

Foreword

In 2008, the initiative was taken to set up an international working group to build up a common knowledge and to exchange experiences and information about kiwiberry (*Actinidia arguta*). The first meeting was held in Ghent (Belgium), from then on our annual meetings were hosted in different European countries; Switzerland, Austria, Germany, The Netherlands and Portugal. Last year we had again a very successful edition, this time in “the Green Heart of Austria”; Styria.

Now we can welcome you in Warsaw, the capital and largest city of Poland. I am convinced we will have again motivating days with interesting presentations and some inspiring visits. The knowledge that is exchanged among the participants during this conference will improve again all aspects of kiwiberry production and marketing. As we know from consumer research kiwiberry is still unknown to an important part of the consumers. We will focus also on topics to increase the interest of the consumers to enjoy the benefits and the taste of kiwiberry.

We are very grateful to our host, Warsaw University of Life Sciences – SGGW and to our main sponsors SGGW, Polish MiniKiwi Growers Association, Clematis Źródło Dobrych Pnaczy, Climbers Nursery Marek Wędrowski and Provincial Pomological Society East-Flanders, Belgium. Many thanks to all others who supported the organization of our seminar. But, most important, a big ‘thank you’ to you all, for your active participation.

Welcome to the 10th edition of the scientific seminar of the European Kiwiberry group!



Filip Debersaques

Chairman



Piotr Latocha

Convener

Program

First day, 23rd May 2019

09:00-09:15 Registration (Building 48, first floor)

Welcome

09:15-09:30 Welcoming

09:30-10:00 The current kiwiberry industry: international cooperation versus competition
Filip Debersaques, Chairman European Kiwiberry Group, Ghent University (Belgium)

Fruit Quality and Postharvest

10:00-10:30 Determining taste in kiwiberry
Luca Fiorentini, Callum Kay, Skool Innovation Limited (New Zealand)

10:30-11:00 How long can you store the kiwiberry fruits?
Tomasz Krupa, Warsaw University of Life Sciences - SGGW (Poland)

11:00-11:30 Insights in kiwifruit and kiwiberry maturity
Callum Kay, Skool Innovation Limited (New Zealand)

11:30-12:00 Coffee break (+ Posters)

Genetics and Breeding

12:00-12:30 Behaviour of some Romanian kiwiberry selections and genotypes in Bucuresti area
Florin Stanica, Lavinia Iliescu, University of Agronomic Sciences and Veterinary Medicine, (Romania)

12:30-13:00 First results of new cultivars in Germany
Alexander Zimmermann, Bavarian State Institute for Viticulture and Horticulture (Germany)

13:00-13:30 Association genetic analysis of *A. arguta* and selections from mountains other than North-eastern China
YanChang Wang et al., Wuhuan Botanical Garden (China)

13:30-14:00 Lunch: Tea and Sandwiches (+ Posters)

Production and Economical Aspects

14:00-14:30 Actual situation of kiwiberry production in Poland
Piotr Latocha, Warsaw University of Life Sciences - SGGW (Poland)

14:30-15:00 Our experience in cultivating kiwiberry
Adam Kostrzewa, MiniKiwi Kostrzewa (Poland)

15:00-15:30 The combined use of fruit and the vegetative mass of *A. arguta*
Nadiia Skrypchenko, National Botanical Garden in Kiev (Ukraine)

15:30-16:00 Current situation of kiwiberry commercial production and market development in China
Jinming Fan, Willem Kokkeel Inno-fresh (China)

16:00-17:00 Visiting kiwiberry collection (SGGW Campus)

~17:30 (18:00) Dinner: „Old Campus” (building 9)

Posters

- P_1. **Anna Bieniek, Ewa Dragańska, Natalia Bielska**, University of Warmia and Mazury, Olsztyn, Poland: „Influence of weather conditions of northeastern Poland on yielding and the quality of fruits of several Ukrainian kiwiberry cultivars"
- P_2. **Anna Bieniek, Bogumił Markuszewski, Piotr Latocha, Natalia Bielska**, University of Warmia and Mazury, Olsztyn, Poland: „Evaluation of *Actinidia arguta* propagation effectiveness with hardwood cuttings"
- P_3. **Natalia Kuźma, Piotr Latocha, Barbara Łata**, Warsaw University of Life Sciences - SGGW, Poland: „Relationship between the soil N-level and the content of biologically active compounds in *Actinidia arguta* 'Geneva' fruit directly after harvest and during fruit cold storage"
- P_4. **Nadiia Skrypchenko**, National Botanical Garden in Kiev, Ukraine: „Study of soil fatigue in gardens with woody vines"
- P_5. **Kamil Osoś, Piotr Latocha**, Warsaw University of Life Sciences - SGGW, Poland: „Effect of gibberellins and boron application on the quality of kiwiberry fruits"
- P_6. **Jan Stefaniak, Agnieszka Stasiak, Piotr Latocha, Barbara Łata**, Warsaw University of Life Sciences - SGGW, Poland: „Fruit bioactive compounds and total antioxidant activity in reference to increasing N fertilization of *Actinidia arguta* plants in field conditions"
- P_7. **Jan Stefaniak, Anna Rzeźnicka, Agnieszka Stasiak, Piotr Latocha, Barbara Łata**, Warsaw University of Life Sciences - SGGW, Poland: „Leaf analysis in the diagnostics of kiwiberry plant nutritional status - summary of a long-term study"
- P_8. **Agnieszka Stasiak, Barbara Łata, Piotr Latocha**, Warsaw University of Life Sciences – SGGW, Poland: „Does genetically diverse pollen affect the quality of kiwiberry fruit?"
- P_9. **Daniel Knysak, Eliza Kostyra, Anna Piotrowska, Sylwia Żakowska-Biemans, Piotr Latocha**, Warsaw University of Life Sciences - SGGW, Poland: „Sensory image of fruit juices mixtures based on kiwiberry (*Actinidia arguta*) and its effect on hedonic response of consumers"

