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Short note

CELEBRATING THE ANNIVERSARY OF PLANT PHYSIOLOGIST LEONIDA NOVICKIENĖ

This year, in July, plant physiologist, habilitated doctor Leonida Novickienė celebrated her anniversary. She was a long-time collaborator of the famous Lithuanian plant physiologist Alfonsas Merkys. Forty years of their joint work left a bright mark on the development of the science of plant physiology. Based on Leonida Novickienė's research, the field of plant developmental physiology studies in Lithuania has been successfully developed so far, and her enthusiasm, belief in scientific progress, inspire young researchers.

Leonida Novickienė was born on 17 July 1930, in Nerimdaičiai village, Telšiai district, in the family of Leonas Prialgauskas and Vanda Drukteinytė. In 1937–1949, she studied at Telšiai Žemaitė Secondary School. In 1949, she entered the Faculty of Natural Sciences of Vilnius University, but after two years of studies, she was expelled from the university due to the then unacceptable social origin. For a couple of years, she worked in various jobs – in a bookstore, a construction company. In 1953, she was allowed to continue her studies at Vilnius University again. From the third year of the studies, Leonida Novickienė chose the speciality of plant physiology at the Department of Plant Anatomy and Physiology, headed by Professor Jonas Dagys. The title of her diploma work was "Changes in the ratio of green leaf carotenoids under the influence of light". Leonida Novickienė graduated from Vilnius University in 1957, acquiring the speciality of biologist-plant physiologist and a teacher of biology and chemistry. During her studies, she established a long-term scientific friendship with Professors Jonas Dagys and Petras Bluzmanas of the Department of Plant Anatomy and Physiology of Vilnius University; they encouraged her to be interested in plant physiology research and chose the path of a researcher. Since 1957, Leonida Novickienė started to work in the Section of Plant Physiologists at the Institute of Biology of the Lithuanian Academy of Science. In 1957, the section was reorganised into the Laboratory of Plant Physiology. At that time, two main research topics, i.e. investigations on the influence of B group vitamins and other plant growth substances on growth and development of cultivated plants, guided by Professor Jonas Dagys, and the physiological reasons of the cereal lodging, guided by young at the time researcher Alfonsas Merkys, were developed. By studying the physiological causes of the lodging of cereals, Alfonsas Merkys linked his scientific insights to the gravitropic reactions of the plants, and the essential to the studies on the activity of phytohormone auxin, also called indoleacetic acid. Leonida Novickienė had experience in research

on plant growth substances, obtained during the study years while working with Professor Jonas Dagys, who was highly educated in this field. He studied at the Universities of Austria, Denmark and the Netherlands, and obtained his PhD at the University of Graz, during the interwar period. For this reason, Alfonsas Merkys invited her to work together. In 1959 and 1961, the Laboratory of Plant Physiology underwent major changes. After the reorganisation of the Institute of Biology of the Lithuanian Academy of Sciences, the employees of the Laboratory of Plant Physiology were moved to the Institute of Botany of the Lithuanian Academy of Sciences. In 1961, Professor Jonas Dagys resigned his position as the Head of the Laboratory of Plant Physiology of the Institute of Botany and continued his work at Vilnius University. The head position of the Laboratory occupied Alfonsas Merkys. Young scientist directed all his efforts to the studies of gravitropic reaction and the role of phytohormone auxin in it. At the beginning of the 20th century, the gravitropic reaction of plants was studied at various laboratories around the world, and it was known that phytohormone auxin activity takes an important part in plant reaction to gravity. The phytohormone auxin itself was one of the first hormones extracted from plants at the beginning of the 20th century. It was accepted that auxin causes cell growth by elongation and, thus, is involved in the gravitropic reaction. In the middle of the 20th century, Professor J. Bonner of the California Institute of Technology, J. Key, a researcher at Indiana University, researchers at Harvard University l. D. Nuden, K.V. Thiman, and others published data linking auxin activity and changes of protein synthesis during the plant cell growth by elongation. In the sixties, the idea that auxin induces transcription of genes, which are coding proteins responsible for physiological response, the elongation of the plant cell wall, was raised at various laboratories of plant physiology around the world. Lithuanian plant physiologists, led by Alfonsas Merkys, supported this point of view. Leonida Novickienė was one of the first laboratory collaborators, studying the condition and metabolism of auxin in the stems of the lodging cereals. She summarised the results of a five-year study in the thesis "Investigation of auxin metabolism and respiration process in the cereals in relation to their resistance to lodging", which she defended at Vilnius University in 1966. After the defence of the doctoral thesis, she was actively involved in further auxin researches, to confirm auxin relation to proteins during the plant cell growth by elongation. Already in 1973, Alfonsas Merkys, Leonida Novickienė along with plant physiologists Albinas Putrimas and Antanas Marčiukaitis published the methodology of the experiment, which allowed determining auxin bound with protein in plant material. This methodology played an important role in the development of studies on the physiological mode of auxin action, the subsequent results of which significantly expanded the general concept of hormonal regulation of plant growth and development. In the early 1970s, the researchers of the Laboratory of Plant Physiology of the Institute of Botany had such great experience in the field, that they could plan specialised studies of the gravitropic reaction of plants such as plant growth and morphogenesis under microgravity conditions; the mechanism of auxin action and its role in the gravitropic reaction; and the development of physiological phytohormone analogues and their application to the practice of agriculture. The latter topic became Leonida's Novickienė's further scientific work, to which she dedicated all her wisdom, research and organisational skills.

