RSC SRC


Leon Kochian
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## Notice académique

Leon Kochian's pioneering research launched international advances in acid-soil crop adaptation, as acid soils greatly limit developing country agriculture. He also demonstrated how larger root systems enhance crop yields, by improving fertilizer/water acquisition, and discovered genes that enhance plant nutrient health and limit heavy metal entry into the food chain. The Canada Excellence Research Chair in Food Security, he is also one of the most highly cited plant scientists, worldwide.

## Évaluation détaillée

Dr. Leon Kochian is one of Canada's most influential and innovative plant scientists and holds the Canada Excellence Research Chair in Food Systems (2016-25). He is professor of Plant Sciences at the University of Saskatchewan (USask), and associate director of the Global Institute for Food Security (2016-2023). Throughout his time at USask, Kochian has advocated for cross- college collaboration in all disciplines within the university's unique array of research facilities, and has been instrumental in recruiting international world-class scientists to his team. His award-winning research has led to major discoveries in root biology and mineral ion transport to improve crop resiliency and climate change adaptation and amelioration.

Kochian was a professor of Plant Biology at Cornell University for over 30 years, and as director of the Robert Holley Center for Agriculture and Health (2008-2016), his leadership increased the center faculty from seven to 25, the budget from $7 million to $15 million/yr and successfully recruited two professors who were recently elected to the US National Academy of Sciences. Kochian has given over 180 keynote talks and published over 270 publications (first/corresponding author on 206) in top journals, including *Nature, Nature Genetics, PNAS, Plant Cell, Molecular Plant* and *Plant Physiology*. He is one of the world's most highly cited researchers (50,296 times) and has an H-Index of 121. Kochian is recognized as one of the world's top scientists, named to Thomas Reuters and then Clarivate's lists of "Most Influential Scientific Minds" in Plant and Animal Science a number of times between 2002 and 2018, named to the Stanford University/Elsevier's Top 2% Scientist Rankings (2017, 2020, 2021, 2023), and was ranked by Research.com as the #1 scientist in plant science and agronomy in Canada (2023,

2024) and the 31st (2023) and 29th (2024) ranked plant scientist/agronomist, worldwide. Kochian received the prestigious Arrell Global Food Innovation Award (2019), which recognizes global excellence in food security, innovation and community impact. He also is a Fellow of the American Association for the Advancement of Science (2008), the American Society of Plant Physiologists (2007), and was elected to the Agricultural Research Service Hall of Fame (2016).

Kochian has been awarded over $60 million in funding from Canadian and US agencies. He has a strong commitment to training the next generation of scientists, having graduated 24 PhD and MSc students, and trained 62 Postdoctoral Fellows and Research Associates. Many of his mentees have since been hired at top universities, government labs and industry, and became world class scientists themselves. These include Dr. David Jones, professor of Environmental Science, Bangor University, Wales (H-Index 129); Dr. Peter Ryan, CSIRO Agriculture and Food, Australia (H- index 74); Dr. Patrick Brown, Distinguished Professor at Univ Calif, Davis (H-index 74); and Miguel Pineros, USDA-ARS and Cornell University Associate Professor (H-index 45).

As a world-leading plant molecular physiologist, Kochian has pioneered novel approaches to discover ion transport genes that improve crop performance. A major problem in developing countries is the solubilization of toxic aluminum (Al) ions from clay minerals in acidic soils, that comprise ∼40 per cent of the world's arable lands. Al toxicity on acid soils reduces crop yields by nearly 70 per cent, due to root damage and reduced root growth. These crop losses have devastating effects on producers around the world. Kochian led an international team that isolated one of the first Al tolerance genes. This gene was cloned in major crops for tropical Africa, South America and Asia. The discovery of the gene in sorghum, *SbMATE* (See CV, Patent 1), and its maize homolog, *ZmMATE1*, allowed normal root growth (Magalhaes et al, *Nature Gen.*39:1156), which virtually eliminated the threat of root injury and supported thriving crop yields. This paper was cited an impressive 884 times and Kochian was first author on the seminal reviews on crop adaptation to acid soils in three *Ann Rev Plant Biol* journals published over three decades (Kochian et al. *Ann. Rev Plant Biology*, 1995; 2004, and 2015). These reviews were cited 2600, 2300, and 995 times, respectively. Building upon this discovery, Kochian worked with sorghum breeders to introgress superior versions of *SbMATE* into Al sensitive sorghum. Field trials with these improved lines showed a 30-50 per cent yield increase on acid soils, providing strong evidence that these genes were essential for breeding Al tolerant sorghum and maize.