Second day, 24th May 2019

08:00-16:00 Technical tour (kiwiberry plantations and other crops)

MiniKiwi Kostrzewa, mature kiwiberry plantation ~9:30-10:30

Grzegorz Kostrzak, Jacek Kostrzewa, young kiwiberry and cornelian cherry (*Cornus mas*) plantations ~11:00-11:30

Mateusz Kośka modern strawberry orchard under cover and blackberry young plantation in pots ~12:00—13:00

Dinner (Nowe Miasto nad Pilicą – central Poland) ~13:00-14:00

Return to Warsaw and end of Seminar ~16:00

ABSTRACTS OF PRESENTATIONS AND POSTERS



The current kiwiberry industry: international cooperation vs competition

DEBERSAQUES F.,¹ DECORTE J.^{1,2}, ¹Ghent University, Belgium, ²BMS Micro-Nutrients, Bornem, Belgium

The commercial production of the kiwiberry is still relatively new in northern and western Europe. Exploratory research into the possibilities and challenges of commercial kiwiberry cultivation was an important first step in the acquisition of the necessary expertise and knowledge to grow this crop. To build up a common knowledge and to exchange the experiences and information of different institutes, universities and growers, the initiative was taken in 2008 to set up an international working group with partners from different countries.

The annual meetings organized by this kiwiberry group focused until now mainly on fertilization, irrigation, pollination, pruning and training of the plants and the shelf life and storage of the fruit. Also the diversity of the different varieties was an important topic in these meetings. This information was often a good base for growers who want to start with the cultivation of kiwiberry. After all their agricultural income was, and still is, under pressure owing to overproduction and geopolitical reasons. Fruit and vegetable growers in Europe looking for new, high efficiency crops are focusing their attention on the kiwiberry.

This results in an increase of new orchards and consequently the increase in supply of kiwiberry in the market. But despite the interesting nutritional and convenience properties (bite-sized and edible skin) this fruit is rather unknown to the consumers. In contrast with other berries, the fruit is most often not ready-to-eat when sold. This could confuse the consumer, especially those who are not familiar with kiwiberry. Also the non-uniform ripening of the fruit is an important challenge. Informing and educating the consumer is essential for long-term success. A new marketing approach will be necessary; kiwifruit marketing specialists as Zespri understood this since long time! Also the product quality is essential for long-term success, therefore much more attention must be paid to efficient grading and stringent quality control.

The difference in the evolution of the phenology of the kiwiberry in the different countries is an advantage to cover a longer period of fruit availability but also to align with supply and demand. However, the 2018 harvest period was in most countries, due to climate conditions, very close to each other. Combining this situation and the fact that kiwiberry is rather unknown, a significant share of the harvest could not be sold.

This is a wakeup call for a good publicity and marketing strategy with focus on quality. An international streamlining of information and experiences is urgently needed. Without measures the commercial interest will decrease and a profitable cultivation of kiwiberry will fail.

Determining taste in kiwiberry

FIORENTINI L., KAY C., Skool Kiwifruit Science and Innovation LTD, New Zealand

There is increasing interest in Kiwiberry (*Actinidia arguta*) from consumers, and this maybe linked to the possibility of eating the whole fruit, without any need to peel the skin, and to their characterisation as “superfruits” rich in vitamin C and nutrients. Kiwiberry is however a very new crop to the market, and the determination of taste in Kiwiberry is a key point for breeders, and for companies, who want to evaluate the liking of their berries by the consumer, either of existing commercialized cultivars or of new cultivar releases prior to entering the market.

Evaluation of the overall quality in Kiwiberry involves both external appearance and overall taste. Cosmetic defects, skin colour, and the berries shapes are usually standardized into ranges or allowances. While determination of taste is typically parametrized to Brix degree (°Bx) and dry matter (DM) that vary depending on the cultivar and the ripening stage.

Kiwiberry overall taste can also be evaluated in complex sensory tests where sweet/sour balance, skin, flesh flavours, texture, and purchase intent are evaluated by groups of respondents, and this type of testing is common practice for food companies before any potential commercialisation of a cultivar.

Kiwiberry skin, appears to be a very important parameter in determining the fruits overall taste. Cultivars of Kiwiberry are typically characterized by bitter, sour, and in some cases chilly skin tastes, that can be disliked by the consumers. The best cultivars in sensory tests are those with smooth skin taste, together with high DM values. Is recommended to consider skin characteristics during breeding programmes.

Finally, determining taste in kiwiberry cultivars can be challenging because taste can change significantly over time. For this reason, is important to identify the quality parameters and the correct eating window and so respond to consumers expectations.

How long can you store minikiwi?