The research data on plant growth regulators were published in the scientific press in the early and mid-20th century. Some synthetic auxins (chlorophenoxyacetic acids called 2,4-D; 2,4,5-T) had already been used in horticultural practice. In the middle of the 20th century, attention was paid to the research on the chemical regulation of crops. With the growing demand for food and crops, most farms around the world used physiologically active substances in addition to agrotechnics. Researchers developed synthetic growth regulators by modifying the chemical composition of natural growth regulators. It was believed that the synthetic compound obtained by modifying the natural structure of plant hormones would have a more active and targeted effect on plant growth and development. The first experiments of Leonida Novickienė were related to the research on the activity of plant growth retardant (growth inhibitor) CCC, which was believed to protect the lodging of cereals. In the 1960s, its effect on cereals was described by American scientists N. Tolbert and S. Wittwer. After testing in Lithuania, CCC was recognised as suitable for regulating the growth of cereals; however, it was not ideal for all

crops. It positively regulated the growth of wheat, but did not affect barley. For this reason, Alfonsas Merkys and Leonida Novickienė tried to create several CCC derivatives based on quarterly ammonium salts that would effectively regulate the growth of barley as well. At their request, under the guidance of a chemist, Professor Vitas Daukšas, four new types of CCC derivatives were synthesised at the Laboratory of Drug Synthesis and Research of the Faculty of Chemistry of Vilnius University. Three of the newly synthesised compounds had a positive effect on the resistance of barley to lodge. In parallel with barley studies with CCC, Leonida Novickienė with the colleagues tested the impact of ethrel (chlorethylphosphonic acid) on the resistance of barley to lodge and found that ethrel had a positive effect on the mechanical tissues of the barley stem. Because the modified CCC derivatives effectively affected plant formation and ethrel – the stem tissue mechanics, Alfonsas Merkys and Leonida Novickienė raised the hypothesis about the modification of CCC and ethrel molecules to create new compounds that would positively affect both mechanical tissue and plant formation. The successful results of the 1971–1975 period were the stimulus for further studies on regulating the growth and development of agricultural plants with synthetic growth regulators in Lithuania. In the early 1980s, barley growth was controlled by terpal, retacel super, fundazole and retardant CCC mixtures with ethrel and chlorethylphosphonic acid salts, but it was recognised that all of these compounds did not have a significant effect on barley formation. Alfonsas Merkys and Leonida Novickienė began to analyse compounds of quaternary ammonium salts that would regulate the growth and development of barley to strengthen the stem tissues and positively affect the formation of generative organs. They decided to modify CCC, DMC (dimethylmorpholine chloride) and DPC (dimethylpiperidine chloride) molecules to get analogues of these compounds. Under the guidance of a chemist, Professor Vitas Daukšas, 42 compounds were synthesised at the Laboratory of Drug Synthesis and Research of the Faculty of Chemistry of Vilnius University. In 1978–1981, the effects of these compounds on the growth and development of various agricultural plants were investigated by applying the laboratory, vegetative and field test methods. After several years of research, the compounds 1-DMC and 3-DMC were found to be the best inhibitors of the growth of barley stems. Under the leadership of Leonida Novickienė, the effect of quarterly ammonium salt analogues (3-DMC and 17-DEC) on the growth and development of monocotyledonous plants was investigated by Laimutė Miliuvienė and Virgilija Gavelienė, based on this material they both defended PhD. In the early 1980s, 3-DMC and 17-DEC were registered as inventions. After the tests carried out in 1985–1990, compound 3-DMC was given the trade name "Venta".

