

Breeding of Two Food Grain Legume Crops

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Introduction

Mungbean (*Vigna radiata*) L. Wilczek and Urdbean (*Vigna mungo*) are important pulse crops worldwide. These commonly are referred to as green gram and black gram, respectively. Figure 1 shows green gram seed.

The two crops have been a significant addition to the diet in Southeast Asia since ancient times, and more recently have become mainstream in North America with use in plant-based protein diets and food products. Mungbean was domesticated in India through selective breeding by local farmers. Currently, mungbean is primarily grown in Southeast Asia, Africa, Australia, and South America. These were produced in America in the 1830s as Chickasaw pea. Most of the mungbean production in the U.S. currently is in Oklahoma. However, some also is grown in Kansas, California, Tennessee, Kentucky, and Texas.

Mungbean and urdbean are short-season (60-90 days) legume crops that can serve multiple uses. These include as a cover crop, a rotational crop, double crop, and a source of food. The other attractive features of this crop are its neutral taste, high nutritional value, easy digestibility, crop demand, tolerance to drought, and many more.

Materials and Methods

In 2017, the Mungbean Breeding Program (MBP) at ISU was started to develop mungbean cultivars as part of the crop diversification efforts in Iowa and the entire

Midwest region. The MBP advances research on mungbean adaptation's suitability in the Midwest region while meeting stakeholders' needs.

In 2017, about 3,000 mungbean and 300 urdbean accessions were obtained from the United States Department of Agriculture (USDA) germplasm collection bank, Griffin, Georgia. These lines underwent extensive field evaluation in Iowa, with 482 mungbean and 30 urdbean lines selected for further research and development. The 482 mungbean lines were sent for genome sequencing to correlate regions in the genome with specific traits, to identify genes responsible for the traits of interest so targeted breeding could occur. Some of the traits of interest and study includes days to flowering, plant height, maturity, seed weight, plant growth habit, lodging, pod shattering, number of seeds/pod, seed quality, protein content, diseases, leaf morphology, and pest resistance. The initial work suggests mungbean farming will easily fit, with minimal adjustments, into the current farmer agriculture and equipment used by soybean farmers. More research is needed to understand field management practices that must be met for farmers to cultivate mungbean in the Midwest region.

Results and Discussion

Mungbean has burst onto the market and is available in many products. Sprouts are a more commonly known form of mungbean and have been eaten around the world and the United States for many years. In recent years, more products have been developed using mungbean as a source of protein. [Beyond Meat](#) is a company that has developed a plant-based meat substitute. Another company using mungbean is [JUST Egg](#), to make an egg substitute. Products include a liquid egg substitute, an egg prepared sous vide, and a

precooked folded egg. Figures 2 and 3 show products from Beyond Meat and Just Egg company products.

Protein substitutes are not the only way mungbean can be sold. Other companies also are actively using mungbean. For instance, these have been used to make nut-free peanut butter. A brand of nut-free peanut butter made from mungbean is [NotNuts](#) as seen in Figure 4 (a). It is available in many varieties. There also is a snack made from mungbean called “[Crunchsters](#)” as seen in Figure 4 (b). Urdbean is being used to make chips and pasta. Figure 5 shows an urdbean product, [BAM](#).

The market for mungbean and urdbean products is growing and more companies are looking at ways to use this crop. The MBP has been working to develop crop varieties that can grow well for United States farmers so they can compete in this market.

2020 Field Season Research Summary

In the 2020 field season, there were three main field trials—yield performance trials, diversity panel for genomic studies, and early generation breeding bulk trials.

Approximately 2,000 plots of diversity panel were planted at two locations with nearly 500 old lines under testing. This panel allowed researchers to evaluate existing mungbean lines and select lines that have valuable traits to integrate into the yield lines. The yield trial, also planted at two locations, had fewer genotypes that come from the past two years of selection for yield performance. The purpose of this testing was to assess the performance of potential varieties in a more

agriculturally relevant environment. Selected lines will be planted again in 2021 and researchers will continue to select lines that perform best for farmers and have desired traits for commercialization. Breeding populations also were tested to develop new varieties in the coming years, by making plant selections.

Researchers are looking at ways to grow the testing sites and looking for farmers who would be interested in growing yield tests. The MBP is continuing to grow, and each season research moves closer to releasing a cultivar that is adapted to the United States, so farmers can tap into the growing plant-based protein food market that commands higher selling price premiums.

Mungbean, urdbean, and soybean share several common features—capability to fix atmospheric nitrogen so no additional N application is required, can be machine harvested with same combine, and share similar disease and insect-pests. This implies research done on breeding for diseases and insect pest in soybean also can be useful for mungbean and urdbean breeding.

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Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee, warranty, or endorsement by Iowa State University and does not imply approval at the exclusion of other products that may be suitable.



Figure 1. Mungbean seed.



Figure 2. Mungbean used as an ingredient in plant-based meat, Beyond Burger. Image Source: <https://www.beyondmeat.com/products/the-beyond-burger/>.



Figure 3. Mung bean protein isolates in “Just Egg.”
Image Source: (<https://www.ju.st/>)



Figure 4 (a) Mungbean based no nut butter. Image Source: <https://www.aegic.org.au/pulse-innovation-leads-to-nut-free-peanut-butter/> (b) Crunchsters snack .Image Source: <https://www.crunchsters.com/>.



Figure 5. BAM Urd bean chips and pasta.
Image source: <https://bamsnacks.com/>