KRUPA T., Warsaw University of Life Sciences - SGGW

The aim of the research was to determine the effectiveness of two methods of storage for maintaining high quality of kiwiberry (MiniKiwi) fruit. The first of the studied factors was the treatment of 1-MCP. The second was the technology of the controlled atmosphere in which the berries were stored. The experiment evaluated the storage ability of two cultivars, 'Geneva' variety at the early time of fruit ripening, and 'Weiki' - whose fruits ripen a few weeks later. During storage, berry firmness, titratable acidity, soluble solids content and fruit consumer evaluation were evaluated. In the sensory study, the taste of berries was evaluated using the following characteristics: sweetness, acidity, astringency, hardness and overall quality. The evaluation was carried out by a minimum of 30 people. Fruit storage time was 16 weeks, and analyzes were carried out every 2 weeks; immediately after storage and after a period of shelf life (after ripening of fruit at 20°C).

Studies have shown that you can store the kiwiberry fruit even for a period of 4 months. It has been proven that the use of 1-MCP contributes to better fruit firmness and additionally inhibits the loss of firmness during shelf life. Kiwiberry stored under controlled atmosphere maintain their high firmness after shelf life, especially under an atmosphere composition of 5%:1.5% (CO₂:O₂). Kiwiberry treated with 1-MCP were rated by consumers as more acidic, tart and harder, but their overall quality was higher than untreated fruit. However, as the shelf life extended, consumers generally rated the fruit as less sweet and generally less tasty.

Insights in kiwifruit and kiwiberry maturity

CALLUM KAY, Skool Kiwifruit Science and Innovation Limited, New Zealand

In order to maximise fruit pack out, cold storage times, and final fruit taste, fruit needs to be harvested at the best possible moment, or at the best maturity for the intended supply chain. Understanding what influences maturity from a climatic point of view, as well as orchard layout, and orchard management will be discussed, and what can be done to assist the grower in making the correct harvest decisions.

Discussion will focus on kiwiberry characteristics in general, and what makes a good kiwiberry in the supply chain. We will look what data is needed to make the correct maturity decisions, the different maturity characteristics (BRIX, Dry Matter, RSS, and Pressure), relationship to each other, and how to read fruit population data. These will be discussed in relation to maturity, packing and cold storage, with insights probed into what happens when this is done well, versus what happens with things start to go wrong.

Behaviour of some Romanian kiwi berry selections and genotypes in București area

STĂNICĂ F., ILIESCU L.M., University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania

Three kiwi berry selections: 'Green Delight', 'Red Delight', 'Big Delight' and few other interesting genotypes were obtained by free and controlled crossings between different cultivars of *Actinidia arguta* - Francesca, Rosana, Jumbo, AA₂, AA₅, AA₆, AA₈ and the male ARM. The Romanian breeding program of kiwifruit species was initiated in 1993 based on the scientific collaboration started between Faculty of Horticulture from București and Vitroplant company from Cesena, Italy. The planting was done on chernozem black soil in the Romanian plain, using some hybrid seedlings. T - bar trellis system was used. The inter row surface was covered with a mixture of perennial grasses and mowed mechanically. Along the row, the soil was kept clean by hand and mechanical cultivation. Drip irrigation and micro spray irrigation system was provided. Organic pest management was applied.

After the first years of plant selection, two male plant elites and eight female plant elites with interesting fruit characteristics, were chosen to be multiplied and tested during the next step of the breeding process. Phenology of the genotypes was studied in comparison with the climatic data and physical and biochemical fruit characteristics were evaluated after ripening. The best of selected genotypes have good fruit characteristics and yield, so they can be successfully cultivated on commercial orchards and in private gardens. They can be also used for further breeding programs. Being more frost resistant than the others kiwi species and having tasty small fruits, smooth skin with different aroma and flesh colour, *A. arguta*, can be extend in Romania to larger surfaces, in all areas that are suitable for peach and plum cultivation.

First results of new kiwiberry cultivars in Germany

ZIMMERMANN A., Bavarian State Institute for Viticulture and Horticulture, Germany

Kiwiberry cultivation in Germany is currently a very small business. Kiwiberries are cultivated on about 30 hectares in Germany with an upward trend. There are only a few farms with an area of 0.5 ha or more. Some farmers with direct sales test various cultivars in small experimental cultivation. The range of varieties is now very large, but not all are suitable for commercial growing. The sale of the fruits is direct from farmer to customer and not yet on larger fruit growing organizations. Maybe some new varieties can change this.

At the Bavarian State Institute of Viticulture and Horticulture various cultivars have been tested for 20 years. There are now 70 different cultivars on the trial fields. The seven best cultivars were planted in winter 2015/2016 at 10 different locations in Germany. This joint test with other agriculture institutes and farmers will bring new results of commercial kiwiberry growing in Germany. The selected varieties are `Fresh Jumbo`, `Super Jumbo`, `Molli`, `Maki`, `Clone 74-49`, `Rote Verona`, and `Red Beauty`. The first results were won in 2017 and 2018.

In the coming years, there will certainly be more good varieties of kiwiberries. Interesting cultivars on the trial fields are for example `Mariered`, `Chang Bay`, and `Honey 1`.