After a successful beginning, Leonida Novickienė's further work was determined by a few circumstances. Because one of the leading research topics at the Laboratory of Plant Physiology of the Institute of Botany was the study of phytohormone auxin activity during gravitropic reaction, and synthetic analogues of phytohormone auxin, 2,4-dichlorophenoxyacetic acid (2,4-D) and naphthylacetic acid (NAA) were known as early as in the 20th century, Alfonsas Merkys and Leonida Novickienė decided to modify the naphthylacetic acid molecule and investigate whether the new compounds affect potato morphogenesis. Based on the programme compiled by Alfonsas Merkys and Leonida Novickienė, the researchers from the Faculty of Chemistry of Vilnius University, Professor Vitas Daukšas, Dr Zita Šaltytė and Dr Robert Martinkus synthesised 16 new naphthylacetic acid compounds. Leonida Novickienė tested the most intense compounds in potato morphogenesis and growth studies under laboratory conditions. After several years of work in collaboration with the researchers of the Vokė Branch of the Lithuanian Institute of Agriculture, Dr Habil Algimantas Bujauskas, Dr Uršulė Čepienė, Dr Juozas Jundulas, most physiologically active compounds were selected. Calcium salt 1- (2-chloroethoxycarbonylmethyl)-4-naphthalenesulfonic acid showed the highest physiological activity; this compound was given a name TA-12. Laboratory and field tests confirmed that TA-12 fully promoted the formation of potato organs. In 1985, it was tested not only in Lithuania, but also in production trials in the farms and laboratories of research institutes in Latvia, Estonia, Russia, Belarus, Ukraine, and Moldova. Positive effects of TA-12 on potato growth, development and yield were obtained everywhere. In the early 1990s, the research on the impact of TA-12 on sugar beet formation was conducted. Under the supervision of Leonida Novickienė, PhD student Gražina Adamonytė and Dr Jonas

Jurevičius in cooperation with the researchers of the Rumokai Experimental Station of the Lithuanian Institute of Agriculture, Dr Modestas Vizgirda and Dr Jonas Mačys, performed comparative studies on the activity of TA-12 and terpenoid-derived fusicoccine, steroid-derived epibrassinolide, 6-benzylamine purine and retardant-type compound composane M in the formation of sugar beet productivity. All tested compounds were found to promote sugar beet productivity, but along with productivity, only TA-12 increased the sugar content in beetroots. In 1989 and 1990, the plant growth regulator TA-12, which has a specific effect on sugar accumulation in beetroots, was presented and positively evaluated at the international exhibition Hungarochem.

In 1994, after summarising the results of 30 years of research, Leonida Novickienė prepared and defended the habilitation work "Physiological principles of modification of the analogues of phytohormones and retardants, regulating the plant growth, development and productivity". With this work, she confirmed the assumptions about the possibility to create synthetic analogues of phytohormones and retardants for targeted regulation of the growth, development, and yield of agricultural plants.

After defending her habilitation work, Leonida Novickienė initiated the research on the effects of synthetic auxin and quaternary ammonium salt analogues on rapeseed growth, morphogenesis and productivity. In 1995–2004, under her guidance, isolated tissue cultures and vegetation tests were performed with different rapeseed varieties. Field tests were performed at the Lithuanian Institute of Agriculture in cooperation with Dr Irena Brazauskienė. Dr Virgilija Gavelienė, Dr Laimutė Miliuvienė and PhD student Danguolė Kazlauskienė were engaged in the study. The first data on the effects of these compounds on rapeseed plants were published in the late 1990s, confirming that auxin analogues TA-12 and TA-14 have a very noticeable modifying effect on rapeseed growth, morphogenesis, and generative organ development, hardening, and overwintering.

