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MORPHOLOGICAL TRAITS OF SOME *LONICERA* SP. VARIETIES AFTER FIRST YEARS GROW IN ROMANIA

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Abstract

The blue honeysuckle (Lonicera caerulea L.) is a perennial fruit-bearing shrub that originated from distant Siberia and northeastern Asia. The objective of this study is to present the morphological traits of 16 varieties of Lonicera sp. from a young orchard established in micro-tunnels and 3 varieties in an open field planted in 2023 at distances of 3.0 × 1.0 m. The characteristics of each variety were analyzed in detail, including height, crown shape, leaf parameters, branch structure, as well as flowers and fruits distinctive traits. The research was conducted in the experimental field of the Faculty of Horticulture - University of Agronomic Sciences and Veterinary Medicine of Bucharest and Research Institute for Fruit Growing Pitești – Mărăcineni involving varieties of Lonicera caerulea and Lonicera kamtschatica planted in the spring - autumn of 2023.

Key words*: Lonicera caerulea, Lonicera kamtschatica, morphology, phenology, traits.*

INTRODUCTION

Blue honeysuckle, scientifically known as *Lonicera caerulea* L., is a member of the Caprifoliaceae family. It goes by various names such as "haskap", "sweet berry honeysuckle", "edible honeysuckle", "Kamchatka berry" and "honeyberry", as mentioned in previous papers by Jurgoński et al. (2013), Jurikova et al. (2012a), Becker and Szakiel (2019), and Rupasinghe et al. (2018). With a circumpolar geographic distribution, predominantly thrives in the boreal and arctic forest zones of Eurasia, this plant is a mesophytic perennial fruit-bearing shrub that originated from Siberia and northeastern Asia and boasts remarkable characteristics as an emerging fruit crop, such as exceptional resilience to harsh winters, flower resistance against severe frosts, and early-season phenology. Blue honeysuckle primarily thrives in boreal and temperate coniferous woodlands, as well as shrublands, fens, and marshes, often growing as undergrowth within forest ecosystems (Mucina, 1997). Like many circumpolar species within the *Lonicera* genus (Rudenberg and Green, 1969), it tends to inhabit river valleys, boreal forests, and forest patches reaching into the tundra in the north, and extending up to mountain timberlines at higher elevations (Skvortsov, 1986). Conversely, in its southernmost regions, it is limited to the upper part of the forest belt and, under protective conditions, may extend into the lower parts of the sub-alpine and alpine zones (Rudenberg and Green, 1969). The northern boundaries of its native distribution are constrained by insufficient summer warmth, severe frosts, and nutrient-poor soils, while heat and drought define its southernmost limits (Sheyko, 2009).

The initial documentation of this plant traces back to the 17th century, while initial endeavors towards its cultivation occurred in Russia in the early 20th century. Ivan Vladimirovich Michurin was a Russian practitioner of selection to produce new types of crop plants, he started his research in pomology and selection and is one of the pioneers that began the study of blue honeysuckles in 1909 in the Tambov region of Russia and recommended to use this plant in orchards. From around 1950, Russian efforts intensified to breed cultivars aimed at maximizing yield, enhancing fruit size and sweetness, and facilitating mechanical harvesting through balanced fruit ripening. Comparable initiatives in various European countries, including Poland, Czech Republic,

Lithuania, Finland, and Slovakia, commenced only towards the end of the 20th century (Celli et al., 2014; EFSA, 2018; Becker and Szakiel, 2019).

Presently, the commonly cultivated Canadian cultivars are derived from the cross-breeding of *L. caerulea* var. *kamtschatica* with the Canadian variety *L. kamtschatica* var. *villosa* and the Japanese (Hokkaido) variety *L. caerulea* var. *emphyllocalyx* (Thompson and Barney, 2007). Conversely, Polish varieties issued from the hybridization of *L. caerulea* var. *kamtschatica* with *L. caerulea* var. *edulis* (Becker and Szakiel, 2019). These particular species yield delectable, fragrant, sweet-and-tart fruits reminiscent of highbush blueberries or bilberries.