Association analysis of *Actinidia arguta* and selections from the wild habitat other than Changbai Mountains

YAN-CHANG WANG Y-CH., LU X., MAN Y, YU M, LEI R, JIANG Z., Wuhan Botanical Garden, Chinese Academy of Sciences, China

Associations between markers and fruit quality traits were investigated on a set of 185 wild *Actinidia arguta* accessions, including main cultivars planting in North-eastern China, using 160 simple sequences repeats (SSR) polymorphism markers. A high level of polymorphism was found with SSR markers, and the mean polymorphism information content was 0.78. The number of alleles per locus varied from 2 to 42, with an average of 17 alleles per marker. The linkage disequilibrium (LD) analysis was significant at a comparison-wise $P < 0.05$ level and a decay of LD was observed. The association analysis revealed a total of 7 significant marker–trait associations for fruit quality traits.

Based on a large number of wild resources, Wuhan Botanical Garden, CAS selected nine new types of *A. arguta*. Fruit of six selections weight within 8-15 gram and are totally purple in colour. SSC of their ripe fruit vary from 16.5% to 19.2%. Dry matter of the purple selections is higher than 20.6%. We also selected three green types with much sweeter or bigger than the cultivars in use from Yanshan Mountains. Seven of them have been applied for plant variety protection or licensed by provincial variety examination and approval committee. Two purple of them will be released in China recently. One excellent variety named ‘Cheart A15’ was introduced with emphasis here. In order to increase storability, fruit size or acquire a sign of ripeness, interspecific crossing were conducted between *A. arguta* and *A. chinensis* or *A. arguta* and other species in the Sect. *Leiocarpae* Dunn. Thousands of hybrids were obtained and selecting is in progress.

Actual situation of kiwiberry production in Poland

LATOCHA P., Warsaw University of Life Sciences – SGGW, Poland

The cultivation of kiwiberry (Mini Kiwi) in Poland is the possibility for growers looking for an alternative to less profitable crops. The year 2018 was the first kiwiberry production in Poland that reached the level at which it was possible to cooperate with larger customers such as retail chains (supermarkets). As the experience from last year showed, kiwiberries can be successfully sold in large-area stores, but this requires the development of many aspects from both sides, growers and traders.

In Poland, studies on *A. arguta* have been conducted for a long time mainly at two universities - Warmia and Mazury in Olsztyn and Warsaw University of Life Sciences - SGGW. The results of this research resulted in the implementation of kiwiberry for commercial cultivation on a larger scale in 2010. Initially, the area grew slowly (2011 - 2015 increase from 5.3 to 8.3 ha) but since 2015 there has been a dynamic growth to 46.7 ha in 2018). The average area of the plantation is 1.73 ha but the largest is 11 ha. The largest density of MiniKiwi plantations is Wielkopolska voivodeship in the west and Grójecko-Warecki region in the central Poland. Along with the age of plantation and gradual entry into yielding, the total yield also increases, which in 2018 amounted 75 tons and 2019 forecasts even 180 tons (unfortunately, will be lower due to heavy spring frosts in April). In 2016 Polish MiniKiwi Growers Association was founded in order to support growers in scientific knowledge and to promote the fruit.

Currently, the main aspects requiring research are developing the cultivation technology to ensure good quality of fruit (main problem is fruit russeting), harvesting technology and storage conditions (extension of fruit supply) and the need for promotional and marketing activities on the domestic market in order to increase the demand for these fruits. Promotional issues are particularly important because it requires a rapidly growing supply of fruit. In 2019, as part of cooperation with the National Union of Fruit and Vegetable Producers, a year-round, professional promotion of Polish berries, including kiwiberry (MiniKiwi), will be carried out. The slogan of the promotion is "Time for Polish Superfruits".

Our experience in cultivating kiwiberry

KOSTRZEWA A., MiniKiwi Kostrzewa, Poland

Our family-run farm is based mostly on blueberry production, which we are growing since 1991, currently on the area of 30 hectares. Other crops that we cultivate are apples, kiwiberry (MiniKiwi), cornelian cherry (*Cornus mas*) and schisandra berry (*Schisandra chinensis*). The kiwiberry plantation was established by Jacek and Renata Kostrzewa, on the place of an old apple orchard in 2011. It is located in Bodzew, Grójec area, on 3 hectares; currently with two cultivars - 'Weiki' and 'Geneva'. Shortly after, a cooperation with Warsaw University of Life Sciences (SGGW) was established; the goal was to bring together theory with practice and give some field for studies in growing in both academic and grower's perspective. Our plantation is one of the first professional kiwiberry orchards in Poland. We are members of Polish MiniKiwi Growers Association since the day of its foundation in 2016. Every season brought new challenges and experiences in growing. Since the first crop in 2014 we are trying to find different markets to sell kiwiberries - with various results. Until 2018 first class fruits were sold mostly abroad, as domestic market was uninterested. Finding buyer for sorted-out, second class fruits was even harder. At the same time, we were facing other experiences. Difficulties that showed up were dying plants after winter, imbalanced strength of grow, devastating spring frosts, hailstorms ruining most of the crop, wind damages, growing problems with organization of picking and sorting fruits as well as with manpower quantity.

