Fruit Growing Research, Vol. XLI, 2025 DOI 10.33045/fgr.v41.2025.10
https://publications.icdp.ro/index.php

CARACTERIZAREA CALITATIVĂ A ARBUȘTILOR FRUCTIFERI ÎN CONDIȚII DE ÎNIERBARE NATURALĂ PE RÂND

QUALITATIVE CHARACTERIZATION OF SMALL FRUIT UNDER NATURAL ROW GRASSING

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Abstract

The aim of the study was to investigate the quality parameters of some berries under natural grassing conditions, in the inter-rows. The experiment was conducted in the period 2023-2024 in a demonstration plantation of the Research Institute of Mountain Stockbreeding and Agriculture, Troyan (Bulgaria) on light grey forest soils. Three blueberry cultivars (Bluecrop, Patriot and Toro) and three blackcurrant cultivars (Byurlovskaya, Ometta and Ben Lomond) were the objects of the study. The data on the biochemical indicators of the study indicate that blueberry and blackcurrant fruits have a high (valuable) biological value. The analysis of blueberry fruit revealed a lack of sucrose in the first experimental year and a very limited sucrose content in the second (0.01 % - Bluecrop and 0.06 % - Patriot). The highest anthocyanin content was found in the cultivar Patriot (85.56-161.50 mg/%) for the genus *Vaccinium* and in the cultivar Ben Lomond (290.37 mg %) for the genus *Ribes*. The relative share of cereal varieties in the interrows of *Vaccinium corymbosum* L. correlated positively with the contents of total sugars (r = 0.666), inverted sugar (r = 0.669) and acids (as malic) (r = 0.975), and the amount of legumes with the contents of sucrose (r = 0.640) and ascorbic acid (r = 0.987). In *Ribes nigrum* L., the percentage of cereal meadow grasses in inter-row strips was strongly negatively correlated with the amount of sucrose (r = -1.000) and ascorbic acid (r = -0.998). Legume species showed a positive correlation with dry weight matter (r = 0.710), refractory solids (r = 0.998), total sugars (r = 0.691), invert sugar (r = 0.999), acids (as malic) (r = 0.972), tannins (r = 0.991) and pectin (r = 0.782). The natural grassland in the inter-row strips of blackcurrant has a higher content of structural fibre components and crude protein, which influences the quality of the forage as an energy source for ruminants. The qualitative analysis of the grassland in the interrows in both orchards allows its use as forage in ruminant feeding.

Cuvinte cheie: *Vaccinium corymbosum* L., *Ribes nigrum* L., zaharoză, antociani, înierbare naturală
Key words: *Vaccinium corymbosum* L., *Ribes nigrum* L., sucrose, anthocyanins, natural browsing

1. Introduction

Worldwide, humanity is threatened by a global ecological crisis and a decrease in food raw materials, which requires the rational use of plant sources as such. According to FAO data, in recent decades, under conditions of global conflicts and world crises, the consumption of fresh fruits has increased manifold (Rodriguez-Saona et al., 2019). Scientific research has substantiated the need for daily consumption of quality fruits and vegetables.

Species of the genera *Vaccinium* and *Ribes* are of important economic, nutritional and medicinal importance. Their typical representatives are small fruit species, such as the highbush blueberry and blackcurrant, which are traditionally grown in the mountainous and semi-mountainous regions of the country, where there are suitable conditions for their cultivation. Interest in the *Vaccinium* and *Ribes* genera is determined by their high levels of secondary metabolites such as polyphenols, anthocyanins, flavonols, organic acids, vitamins, moderate content of minerals, etc., which positively influence physiological processes in the human body (Martineau et al., 2006; Krikorian et al., 2010; Stull et al., 2010; Norberto et al., 2013; Sun et al., 2016; Yang et al., 2019 making them suitable components in a daily, healthy human diet.

At present, the soils on which small crops are grown are subjected to the harmful effects of pollution as a result of intensive industrialization, erosion processes of the fertile soil layer, water scarcity, etc. The sloping terrain in the semi-mountainous areas is a major factor in degradation processes (such as erosion) affecting the sustainable cultivation of small fruit crops. The presence of grass plant cover between the rows of orchards is a prerequisite for overcoming some of these problems.