In Poland, the assortment include 'Wojtek', 'Jolanta', 'Atut', 'Duet', 'Brazowa', 'Czarna', and 'Warszawa' (Becker and Szakiel, 2019; Kaczmarska et al., 2015; Ochmian et al., 2012; Ochmian et al., 2008). Meanwhile, the most popular Canadian varieties are 'Blue Belle', 'Blue Bird', 'Blue Moon', 'Blue Velvet' 'Tundra', 'Aurora', 'Borealis', 'Indigo Gem' and 'Honeybee' (Becker and Szakiel, 2019; Rupasinghe et al., 2018; Rupasinghe et al., 2012). The fully developed shrub displays a dense, upright shape. These shrubs can grow up to 2 meters tall and spread to a width of 1.5-2 meters (Figure 1).

Figure 1. *L. caerulea* var. 'Zojka' in the experimental field of the Faculty of Horticulture Bucharest

The bush blossoms concurrently with leaf development. Their flowers are soft yellow, rich in nectar, with a delicate, pleasing scent.

Research has demonstrated significant variations in flowering time, sometimes exceeding two weeks, among identical varieties in different years. In Canada, blue honeysuckle typically starts flowering in early May, whereas in Poland, it usually blooms by late April (Gawroński et al., 2014). However, the timing of flowering is greatly influenced by climatic factors, especially temperature (Figure 2).

Figure 2. *L. caerulea* var. 'Blue velvet' in the experimental field of the Faculty of Horticulture Bucharest

Another significant factor is the variety itself, flowering duration can range from 7 to 15 days depending on the specific variety (Dawson, 2017). Given that blue honeysuckle is not self-pollinating, it relies on the presence of a different variety flowering simultaneously nearby for cross-pollination to take place. While a solitary blue honeysuckle shrub can still produce fruit, the yield is typically less abundant (Frier et al., 2016).

Blue honeysuckle typically begins bearing fruit in the second year after planting, with the full harvest potential, ranging from 3 to 5 kg, achievable 8 to 15 years post-planting (Dawson, 2017). The berries are characterized by their fleshy, elongated shape, navy blue coloration, and are adorned with a waxy, blue coating.

MATERIALS AND METHODS

The research was conducted in the experimental field of the Faculty of Horticulture - University of Agronomic Sciences and Veterinary Medicine of Bucharest (Figure 3) and Research Institute for Fruit Growing Pitești - Mărăcineni. The plant material consisted of 16 varieties of *Lonicera caerulea* from a young orchard established in micro-tunnels and 3 varieties of *Lonicera kamtschatica* planted in open field in the spring - autumn of 2023 at the distances of 3.0 × 1.0 m. The varieties of *Lonicera caerulea* included in this study were as follow: 'Zojka', 'Wojtek', 'Ruth', 'Rebecca', 'Larisa', '*L. kamtschatica*', 'Atut', 'Jolanta', 'Eisher', 'Indigi jam', 'Blue velvet', 'Blue pacific', 'Blue moon', 'Blue forest', Aurora', 'Borealis' and 'Kami', 'SI-15' 'SI-22' (from ICDP Pitești - Mărăcineni).

Figure 3. Experimental field with the *Lonicera caerulea* varieties at USAMV Bucharest

The habit and vigour of the plants were evaluated by measuring the height, diameter, number of stems/plants, number of annual growths/plants, Σ of the annual growths.
The fructification capacity was assessed by the number of inflorescence and number of flowers and fruits per plant.
The mature leaves were analysed using the WinFolia 2022 software, measuring the leaf blade length and width, length of the petiole, and the basal and apical angles of the blade.
For morphological and micromorphological analyses, flowers and leaves were collected in April 2024 and examined fresh under a binocular and microscope. The biological material was studied using an Optica microscope and photographed with a Motorola digital camera in the Botany-Morphology and Plant Anatomy laboratory at USAMV Bucharest. Additionally, photographs were taken with a Motorola camera and a Leica S8AP0 binocular at various magnifications. Flowers were analysed at full bloom.
Diameter of the open flower, length of the petals and pistil, with of the petal and the number of stamens were measured or counted for all varieties.
Fruits were sampled at maturity, calculating their weight, widths, length, firmness, total sugars and total acidity.
From each variety it was collected 20 fruits for the morphological measurements done using a digital caliper and the weight was calculated as an average of 10 fruits/variety using the electronic balance Partner PS 1200 R2.
The total sugar was measured using the digital refractometer Milwaukee MA871.
For the pH and fruit's acidity, it was used a titrator device SI Analytics Titroline 5000 and for the firmness the Penetrometer 53205SP. Dry matter content was also recorded using oven Memmert GmbH.
Data retrieved were subjected to statistical analysis using one-way analysis of variance and the multiple range test Duncan by SPSS system.