Season 2018 can be considered critical for two reasons. Thanks to good weather conditions, we managed to reach record-breaking crop quantity - over 20 tons per hectare overall ('Geneva'). In some parts of plantation it even caused breaking the supporting constructions and destroying parts of crop. Second important thing was gradually opening of Polish market for kiwiberries, as some of the biggest supermarket chains in Poland took first parts for retail. Thanks to that (as well as other actions), the kiwiberries slowly starting to be recognizable for domestic customer. Nowadays we believe that growing actinidia in our conditions can have some good perspectives, however it can be very labor-intensive, easily damaged and unstable in selling. At the present, we are trying to focus on two aspects - striving for the highest possible quality of the crop and reaching the highest awareness of this product for polish consumer - also collectively, as the members of Polish MiniKiwi Growers Association.

Combined use of fruit and vegetative mass of *A. arguta*

SKRYPCHENKO N., M. Grishko National Botanical Garden of the National Academy of Sciences of Ukraine, Ukraine

Actinidia arguta (Siebold et Zucc.) Planch. ex Miq. fruit have a high level of biologically active substances, are characterized by unique medicinal properties and may be a valuable raw material for the processing industry. The balanced combination of the main components of the chemical composition of the actinidia fruit gives the opportunity to obtain products of their processing (juices, jellies, jam, compotes, pastille, marmalade, etc) with beneficial properties. Jelly actinidia product has a drug-preventive function and is characterized by high biological value in combination with anti-mutagenic properties. On the base of juice with pulp and phytosorbent (gelatinous apple pectin) a new type of jelly products with detoxification properties is patented. The content of ascorbic acid in the compote of the proposed formulation of actinidia berries reaches 40.5 mg / 100 g. The use of 200 g of compote provides the daily need of an adult for vitamin C. The content of carotenoids in actinidia fruit jam, in particular β -carotene, reaches at 87.7–89.7% of the initial level (0.23–0.43 mg / 100 g). The highest content of carotenoids has the products made of 'Purpurovaja Sadovaja' cultivar which have red fruits.

The actinidia seeds, which remain after the processing of berries, contains a significant amount of fatty oil ($34.9 \pm 1.8\%$), which has a pleasant aroma and is characterized by a high content of carotenoids (8.9%). The twelve higher fatty acids with the maximum content (64.55%) of linolenic acid (omega-3) were identified by the chromatographic method in the lipid fraction.

For the expansion of raw materials in order to create a new phytopreparation, a pharmacological study of actinidia vegetative organs was carried out, which showed a high content of phenolic compounds, hydroxycholic acids, flavonoids and tannins; their localization was revealed and quantitative content was determined.

In conclusions fruit and vegetative mass of *A. arguta* are valuable raw materials for obtaining the different processed products that contain biologically active compounds and contribute to the enhancement of human immunity.

Current situation of Kiwiberry commercial production and market development in China

FAN J., KOKKEEL W., Sichuan Yinuosi Agricultural Technology Co, Ltd. InnoFresh, China

Mei Mei is the brand name of our great kiwiberries (*Actinidia arguta*). Mei Mei kiwiberries started growing in 2012 in Yucheng district, Ya'an city, Sichuan Province, where they were well taken care of by a team of people from both China and the Netherlands who have a great deal of experience and resources in the fruit and vegetable industry. Mei Mei has been growing ever since and is now planted at kiwiberry plantations around China. This is how we are currently the first commercialized and large-scale plantation of kiwiberries in China.

Mei Mei has started to grow under the name of the company InnoFresh, the leading grower of kiwiberry in China. InnoFresh's key principle is through innovative technologies and products, we strive to upgrade the level of the agriculture industry. By helping growers grow better, helping consumers to have better choices on fruits and to help the planet become greener.

Kiwiberry has been commercialized cultivation in China since 2012. Currently China is the largest producing area of kiwiberry in the world, as of 2017, total production area of kiwiberry has reached to 1500 hectares. InnoFresh has introduced various kiwiberry varieties from Europe under the great help of Filip Debersaques, the company has become one of the major players in kiwiberry sector. After 7 years development, we have accumulated quite some information on both production and marketing sectors, the present situation of kiwiberry commercial production and market development in China will be expounded in four aspects: current production status in China, challenges and opportunities for the industry, marketing channels, and thoughts on future development.

Influence of weather conditions of north-eastern Poland on yielding and the quality of several Ukrainian kiwiberry cultivars

BIENIEK A, DRAGAŃSKA E, BIELSKA N, University of Warmia and Mazury in Olsztyn - UWM, Poland

Due to climatic conditions, the range of species that can be introduced to commercial cultivation in the countries of north-eastern Europe is limited. Producers in these regions are interested in growing plants that are resistant to frost and spring ground frosts. *Actinidia arguta* (Siebold et Zucc.) Planch. ex. Miq.) is particularly highly valued since it is a species whose fruit offers many bioactive substances.

The study was conducted in 1996-2018 on four Ukrainian kiwiberry cultivars (*A. arguta*) grown in the Experimental Garden of the University of Warmia and Mazury in Olsztyn (north-eastern Poland, latitude: 53°50'N, 20°31'E). This study analysed the effects of weather conditions on the yield and weight of fruits of four kiwiberry cultivars. The tested cultivars included 'Figurnaja', 'Kijevskaja Gibrydnaja', 'Kijevskaja Krupnoplodnaja', 'Purpurovaja Sadovaja'. Five 'Weiki' vines were used as pollinators for those cultivars. In the Autumn of 1996, one-year-old plants of these cultivars were planted in two rows, spaced at 1.5 × 2 m, in five replications, and each plant constituted a replication. Vines were planted in 4 m-high A-shaped metal support structures. The characteristics of weather conditions prevailing in 2000-2018 were based on daily meteorological data originating from the station of the Institute of Meteorology and Water Management in Olsztyn.

