene is that it occurs fairly extensively in bean germplasm and landraces which have not been developed through any genetic improvement efforts. Why the I gene is found across such diverse bean genotypes and classes has always been of interest. This is unusual for a disease resistance factor which is usually limited to a few genotypes and is only spread by active breeding programs. Many standard tropical black beans appear to carry the I gene although improvement efforts to specifically incorporate the gene were not pursued. Probably the most significant example of the ubiquitous presence of the I gene in black beans occurs with the old vine black turtle soup (BTS) bean. BTS which originated in Venezuela was first introduced into New York and was produced commercially in that state. Since vine BTS was heterogeneous for the I gene, it was reselected in California for agronomic uniformity and BCMV resistance resulting in the release of the T-39 cultivar. It is interesting that the I gene is widespread in the Central American black bean class yet it was first identified in garden beans from the distinct Andean origin.

At MSU the I gene from the Corbett Refugee source was incorporated successfully into both navy beans (Seafarer), kidney beans (Montcalm) and cranberry beans (Cran028). The source of resistance widely used in other U.S. programs was from Corbett Refugee, but none of these programs encountered problems with linkages between the I gene and less desirable traits. However, work conducted at CIAT by Temple and Morales (2) had a very different result. They encountered an absolute linkage between the I gene and color-intensifying genes which condition darker seed coat colors. These color genes produced purple shades when reds were desired. This linkage dramatically slowed the progress of the CIAT program in those countries where light (soft) red or red mottle seed types were desired in combination with BCMV resistance. Similar problems had not been encountered by the MSU program in breeding work involving either red beans from the dark red kidney or cranberry class. The major difference, however, between the two programs lies in the source of I gene utilized. The MSU program used the Corbett Refugee source while the CIAT program used sources available in the black beans. Recognizing that the black beans belong to the Meso-American center of domestication and the Corbett Refugee types belong to the

Andean center, it is interesting to speculate that the I gene or its associations with other traits are different between beans from the two centers.

Despite the near heroic efforts of CIAT staff to break the linkage between the I gene and the color intensifying factors, the association was never broken. Instead, components within the landrace Pompadour beans in the Dominican Republic which had satisfactory red (mottle) color yet possessed the I gene were identified. This finding was made at MSU in cooperative work with the CRSP program at the University of Puerto Rico when attempts were being made to assess all the genetic resistance factors of the Dominican Pompadours. These beans have now become the cornerstone of the CIAT program to incorporate BCMV hypersensitive resistance into the small red Central American types. The interesting aspect of this finding is that the Pompadour belongs to the same Andean center from which the original sources of the independent I gene were first identified. This evidence seems to suggest that possibly two independent sources of the I gene exist and these are associated with the different centers of domestication. It should now be possible to elucidate this theory, utilizng modern molecular techniques of gene mapping using RFLPs. The genes could have evolved independently over the time of domestication of the beans within the two centers. The more likely suggestion is that the I gene, which is associated with certain color intensifying genes in the Meso-American center, has remained independent of these color alleles in the Andean center. This linkage in the Meso-American center could have been broken and different color alleles reassociated with the I gene within the Andean germplasm.

Literature Cited

1. Ali, A. M. 1950. Genetics of resistance to the common bean mosaic virus (bean virus 1) in the bean (Phaseolus vulgaris L.). Phytopathology 40:69-79.

2. Temple, S. R. and F. J. Morales. 1986. Linkage of dominant hypersensitive resistance to bean common mosaic virus to seed color in Phaseolus vulgaris L. Euphytica 35:331-333.