RESULTS AND DISCUSSIONS

In the Spring of 2024, after the vegetation start and in the timeline with the occurency of the flowers at the variety level the samples were subsequntely collected and analyzed in the lab according to the methodology previously described.

Flowers

The size of the flowers varied between 1.2-2cm, are pale yellow, hermaphrodite, with a differentiated floral cover in the calyx and corolla, the sepals are small, the petals are 5 united at the base, 5 stamens arranged in alternation with the sepals (Figures 4, 5).

Figure 4. Flowers of *Lonicera caerulea*

The anthers are exserted, dorsofixed with a longitudinal opening. The style exceeds the corolla, nectaries may be present in the corolla tube.
The flowers are arranged in inflorescences. The inflorescences can have 2, 3 or sometimes 4 flowers.

Figure 5. Dorsifixed stamens with longitudinal opening

The corolla tube presents numerous secretory hairs and tectors (Figures 6, 7, 8).

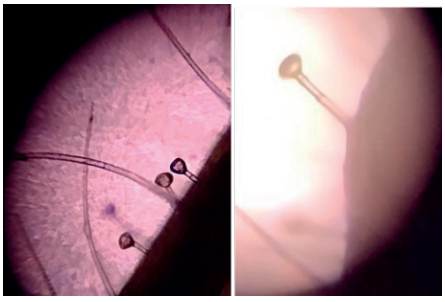


Figure 6. The corolla tube of *Lonicera caerulea*

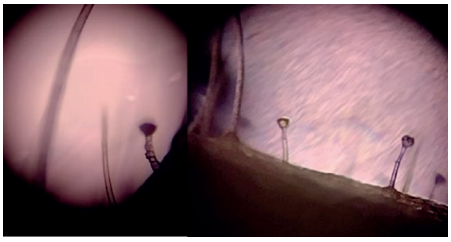


Figure 7. Secretory and tectors hairs in the corolla tube of *Lonicera caerulea*

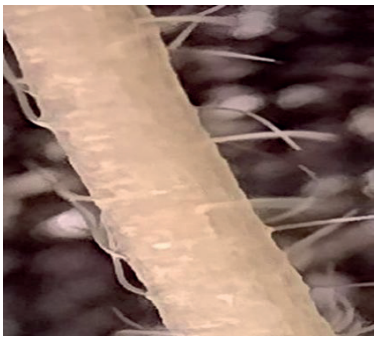


Figure 8. Upper epidermis with tector and secretory hairs

Leaves

The measured leaf parameters are presented in Table 1. The leaves have more tector and secretory hairs on the upper epidermis than on the lower one (Figures 9 and 10).

Figure 9. Lower epidermis with tector and secretory hairs

Figure 10. Superior epidermis with tector and secretory hairs

Fruits

Fruits characteristics are summarized in Table 2. The weight varied from 0.77 g at 'Eisher' to 1.69 g at 'Blue Pacific' with an average of 1.13 g.
The shape and color of the varieties are emphasized in the Figure 11, with distinctive redish tones at 'Rebeca' variety and darker blue at 'Blue Moon'. Smallest fruits were observed at the both selections of Pitesti.