The results of the yield and fruit quality were not included in 2007, 2016 and 2017, because these were years in which no yield was obtained. In spring 2007 and 2017, intensive ground frosts occurring on several days in April and May (with a recorded ground temperature of -7.1 °C) severely damaged young shoots, leaves and flower buds and resulted in no yield. In 2016, an intensive rejuvenating cut was made and the height of the plants was reduced to 2.5 m. In the remaining years of the research, both the yielding and the weight of the fruits were significantly different. The significantly highest average yields were obtained for the 'Purpurovaja Sadovaja', while the lowest were recorded for 'Kijevskaja Krupnoplodnaja'. The average yields from all varieties were the significantly highest in 2005. The highest average fruit weight for a cultivar was obtained in 2004 and the lowest in 2018.

Evaluation of *Actinidia arguta* propagation effectiveness with hardwood cuttings

BIENIEK A.¹, MARKUSZEWSKI B.¹, LATOCHA P.², BIELSKA N.¹, ¹University of Warmia and Mazury in Olsztyn - UWM, Poland. ²Warsaw University of Life Sciences - SGGW, Poland

Actinidia arguta is becoming increasingly popular and valued from year to year. Kiwiberry is currently more frequently regarded as a fruit plant rather than as an ornamental shrub. This is because their fruit satisfies a consumer's need for tasty, natural and functional food produced in a clean environment. The production of *A. arguta* has been rapidly expanding in Poland in recent years. Accordingly, the importance of the kiwifruit industry has led to an increasing need for propagation material. The kiwiberry can be propagated by sexual reproduction and by vegetative methods (green or hardwood cuttings, grafting or budding). It is usually propagated by hardwood cuttings, but with different success rates. The main problem with hardwood cutting is the tendency for cutting to form excessive callus and few roots. Rooting with this method is definitely improved by the use of a heated substrate. Therefore, in the current experiment, the effectiveness of the propagation method used for several cultivars of *A. arguta* was assessed.

The hardwood cuttings for rooting were taken in February from the following cultivars: 'Figurnaja', 'Kijevskaja Krupnoplodnaja', 'Kijevskaja Gibrydnaja', 'Sientiabrskaja', 'Purpurovaja Sadovaja', 'Domino', 'Geneva' 'Ananasnaja' ('Anna'), 'Weiki' (female), 'Weiki' (male), 'Verde', 'Bingo', 'Jumbo', 'Twist', 'Scarlet September', 'MSU', and clone 74-49. In the experiment located in a greenhouse of the University of Warmia and Mazury in Olsztyn, 15-20 cm-long (3-4 internodes) lignified cuttings were used. They were immersed in the AB aqua rooting preparation for hardwood and semi-woody cuttings before being planted in the substrate. The prepared cuttings were placed in openwork boxes filled with universal soil with perlite in a ratio of 1:1. The boxes with cuttings were placed in a greenhouse on heated tables with a mat temperature of 25 °C. The air temperature in the greenhouse was 24 °C. The plants were automatically fogged from the top and the humidity was 80%. Droplet irrigation was also included once a day for five minutes. The assessment of the degree of rooting was carried out in Autumn. The highest rooting percentage (90%) was found for 'Verde', as well as 'Jumbo' and 'MSU' (85% each). The lowest rooting percentage (10%) was noted for the following cultivars: 'Domino', 'Ananasnaja' and 'Weiki' (female).

Relationship between the soil N fertility and the content of biologically active compounds in *Actinidia arguta* 'Geneva' fruit directly after harvest and during cold storage

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The fruit antioxidant properties and their changes during maturation, storage and shelf-life were widely discussed in many scientific papers. It is expected that crop cultivars with a higher antioxidant ability have better stress resistance, nutritional quality and storage characteristics. The aim of this study was therefore to test the antioxidant status of *Actinidia arguta* 'Geneva' fruit after harvest and during cold storage in relation to different soil N level (3, 5, 8 mg 100 g⁻¹ of dry soil weight) which were applied into soil in early Spring. According to our research 'Geneva' fruit is characterized by a higher antioxidant potential compared to other cultivars recommended for commercial cultivation such as 'Weiki', 'Bingo' and 'Ananasnaya'

Fruit total vitamin C and phenolic contents as well as total antioxidant activity were determined. Three tests (FRAP, ABTS, and DPPH) were employed to evaluate the impact of increasing N fertilisation and time of storage on kiwiberry total antioxidant activity. The analyses were carried out just after harvest and then at intervals of 7 days during the period of 2 months cold fruit storage (eight fruit samplings). Both main factors i.e. nitrogen fertilization and time of storage influenced significantly the concentration of bioactives and total antioxidant activity. However there was no interaction between the main factors. Fruits sampled from the treatment with the lowest soil N-fertility were characterized by the greatest antioxidant potential. During the cold storage fruit ascorbate content decreased by 35%. The total phenolic concentration as well as the total antioxidant activity were either increasing or remaining unchanged until the 6th week of storage. It can be concluded that fruit internal quality was maintained quite well during the analyzed storage time.

This study was partially funded by the National Centre for Research and Development (NCBiR) Poland, grant no. PBS3/A8/35/2015.