Kochian is also recognized for discovering new approaches for the rapid identification of plant transport genes underlying important agronomic traits. Which resulted in cloning of the first plant genes via complementation of yeast mutants. He was part of a team using yeast complementation with plant gene libraries to clone the first plant potassium ($K^+$) transport gene, that opened up the cloning of hundreds of other plant transport genes, and revolutionized plant transport biology. Kochian also identified genes for transport proteins that absorb the essential micronutrient ions, (e.g., iron, magnesium and zinc), as well as root uptake of toxic metals/metalloids (e.g., cadmium, arsenic), and therefore into the food chain. This discovery opened up possibilities for reducing heavy metal accumulation in edible plant tissues, and was also used to develop plants that can phtoremediate or "clean up" soils contaminated by heavy metals. Kochian's research in this area helped trigger interest in new plant-based industries such

as, Edenspace Inc. (formerly Phytotech, Est. 1996). a phyoremediation company which uses innovative bioengineered plants to clean up contaminated environments. Edenscape's first hire was Kochian's finishing PhD student, Dr. Jianwei Huang

Kochian is also a leader in discoveries on the role of root system architecture in improving several areas of plant health and overall production, and reducing environmental pollutants. His research demonstrated that more extensive root systems can play key roles in efficient mineral nutrient and water acquisition, a significant finding for improving agricultural sustainability, and reducing the carbon and environmental footprint of crop production by reducing certain fertilizer inputs. For example, Kochian showed that plant cultivars having larger root systems had enhanced phosphorus (P) acquisition in low P soils. He also discovered that these cultivars with larger root systems were a win-win situation for growers, as the larger root systems also conferred enhanced nitrogen (N) acquisition in low-N soils, and improved performance under drought (Liu et al., *aBiotech* 4: 315). Since larger root systems absorb more N and P fertilizer, this can result in major reductions in fertilizer costs, and decreased environmental costs from N and P runoff into surface and ground waters. Kochian's lab also pioneered the development of root imaging platforms that quantify root traits in two- and three- dimensions. These platforms greatly speed up root imaging and root trait quantification on thousands of cultivars in a crop species (Clark et al *Plant Physiol* 2011; 2013; Chandnani et al, *Plant Phenomics* 5:), enabling genetic mapping of genes enhancing root system size. This critical advancement supported Kochian's goal of developing the resources to help plant breeders better understand the, "hidden-half of the plant," the root system, to successfully increase yield and largely reduce devastating environmental impacts from toxic metals.

Kochian has held several important leadership roles throughout his career. Of note, as member of the Executive Committee, American Society of Plant Biologists (ASPB), the world's largest plant scientific organization, he was able to build strong links between ASPB and African scientists, to promote growth in the agricultural sciences in Africa. This involved organizing and leading large workshops in 2011 in Nairobi and Mali, where African scientists were trained in molecular breeding as well as bringing 20 African scientists to the annual meeting to connect with ASPB scientists and develop collaborative research links.

Projections show that food production must double by 2050 to feed the world's growing population. Kochian has proven himself one of the world's most influential scientists addressing food security. His work has made monumental impacts on how growers and producers look at growing the food we eat to nourish our lives. His knowledge continues to flourish and create positive change with the influence of his mentees, students and team of dedicated scientists