Tabel 1. Leaf parameters of *Lonicera caerulea* varieties

Variety	Leaf Area (mm^2)	Perimeter (mm)	Vert Length (mm)	Horiz Width (mm)	Avg Horiz Width (mm)	Aspect Ratio (W/L)	Form Coefficient	Blade Length (mm)	Max Perp Width (mm)	Posi Max Perp Width (mm)	Perp Width 1 (mm)	Perp Width 2 (mm)	Lobe Angle 1	Lobe Angle2	Petiole Length (cm)	Petiole Area (cm^2)
Zojka	162.78	164.39	65.21	35.91	24.99	0.55	0,75	64.10	35.63	31.73	35.16	15.68	42.60	41.7	0.24	0.02
Wojtek	93.38	99.84	58.45	35.49	24.21	0.61	10.22	37.30	35.30	8.81	31.04	11.17	70.00	58.20	0.26	0.04
Ruth	83.57	116,67	47.15	24.70	17.32	0.52	0,75	46.74	24.39	23.51	24.21	12.26	41.00	38.38	0.10	0.01
Rebecca	121.71	143.77	58.62	30.56	20.67	0.52	0,74	58.11	30.12	28.58	29.85	12.97	32.2	38.20	0.16	0.02
Larisa	108.12	130.89	51.00	31.21	21.26	0.62	0.79	49.91	30.97	24.71	30.82	14.12	38.63	43.82	0.20	0.02
L. kamtschatica	115.42	139.44	56.28	29.88	20.43	0.53	0.74	55.51	29.63	23.86	29.07	11.46	43.82	41.64	0.16	0.03
Atut	153.70	153.77	57.52	37.13	26.55	0.65	0.81	58.13	36.37	28.207	36.15	16.98	46.64	45.27	0.23	0.03
Jolanta	122.68	140.29	57.38	31.83	21.34	0.56	0.78	57.23	31.03	27.43	30.76	13.63	31.09	38.73	1.07	0.04
Eisher	57.11	100.00	44.29	19.06	13.01	0.43	0.71	42.68	18.66	20.39	18.18	1.96	36.4	32.40	0.13	0.08
Indigi jam	134.85	147.39	62.43	32.20	21.71	0.52	0.78	60.05	31.98	27.85	31.66	12.84	45.09	40.18	0.36	0.07
Blue velvet	113.78	132.62	53.03	30.81	21.25	0.58	0.80	52.32	30.47	26.13	30.11	14.95	43.00	40.89	0.14	0.01
Blue pacific	151.26	156.31	64.02	33.59	23.24	0.53	0.76	62.72	33.30	29.10	33.02	15.67	38.2	39.30	0.19	0.03
Blue moon	153.34	162.30	67.34	34.39	22.78	0.51	0.72	65.88	34.07	30.94	33.78	14.62	23.5	38.40	0.24	0.03
Blue forest	121.70	140.84	57.45	31.32	21.12	0.55	0.77	56.27	30.95	27.206	30.59	12.34	38.5	40.3	0.21	0.02
Aurora	108.25	144.85	61.69	25.21	17.38	0.41	0.64	60.70	24.90	29.07	24.25	11.52	35.09	32.67	0.17	0.01
Borealis	81.23	126.54	53.44	22.99	15.13	0.43	0.63	52.83	22.67	24.67	22.19	2.07	31.1	33.50	0.16	0.01
Kami	84.00	121.15	49.66	23.97	16.86	0.48	0.71	49.65	23.61	23.85	23.20	6,44	45.8	36.90	0.06	0.005
SI-15	69.85	113.22	47.27	21.47	14.77	0.46	0.68	46.96	21.22	22.21	20.98	1.84	41.3	35.10	0.08	0.006
SI-22	63.13	107.99	45.00	20.45	13.97	0.46	0.68	44.99	20.06	23.55	19.622	2.20	40	34.00	0.10	0.01

