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Dry bean collection from around the world helps Nebraska breeding efforts

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Developing new dry bean cultivars with improved resistance to disease and drought requires a broad genetic base.

That's why University of Nebraska-Lincoln Dry Bean Breeding Specialist Dr. Carlos Urrea has assembled a collection of about 1,900 types of dry bean seeds, some domesticated and some wild, from around the globe.

At the UNL Panhandle Research and Extension Center near Scottsbluff, Urrea uses the bean collection (about 36 seeds of each type) to maximize the size of the gene pool available to his breeding program.

In his molecular laboratory, Urrea and his staff use molecular markers to identify sequences of DNA that control traits such as disease resistance or drought tolerance. Once the DNA sequences are identified, they can be introduced into new cultivars of the market classes commonly grown in Nebraska – great northern, navy, pinto, light red kidneys, and others. The use of molecular markers, a relatively new technique in plant breeding, helps shorten the time it takes to breed new cultivars.

So far, UNL has released one new cultivar out of this effort: NE1-06-12, a great northern with enhanced resistance to common bacterial blight and bean common rust. NE1-06-12 will be marketed as Coyne.

Urrea is using the core collection to provide the largest pool in which to search for genes that control resistance to other diseases, such as bacterial blights, fungal diseases, and viral diseases. A graduate student who is working at the Panhandle Center, Jorge Venegas, has found the gene that provides resistance to rust, as well as the molecular marker tied to the gene, Urrea said.

"We have to have knowledge, access, and use all of the diversity available in cultivated beans and their wild relatives," Urrea said.

The range and variety of dry edible beans might surprise consumers who usually see white beans, pintos, kidneys and a few other types on their plates. The common bean was first domesticated in central and south America more than 7,000 years ago, according to the Jefferson Institute, before moving northward through Mexico and into North America. Today Nebraska is among the national leaders in dry bean production. The state ranks first in Great Northern beans and second in the volume of pintos produced in 2007, according to the Nebraska Department of Agriculture.

UNL hired Urrea in 2005 as dry bean breeding specialist. He is based at Scottsbluff, in the heart of the state's dry bean industry.

Urrea's core bean collection comes from two organizations. About 1,400 cultivars come from CIAT, the International Center for Tropical Agriculture at Palmira, Colombia. More than 400 come from the USDA Agricultural Research Service Western Regional Plant Introduction Station at Pullman, Wash.

The collection can be divided into primary, secondary and tertiary gene pools. The primary gene pool for dry edible beans consists of domesticated cultivars plus some wild beans that are closely related. The secondary gene pool consists of runner beans that are more distant relations to domesticated dry edible beans. The tertiary gene pool is made up of small beans, originating from the southwestern United States and points to the south, which might be sources of drought tolerance traits.

If a desirable trait cannot be found from the beans in the primary gene pool, Urrea and his team look in the secondary pool, then the tertiary. It is more complicated to cross-breed beans from the secondary and tertiary gene pools with domesticated dry bean cultivars, Urrea said. All of the beans from USDA belong to the primary gene pool. Of the CIAT beans, 1,279 are of the primary gene pool, 71 secondary, and 244 tertiary.

The core collection is grouped by seed size, seed shape, center or origin and primary center of domestication. The collection consists of representatives of each of the various groupings. For example, Urrea said, there are three races of beans from each center of origin.

Great northern and pintos, the most common market classes grown in western Nebraska, come from the Middle America center of domestication and belong of the Mesoamerica race. They originated in Central America, from Mexico

to Guatemala. Large red kidney beans, another market class grown in this area, are of the Nueva Granada race, originating in Andean South America, from Colombia all the way to Patagonia.

One of Urrea's current projects is to look for the source of resistance to bacterial wilt. First he tested all the beans from the USDA collection, which represents all of the variability in domestic dry beans all the way from the U.S. to Argentina. Of the 405 entries, he found one that looks promising. Tests are being repeated for that cultivar.

Recently he planted more than 800 bean types from the CIAT collection. Like the USDA beans, these will be inoculated with the disease and then each cultivar checked for resistance.

The gene that confers the resistance will come from a wild bean, Urrea said. But wild beans are smaller than domesticated species. Getting the key gene sequence from a wild bean into a great northern bean with the required seed size would take five years using regular hybridization, working year-round in a greenhouse. First the wild bean is crossed with a cultivated bean, then it is "back crossed" for eight to 10 generations with the cultivated bean.

Using molecular markers to identify the gene sequence shortens the period required to isolate the genes responsible for the trait.



Several of the dry bean types represented in Dr. Carlos Urrea's core collection of about 1,900 types of dry beans: In the column on the left are two types of wild beans. The seeds are smaller than domesticated beans, but they belong to the primary gene pool, which can be readily crossed with domesticated beans in the primary gene pool. In the second column are several domesticated cultivars from the primary gene pool, including Great Northerns at bottom. In the third column are several domesticated cultivars from the secondary gene pool, and in the fourth column are several domesticated cultivars from the tertiary gene pool. Beans in the secondary and tertiary gene pools are more difficult to cross with those from the primary gene pool, but they may hold some genetic traits, such as drought tolerance, that will help the dry bean industry in western Nebraska.

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Dry bean breeding specialist Dr. Carlos Urrea checks on some of the 800 bean types from the CIAT collection planted in a greenhouse at Scottsbluff. The bean types will be checked for resistance to bacterial wilt.