Assessing the works of Leonida Novickienė from the current point of view, we can say that together with Alfonsas Merkys she has developed a theoretical basis for the synthesis and use of new narrow specialisation phytohormones physiological analogues, increasing the targeted and selective productivity of economically vital plant organs. On the issues of growth regulators, she with colleagues has published about 200 research papers. Five doctoral theses have been defended based on research topics developed by her, seven original plant growth and development modifying compounds have been registered as products useful for practical crop production. In 2001, she, along with academician Alfonsas Merkys, Dr Habil. Jūratė Darginavičienė and Dr Romualdas Laurinavičius, was awarded the Lithuanian Science Prize.

As a great enthusiast of plant physiology science, Leonida Novickienė participated in dissertation defence committees, opposed the works of colleagues, always supported young scientists, consulted, and inspired them to work. She also paid a lot of attention to public scientific activities. In 1988, along with academician Alfonsas Merkys, she actively participated in the establishing of the Lithuanian Society of Plant Physiologists, for many years worked on its board, participated in organising the main scientific events of the society.

"The experiment is so extraordinary ..." with these words she encouraged young people to devote themselves to research work. Always benevolent, sincere, believing in the uninterrupted progress of humanity, she is an example for young Lithuanian researchers.

LIST OF THE MAIN SCIENTIFIC WORKS OF LEONIDA NOVICKIENĖ

Books

Darginavičienė J., Novickienė L., 2002: Augimo problemos šiuolaikinėje augalų fiziologijoje. – Vilnius.

Novickienė L., Ričkienė A., 2007: Alfonsas Merkys – augalų fiziologas. – Vilnius.

Lithuanian Science Prize

Leonida Novickienė along with coauthors A. Merkys, J. Darginavičienė, R. Laurinavičius was awarded the Lithuanian science prize of 2001 for the cycle of works "Management of plant growth and spatial orientation physiology (1960–2000 m.)".

Doctoral thesis

Novickiene L., 1966: Issledovanie obmena auksinov i processa dyxanija v zlakovyx rastenijax v svjazi s ix ustojčivost′ju k poleganiju: Avtoreferat dis.

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Novickiene L., 1994: Augalų augimą, vystymąsi ir produktyvumą reguliuojančių fitohormonų ir retardantų analogų kūrimo fiziologiniai pagrindai. Physiological principles of modification of the analogues of phytohormones and retardants, regulating the plant growth, development and productivity: = Fiziologičeskie osnovy sozdanija analogov fitogormonov i retardantov dlja napravlennoj reguljacii rosta, razvitija i produktivnosti rastenij – Vilnius.

Research papers

Merkis A., Novickiene L., Putrimas A., Marciukaitis A., 1973: Opredelenie v rastitel′nom materiale β-indoliluksusnoj kisloty, svjazannoj s belkami. – In: Metody opredelenija fitogormonov, ingibitorov rosta, defoliantov i gerbicidov: 30–38. – Moskva.

Novickiene L., Merkys A., Adamonytė G., 1988: Novye proizvodnye β-naftiluksusnoj kisloty, povyšajuščie produktivnost′rkartofelja i saxarnoj svėkly: 330–335. – In: Hungagrochem-88: fertilizers, lectures, posters. – Kesztely.

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Novickienė L., Gavelienė V., Merkys A., Brazauskienė I., 1999: Augimo reguliatorių panaudojimo galimybės vasarinių rapsų auginimo technologijoje: 1. Auksino analogų poveikis rapsų augimui, generatyvinių organų ir derliaus komponentų formavimuisi. – Žemės ūkio mokslai, 4: 33–38.

Novickienė L., Miliuvienė L., Gavelienė V., 2003: Dimetylmorpholinium chloride analogues and their effect on plants. – Russian Journal of Plant Physiology, 50(5): 547–552.

Novickienė L., Asakavičiūtė R., 2006: Analogues of auxin modifying growth and development of some monocot and dicot plants. – Acta Physiologiae Plantarum, 28(6): 509–515.

Merkys A., Novickienė L., Darginavičienė J., Maksimov G., 2007: Advantages of auxin analogues as plant growth and productivity regulators. – International Journal of Environment and Pollution, 29(4): 443–456.

Gavelienė V., Novickienė L., Pakalniškytė L., 2013: Effect of auxin physiological analogues on rapeseed (*Brassica napus* L.) cold hardening, seed yield and quality. – Journal of Plant Research, 126: 283–292.

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