Table 2. Fruit parameters of *Lonicera caerulea* varieties

Varieties	Weight (g)	Width 1 (mm)	Width 2 (mm)	Length (mm)
Zojka	1.04^{efg}	8.79^{g}	9.48^{def}	22.26^{c}
Wojtek	1.10^{def}	10.52^{def}	8.97^{efg}	23.78^{ab}
Ruth	0.92^{fgh}	9.80^{efg}	8.82^{efg}	15.89^{h}
Rebecca	1.43^{ab}	11.22^{bcd}	9.71^{cde}	20.58^{cd}
Larisa	0.88^{gh}	10.47^{def}	8.50^{fgh}	20.43^{cd}
L. kamtschatica	1.19^{cde}	12.30^{ab}	10.31^{abc}	17.00^{efg}
Atut	1.35^{abc}	10.89^{cde}	10.06^{bcd}	23.60^{ab}
Jolanta	1.12^{def}	9.39^{fg}	8.23^{gh}	22.58^{b}
Eisher	0.77^{hi}	8.85^{g}	7.84^{h}	19.72^{d}
Indigi jam	1.31^{abcd}	12.56^{a}	10.54^{ab}	19.47^{d}
Blue velvet	1.06^{efg}	10.28^{def}	8.96^{efg}	18.43^{def}
Blue pacific	1.69^{a}	12.46^{ab}	10.74^{a}	22.73^{b}
Blue moon	1.16^{cde}	11.79^{abc}	9.68^{cde}	18.44^{def}
Blue forest	1.02^{efg}	10.30^{def}	9.12^{defg}	18.91^{de}
Aurora	1.06^{efg}	10.05^{def}	8.34^{gh}	23.30^{ab}
Borealis	1.04^{efg}	10.64^{cde}	9.09^{defg}	16.39^{gh}
Kami	0.68^{i}	3.43^{h}	3.10^{i}	2.46^{a}
SL-15-17	0.44^{j}	2.87^{hi}	2.60^{i}	1.62^{h}
SL-22-17	0.50^{j}	2.10^{j}	2.23^{i}	1.94^{d}

*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; $p \leq 0.05$.

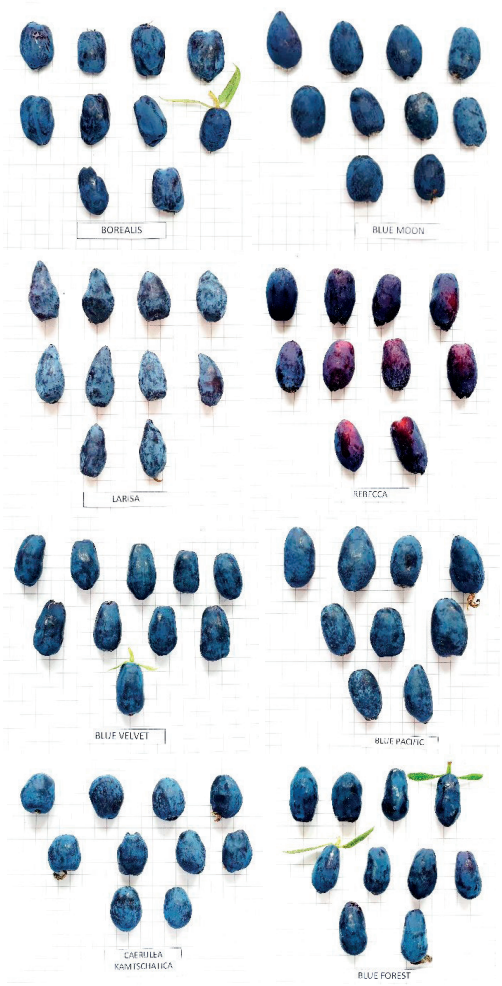


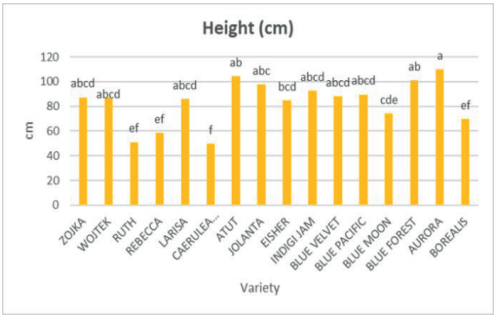
Figure 11. Shape and color of some *Lonicera* varieties at the harvest time

Concerning the plant behavior in terms of vigor and biometric particularities after the first vegetation period, we observed that differences at the variety level were consistent and statistically assured.

For instance, the tallest plants (Figure 12) were 'Aurora' variety that overpassed the other varieties together with 'Atut' which grew higher than 100 cm.

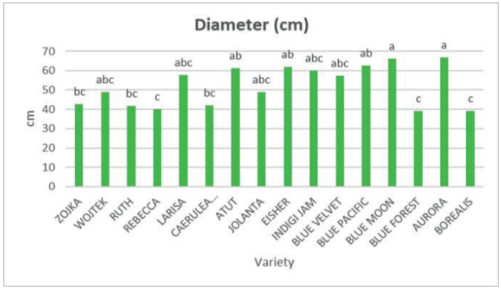
An homogenous group was remarked between 85 to 100 cm and the smallest ones seized at 'Ruth', 'Rebecca' and '*L. kamtschatica*'.