Study of soil fatigue in gardens with woody vines

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The study of the phenomenon of the soil fatigue in fruit gardens is of great importance, since plants that grow over many years in one place, release in the environment the substances of different biochemical composition, which play an extremely important role in the functioning of phytocoenoses.

Actinidia arguta (Siebold et Zucc.) Planch. ex Miq. is a new promising fruit crop. Vegetative and generative organs of *A. arguta* have a high content of the different compounds, in particular phenols, that can enter to the root environment by leaching precipitation, rotting plant residues or as part of root extracts and cause the allelopathic effects.

The research was carried out on the plots of woodyvines of the M. Gryshko National Botanic Garden. Allelopathic activity of the soil was studied by modified Neubauer and Schneider method.

It was found, that the presence of allelochemicals in the rizosphere soil from under the liana *Vitis vinifera* and *Schizandra chinensis*, which have grown in monoculture during more than 50 years, inhibit the growth processes of the test objects, which indicates the appearance of soil fatigue. At the same time, in the variant with soil from under actinidia (monoculture) the stimulation of the growth of test objects was found to be 35-40%, that is the plants of actinidia do not cause soil fatigue after long growing period. It is worth noting that even in variants where actinidia grows after other vines, the soil fatigue was significantly reduced.

Actinidia plants do not cause soil fatigue after prolonged growth as monoculture, and when cultivating of actinidia after grapes and *S. chinensis*, the soil fatigue is significantly reduced, compared with variants of their prolonged growth as monoculture. So the plants of *A. arguta* may be used for soil phytoremediation in fruit gardens.

Effect of gibberellins and boron application on the quality of kiwiberry fruits

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Actinidia arguta fruits are becoming more and more popular and more accessible to consumers. Over time, the problem will not be the availability of fruits but their quality. The aim of the research was to check how plants treated with gibberellin and boron will affect the quality of kiwiberry fruit. The experiment was carried out on a female variation of the *A. arguta* 'Geneva'.

Four combinations were purposed: GA₄₊₇, boron, GA₄₊₇ and boron, control. In each combination were 4 replicates (one plant as replicate). They were sprayed with Gibb Plus 11 SL twice in a single dose of 0.5 L / ha. It was used after blooming at an interval of 1 week between treatments. Spraying with Cropvit B twice in a single dose of 3 L / ha. It was used in the bloating phase of the buds and in the balloon phase. It was implemented combination with Gibb Plus 11 SL and Cropvit B, in the same doses and dates as above. Several qualitative parameters were analysed for e. g: mean fruit weight, percentage of commercial fruit (minimum 18 mm in diameter), russeting skin, extract content, number and weight of seeds

Using gibberellins have an effect on the mean weight of *A. arguta* 'Geneva' berries. The combination of boron and gibberellins jointly have the greatest impact on fruit quality, resulting in the smallest number of strongly russeting fruits. All preparations (also combined) have a positive effect on the weight of seeds. Seeds with the highest weight were obtained from fruits harvested from plants treated with gibberellins and boron. The other parameters had no effect.

Fruit bioactive compounds and total antioxidant activity in reference to increasing N fertilization of *Actinidia arguta* plants in field conditions

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Internal factors, such as genotype, along with external factors are the two primary factors affecting fruit chemical characteristics. Agronomic management practices such as the farming or tillage systems, soil quality traits, fertilization or weather conditions during the growing season, are some of the major external factors that can modify tissue phytochemical content. The kiwiberry is characterised by high concentrations of biologically active phytonutrients, which concentration may increase or decrease due to agronomic management practises. Nitrogen is one of the most crucial macronutrients in the control of both qualitative and quantitative yield attributes. The aim of this study was therefore to test the relationship between the fruit's antioxidants as well as total antioxidant activity and increasing nitrogen fertilizing *Actinidia arguta* plants in field conditions.

The soil N treatments examined were 3 (N1), 5 (N2) and 8 (N3) mg N 100 g⁻¹ soil dry weight. N doses for respective N treatments were calculated on the basis of available N content in the soil, soil density (1.5 kg dm⁻³ on average) and a topsoil depth of 0.2 m. Two commercially available cultivars, 'Weiki' and 'Geneva', were selected and tested in 2015 and 2016. Based on the overall weather conditions in 2015 and 2016, these two growing seasons were substantially different.

Irrespective of the growing season, total glutathione and ascorbic acid contents were not affected by soil N fertility. Higher soil N level resulted in an increase of carotenoid content and a decrease of phenolic content. Only rutin, regardless of the growing season, showed a similar N-dependent response as total phenolics. No clear response to increasing N level in the other individual phenolic compounds was noted. Total antioxidant activity declined gradually with a greater plant N supply. Based on yield level and fruit antioxidant properties the optimum soil N range for *A. arguta* was between 3 and 5 mg N per 100 g of soil.

This study was funded by the National Centre for Research and Development (NCBiR) Poland, grant no. PBS3/A8/35/2015.

Leaf analysis in the diagnostics of kiwiberry plant nutritional status - summary of a long-term study

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Plant nutrition is a key factor in crop management that affects both qualitative and quantitative yield attributes. A deficit and excess of essential nutrients both have a negative impact on plants and the surrounding environment. Taking these factors into account, a knowledge-based fertilisation concept should be included to elaborate optimal strategy for plant feeding with macro- and micronutrients. Soil and plant chemical analyses should be a principal support when nutrient doses are counted. The aim of this study were therefore: i) to assess the seasonal nutrient content changes in leaves of kiwiberry, ii) to join the level of leaf nutrient content with the plant nutritional status (sufficient or not) and finally, iii) to indicate an optimal time for leaf sampling for the diagnostic purposes.

