Stories of change

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Blending cutting edge science with farmers' know-how to improve food security in Colombia

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Key messages

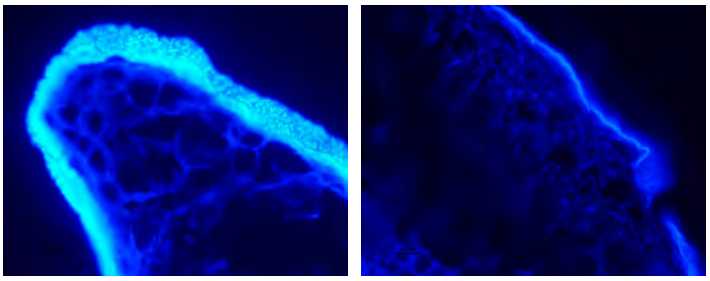
- Researchers identified new genes for resistance to late blight disease in potato employing advanced genomics and chromatographic technologies. Some of these genes are present in three new cultivars that were developed in this project: Criolla Sua Pa, Criolla Dorada and Criolla Ocarina. These genes can now be used to replace susceptible genes when breeding new varieties.
- Participatory research by native farming communities and researchers led to the production and selection of the three new yellow potato cultivars with higher yield and nutritional qualities than the commercial cultivar Criolla Colombia.
- The new cultivars have higher resistance to late blight disease than Criolla Colombia. This will reduce the number of fungicide applications, thus reducing adverse environmental impacts and leading to better health.

Context

In rural Colombia, most families own small farms (less than three hectares) on which they chiefly grow potatoes. With such a limited land area, planting high yielding varieties is vital, in order to obtain adequate yield for both consumption and sale. However, the reality for many farmers is very different. In Nariño department, the *Improving Potato Production for Increased Food Security of Indigenous Communities in Colombia* project worked with native communities in five municipalities for whom malnutrition is a serious problem. These families grow yellow potato varieties that have low yield and low resistance to late blight, a devastating disease that causes heavy losses in potato yield. Despite spraying their crops up to 15 times a season in order to control the disease (a practice in itself both expensive and hazardous) their yields remain low. This, combined with a nutritionally poor diet, leads to poor health and high rates of iron deficiency, especially in small children.

In seeking to address this problem, the Universidad Nacional de Colombia and McGill

University, in collaboration with New Brunswick University, worked in the field with the farming communities, and in the laboratory using advanced scientific techniques, to develop new yellow potato varieties. Project researchers identified potato genes that enhance resistance to late blight disease and increase the nutritional content. This led to the development of new potato cultivars, now released, which have improved yield, nutritional qualities and health benefits. Preliminary findings even suggest that the consumption of these yellow potatoes can slow down the growth of colon cancer cells and improve the body's capacity to fight other important human diseases.



Cell wall of a resistant potato variety | *Cell wall of a susceptible potato variety*

Figure 1: Potato stem sections showing thick cell walls in late blight resistant cultivars that prevent the spread of the disease

Emerging outcomes

Identifying and developing potatoes with resistance to late blight

Conventional breeding methods to improve disease resistance are both expensive and take a long time. Using advanced chromatographic and genome sequencing technologies, project researchers identified potato genes that enable certain potato varieties to resist late blight. The genes were responsible for the production of chemicals in the plant that led to the building of thicker cell walls; this reduced the disease severity (Figure 1). Researchers found that new cultivars selected by the project contained some of these natural genes, and therefore had higher levels of resistance to late blight.

In participatory research with the Nariño communities, the project tested 30 genotypes and from them selected three potato cultivars: Criolla Sua Pa, Criolla Ocarina and Criolla Dorada. These were found to have higher yield, a better response to fertiliser, and greater resistance to late blight due to the newly-identified resistant genes (Figure 2). For instance, compared to the most cultivated commercial cultivar (Criolla Colombia), Criolla Sua Pa yielded up to 15% more and Criolla Dorada was more than twice as resistant to late blight (Figure 2).

All three cultivars were registered with the national seed certification authority, and six tons of certified seed potatoes of the new varieties were distributed to 650 farming families for multiplication. This seed material is being marketed initially to nearby communities in Nariño