The plant shape is also very different from one variety to another, with the tendency of bigger diameter of the plants at the same variety with higher stems (Figure 13).



*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

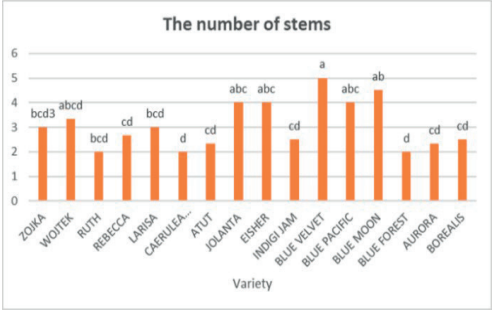
Figure 12. The differences in vigour at the level of *Lonicera* varieties



*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

Figure 13. The plant diameter at the *Lonicera* varieties

An interesting observation is related to the number of stems/plant (Figure 14.) that are not anymore correlated with the hight of the plants, in this case, 'Aurora' and 'Atut' registered less than 3 stems/plant while the group of 85-100 cm height encountered more that 4 stems/plant.



*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

Figure 14. The number of stems/plant at the *Lonicera* varieties

The number of annual growths (Figure 15) indicate 'Ruth' as a very weak vigour close by 'Rebecca' and 'Blue forest'.
A more active plants were remarked at 'Atut' as well as the sum of the annual growths (Figure 16).

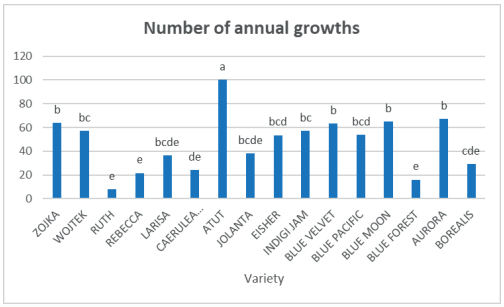


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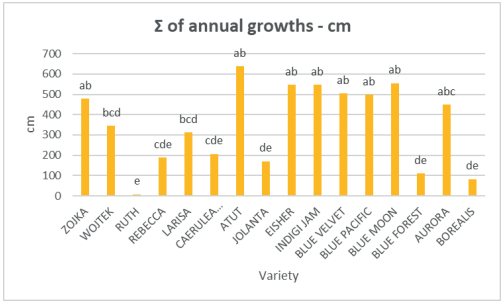
Figure 15. The number of annual growths/plant at *Lonicera* varieties



*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

Figure 16. The total annual growths/plant at *Lonicera* varieties

In the second year after planting, all varieties of *Lonicera* sp set up fruits. The fructification parameters are indicating the variety 'Indigi jam' as a very fertile one considering the higher values of the number of inflorescences/plant (Figure 17) and the total number of flowers/plant (Figure 18).
Fruits of *Lonicera caerulea* are very soft and therefore with a short storability and shelf life capacity.
The quality of the fruits starts from the size and continue with the most use physio-chemical characteristics that define the overall value of the variety.

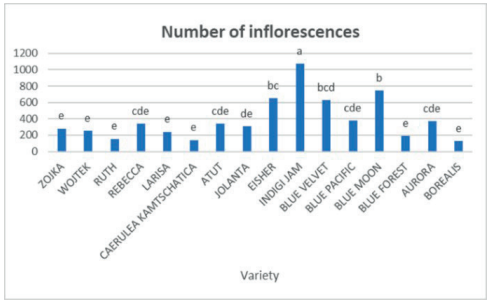


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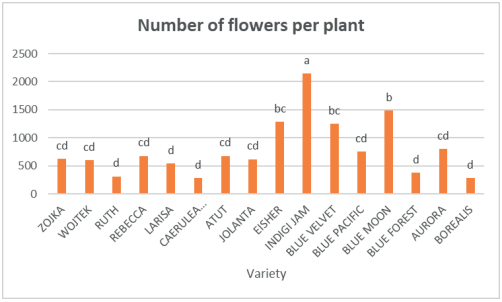
Figure 17. The number of inflorescences formed/plant at *Lonicera* varieties