Leaf samples of ‘Weiki’ and ‘Geneva’ for nutrients content were collected at 5 time points during growing season starting from the May 28 in 2015, June 2 in 2016 and May 22 in 2018 and continuing every 3 weeks to the mid or end of August. Every sample consisted of 24 leaves growing on the same height, of similar size and they were gathered evenly from shoots on both sides of every plant. Standard procedures were used to analyse the leaf total nutrient contents.

The pattern of changes depended strongly on the nutrient and next on the growing season. Although cultivars differed in the mean nutrients content they expressed rather similar pattern of macro- and micronutrients changes during growing period. With time N and K contents decreased, while Ca, Mg, B, Fe and Mn increased. The size of the content decrease/increase in subsequent terms depended strongly on the tested nutrient. Fluctuation of P, S, Cu and Zn contents during growing period was less clear and/or more cultivar dependent. Leaves sampled between the third decade of June to mid-July expressed a certain stability in the nutrient content, especially macronutrient. Leaf analysis is particularly useful in N doses determination. This period of time seems to be appropriate for leaf sampling for chemical analysis.

This study was funded by the National Centre for Research and Development (NCBiR) Poland, grant no. PBS3/A8/35/2015.

Does genetically diverse pollen affect the quality of kiwiberry fruit?

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Kiwiberry (*Actinidia arguta*) as a tasty source of antioxidants and Vitamin C, is becoming more and more popular among consumers and fruit producers. Cultivating this dioecious plant, makes the possibility of choosing the pollen source. Then, the aim of the work was to check, if the source may influence the fruit quality. A study was provided on three female *A. arguta* cultivars, which were hand pollinated with pollen from five male cultivars: three *A. arguta*, one *A. arguta* var. *purpurea* ‘Rot’ and *A. chinensis* var. *deliciosa* ‘Tomuri’.

Hand pollination was made in controlled conditions on isolated shoots. Average fruit weight and biochemical features – fruit total phenolic concentration (TPC), ascorbate (ASC), pigments, total antioxidant activity and seed proteins profile were evaluated. TPC was determined using the Folin–Ciocalteu reagent assay. ASC, individual phenolic compounds and pigments composition were analysed using HPLC technique. Seed protein composition was analysed based on SDS-PAGE.

It turned out that ASC content was not influenced by pollen source, whereas high impact was noticed for dry matter and phenolic contents. *A. chinensis* var. *deliciosa* ‘Tomuri’ affected the protein spectrum with a 17 and 23kDa protein. Results suggests that male plants should be selected individually for particular female cultivar. Also *A. chinensis* var. *deliciosa* ‘Tomuri’ seems to be good pollinizer for *A. arguta* female plants.

This study was supported with the National Centre for Research and Development (NCBiR) Poland, grant no. PBS3/A8/35/2015.

Sensory image of fruit juices mixtures based on kiwiberry (*Actinidia arguta*) and its effect on hedonic response of consumers

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The expanding popularity of kiwiberry results from its sensory characteristics as well as high nutritional value. The kiwiberry juice is a new product concept which allows profit the valuable properties of this fruit throughout the year. The question is: “How the addition of various amounts of juices affect the sensory image and consumers acceptance of fruit juices mixtures based on kiwiberry?”. The aims of the study were: 1) to determine the similarities and differences in the sensory characteristics of fruit juices mixtures based on kiwiberry; 2) to assess the consumers’ liking and emotional response regarding the products; 3) to analyze the relationship between the expected and experienced liking and willingness to buy of the juices; 4) to establish the optimal sensory image of the juices determining their positive hedonic perception among consumers. The products used in the study were kiwiberry juices (100%) mixed in the following proportions with apple, plum and pear juice: 90%/10%, 80%/20%, 70%/30%; 60%/40%; 50%/50%, respectively.

The study consisted of three main parts: 1) Profiling of the juices (Quantitative Descriptive Analysis), 2) assessment of sensory and emotional characteristics (Check-All-That-Apply questionnaire), 3) evaluation of hedonic response on a 9-point scale. The consumer study involved 110 young adults consumers (18-21 years old). They participated in the second and third stages of the research.

Sensory quality of kiwiberry juice mixed with other juices in ratio 70%/30%; 60%/40%; 50%/50% was positively associated with the intensity of fruits attributes (apple, plum, pear), sweet odor and taste, sweet aftertaste, feeling of harmoniousness and essentiality in the juices. The remaining juices (100% kiwiberry, kiwiberry juice mixed with other juices: 90%/10%, 80%/10%) were mainly intense in kiwiberry odor and taste, sour odor and taste, persistence flavor, green odor and flavor, and were perceived as more dense and viscous. The effect of rising amount of other juices in kiwiberry juices on profile characteristics was selective: it enhanced and suppressed intensity of some key attributes. Some differences in liking of juices (especially in taste/flavor) were also observed. The relationship between the expected and experienced liking and willingness to buy of the juices depended on the mutual proportions between the amount of kiwiberry juice and other juices and determined the emotional and hedonic reactions of consumers.