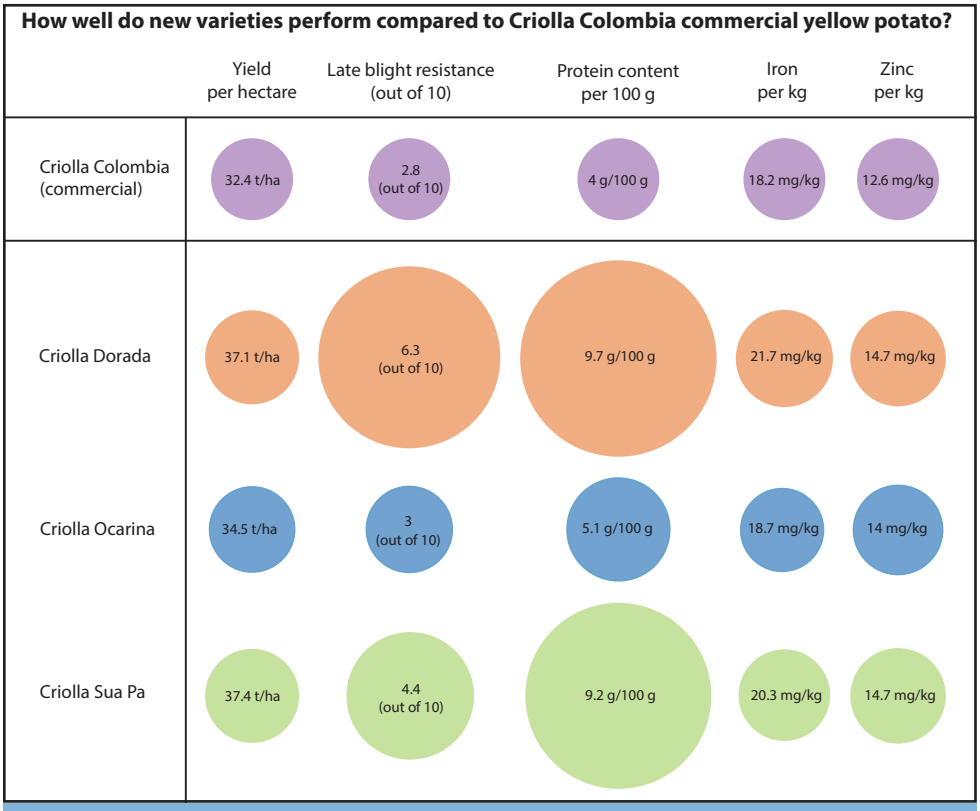


Figure 2: Yield, resistance to late blight, protein and minerals in new yellow potato varieties compared to the most cultivated commercial variety, Criolla Colombia

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The new potato cultivars have the potential to improve the daily nutrition and long-term health of communities

department. Higher yields will allow farmers to have surplus potatoes, which can be sold to increase household income. This surplus can be transported countrywide, enabling many more farmers to adopt the new varieties and potentially having a significant impact on the nutrition of the Colombian population.

Improved nutrition and health

The new varieties provide double the amount of protein, and nearly 20% more iron and zinc than the Criolla Colombia cultivar. Preliminary results from clinical studies have found 10.6% less iron deficiency in children that consumed the improved potatoes compared to those that consumed other varieties. Thus, the new potato cultivars have the potential to improve both the daily nutrition of communities and their long-term health.

In addition, the new potato varieties contain several plant chemical compounds that could offer major health benefits. These include chlorogenic acid, which reduces colon cancer and cardiovascular diseases. A meal-sized portion of the best potato variety was tested in an artificial gut which mimics the human digestive system. The potato was found to release significant quantities of chronic disease-ameliorating molecules, capable of being absorbed into the blood. In fighting disease, these molecules have the potential, both within the colon and other parts of the body, to slow down the growth rate of cancer cells and other disease conditions. Further research, to investigate the actual impact of potato consumption on disease prevalence within the communities is now needed.

Improved knowledge of potato selection and production

An educational booklet on good agricultural practices was produced and used to educate more than 320 families via Farmer Field Schools (Escuelas de Campo de Agricultores - ECA) in Nariño department. Through this educational program, the communities learned improved methods for growing the three new cultivars and one commercial cultivar. As a result, they achieved higher yields, more efficient, locally-adapted fertilizer application, and a halving of the number of fungicide applications per season. In addition, their potato crops also benefited from an improvement in flavor, confirmed by an expert panel. By adopting good agronomic practices such as recommended fertilizer application and late blight control with less fungicide, the communities learned how to improve their yields while reducing their production costs.

Conclusion

Through their joint efforts, researchers and communities selected three new potato

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To select the best cultivars, farmers and researchers worked together

varieties with higher yield, nutritional content and late blight disease resistance. Adoption and consumption of these potatoes has the potential to reduce chronic diseases and lessen the environmental impact of potato production, through reduced fungicide usage.

The project also generated significant research knowledge that will continue to provide benefits. The project's Colombian research team, for example, can now employ several state-of-the-art technologies which will enable them to produce more high value cultivars and continue to deliver them to the native communities. The advanced technologies which enabled the identification of novel genes for resistance against late blight can, in future, be used to combat other diseases and pests, both in potatoes and other crops. Through the use of 'cisgenic' technology (whereby genes found within the same species of plant are transferred to create new cultivars), the researchers will be able to incorporate disease-resistant genes in otherwise desirable plant types, thereby increasing farmers' productivity not only in Nariño but nationwide.

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Communities learned how to improve their yields and reduce production costs

References

- IDRC. *Improving Potato Production for Increased Food Security of Indigenous Communities in Colombia*. http://bit.ly/13jbepj.
- Pushpa, D., Yogendra, K., Gunnaiah, R., Kushalappa, A.C. and Murphy, A. (2014). Identification of Late Blight Resistance Related Metabolites and Genes in Potato Through Non-targeted Metabolomics. *Plant Molecular Biology Reporter*, 32: 584-595.
- Rodriguez, L.E. and Tinjaca, S. (2014). *Informe de Resultados, Pruebas de Evaluación Agronómica (PEA) de Genotipos de Papa Criolla (Solanum tuberosum Grupo Phureja) Para la Región Natural Andina, Subregión Natural Nudo de los Pastos*. Universidad Nacional de Colombia, Facultad de Ciencias Agrarias. Bogotá, Colombia.
- SAN Nariño Project Website. http://bit.ly/1sdUFQf.
- Yogendra, K.N., Kushalappa, A.C., Sarmiento, F., Rodriguez, E.L. and Mosquera, T. (2014). Metabolomics Deciphers Quantitative Resistance Mechanisms in Diploid Potato Clones Against Late Blight. *Functional Plant Biology*. http://bit.ly/1vhGPUS.
- Yogendra, K.N., Pushpa, D., Mosa, K., Kushalappa, A.C., Murphy, A. and Mosquera, T. (2014). Quantitative Resistance in Potato Leaves to Late Blight Associated with Induced Hydroxycinnamic Acid Amides. *Functional and Integrative Genomics*, 14: 285-298.
- YouTube. (2014). *Mejores Papas Para la Seguridad Alimentaria en Colombia* (with English subtitles). http://bit.ly/1vHxtvZ.

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