*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

Figure 18. The number of flowers/plant at *Lonicera* varieties

In the Table 3, data showes that the firmest fruits were from 'Zojka', 'Wojtek' and *L. kamtschatica* where the values are over the threshold of 5 kgf/cm^2.
Sweeter fruits were harvested from *L. kamtschatica* (13.44^{0}Brix), 'Indigi jam' with 14.05^{0}Brix and both selection from Pitesti while 'Jolanta' accumulated only 10.09^{0}Brix. Far away from the other varieties is 'Ruth' which riched a percent of 23.19 dry matter. 'Eisher' and the same 'Indigi jam' proved to have the highest contents of dried matter as well as *L. kamtschatica* which had more than 15% of dry substance. pH values varied between 2 and 3 with a higher values at the Pitesti selections, close with the values reported by Gorzelany J et all, 2023. In their experiment, juice pH ranged between 3.7-3.32 at *L. kamtschatica* and 3.13-3.52 at *L. emphyllocalyx*. Gerbrand et al. (2020, found out a pH of *Lonicera caerulea* varying from 2.42 to 3.10.

Table 3. Fruit properties of *Lonicera caerulea* varieties at the first pick

Variety	Firmness (kgf/cm^2)	Total sugars (°Brix)	Dry matte content (%)	pH
ZOJKA	5.82^{c}	11.27^{ef}	12.47^{i}	2.77^{fgh}
WOJTEK	5.32^{cd}	11.33^{ef}	12.16^{ij}	2.64^{ijk}
RUTH	2.81^{ef}	13.2^{abcde}	23.19^{a}	2.78^{fg}
REBECCA	2.87^{ef}	11.28^{ef}	13.93^{f}	2.71^{ghi}
LARISA	3.41^{def}	12.57^{cde}	13.08^{h}	2.61^{jk}
KAMTSCHATICA	5.73^{c}	13.44^{abc}	15.77^{ab}	2.73^{ghi}
ATUT	2.53^{f}	12.99^{bcde}	13.78^{g}	2.71^{ghi}
JOLANTA	4.22^{cdef}	10.09^{f}	11.95^{j}	2.61^{jk}
EISHER	3.01^{ef}	12.73^{bcde}	15.06^{cd}	2.77^{fgh}
INDIGI JAM	4.98^{cde}	14.05^{abc}	15.48^{bc}	2.76^{fgh}
BLUE VELVET	4.15^{cdef}	11.51^{def}	11.98^{j}	2.56^{k}
BLUE PACIFIC	3.73^{cdef}	12.34^{cde}	11.94^{j}	2.8^{fg}
BLUE MOON	3.86^{cdef}	11.36^{ef}	13.57^{fg}	2.83^{de}
BLUE FOREST	3.57^{def}	11.3^{ef}	12.95^{h}	2.81^{ef}
AURORA	4.12^{cdef}	12.56^{cde}	14.56^{e}	2.96^{gh}
BOREALIS	3.58^{def}	11.58^{def}	13.11^{h}	2.76^{ghi}
Kami	1.19	13.33^{abcd}	13.33^{gh}	3.08^{bc}
SL-15-17	1.24	14.43^{ab}	14.43^{e}	3.42^{ab}
SL-22-17	1.49	14.86^{a}	14.86^{cd}	3.81^{a}

*Same letters show no significant difference. Different letters between items indicates significant differences according to Duncan's multiple range test; p≤ 0.05.

CONCLUSIONS

The variability in traits for all varieties of *Lonicera* sp was more expressed for vegetative characteristics of plant and fruit size and less in case of pH, total sugar content and dry substance.

Morphological traits for all 19 varieties of honeysuckle indicated a large variability in terms of leaf and flower botanic characteristics.

In our growing condition, the most vigorous variety of *Lonicera* sp was 'Aurora' closely followed by 'Atut'.

'Blue velvet' presented the most spread growth among the varieties of *Lonicera* sp.

'Indigi jam' performed better in terms of number of flowers and fruits/plant and also for the total sugar content.

The biggest fruits were harvested from 'Blue Pacific' and the highest content of dry substance accumulated in the fruit was recorded at 'Ruth' variety.

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