Maintenance of inter-row strips in orchards is a key factor related to soil composition improvements, suppression of weedy vegetation in the trunk of the fruit crop and provision of optimum space for application of agronomic measures including spraying of growth regulators and biofertilizers, pesticides, fungicides, and fruit harvesting (Kundu, 2020). Inter-row management practices should be subordinate to the botanical requirements, growth and development of the main fruit crops, while creating conditions to enhance overall sustainability in an agroecosystem (Das et al., 2021; Dumitru et al., 2024).

The aim of the study was to determine the quality parameters of some small fruit species under conditions of natural inter-row grassing.

2. Material and methods

The trial was conducted during the period 2023-2024 in a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture, Troyan. Blueberry cultivars 'Bluecrop', 'Patriot' and ‘Toro’ and currant cultivars 'Byurlovskaya', 'Ometta' and 'Ben Lomond', which thrive successfully in semi-mountainous conditions, were the subjects of the study. The experimental plantation of blueberries was established in 2019 and of blackcurrants in 2016. The plants are grown under irrigated conditions with drip irrigation applied. The inter-rows are naturally grassed, with the necessary grass cuttings applied, and the in-row area is maintained in black fallow through tillage. The collection plantation is situated at 470 m altitude, on an east-facing slope. The soils are light grey forest soils with pH = 4.6-5.6. Based on the analyses carried out, the soil was classified as heavy sandy loam to clay loam, moderately eroded, and with low humus content. Harvesting was carried out manually (July-August), after the fruits had acquired their characteristic colouring and was stored in polyethylene boxes.

Biochemical study indicators

The biochemical analyses of the fruits of the two studied crops were performed in the chemical laboratory of RIMSA - Troyan. The following indicators were analysed:

- Dry weight (%);
- Dry matter by Re (%);
- Sugars (total, invert and sucrose %) and malic acid has been made, according to the method of Schoorl Regenbogen (Donchev et al., 2001);
- Acids (as malic) (%) - by titration with 0.1 n NaOH;
- Ascorbic acid (mg, %) has been made by the following method: 10 g of the ground sample is quantitatively transferred into a 100 cm^3 volumetric flask. Top up with 2% HCL, then filter. Take 20 ml and place in a 100 ml Erlenmeyer flask, adding 10 ml H_2O and 5 ml KJ. Titrate with KJO_3 (in the case of starch indicator) until a deep blue-permanent coloration;
- Tannins substances (%) according to the method of Levental (Donchev et al., 2000), Chemicals: 1: 4 H_2SO_4, titrated by 0.1 N KM_4O_4 and an indicator (indigo carmine);
- Anthocyanins (mg %) - by the method of Fuleki and Franciss (1968);
- Pectin (%) - by the method of Melitz (Donchev et al., 2000), Chemicals: 0.1 N NaOH, 1 n CH_3 COOH, $CaCl_2$, $AgNO_3$;
- Total polyphenols (mg/100 g) - Folin-Ciocalteu, (Singleton and Rossi, 1965).

The qualitative composition of the natural grassland in the inter-rows of the two orchards was analyzed in order to use it as forage in the feeding of ruminants kept at the Research Institute of Mountain Stockbreeding and Agriculture, Troyan.

Indicators of spontaneous interrow vegetation of the studied fruit species:

- Botanical composition of the grass stand (%) - by analysis of fresh grass samples taken at mowing. Percentages of cereal, legume and various grass varieties were weighted.
- Chemical composition of grassland - by *Weende* analysis were determined: Crude protein (CP, %) by *Kjeldahl*; Crude fibre (CF, %); Crude fat (CF, %) - by extraction in *Soxhlet* type extractor ; Ash (%) - degradation of organic matter by gradual combustion of the sample in a muffle furnace at 550°C; NFE (%) = 100 - (CP, % + CF, % + FC, % + Ash, % + Moisture, %); Calcium (Ca, %) - by Stotz (complexometric) and Phosphorus (P, %) - by vanadate-molybdate reagent by Gericke and Kurmis method - spectrophotometer (*Agilent 8453 UV - visible Spectroscopy System*) measuring in the region 425 ηm.
- Fibrous structural components of the plant cell: Neutral-detergent fibers (NDF, %); Acid-detergent fibre (ADF, %) and Acid-detergent lignin (ADL, %) by the detergent assay of Van Soest and Robertson (1979), Hemicellulose (%) = NDF - ADF and Cellulose (%) = ADF - ADL and *in vitro* dry matter digestibility (INDMD, %) by the two-step pepsin-cellulase method of Aufrere (1982).

Analysis of variance ANOVA was used for statistical processing of the data.

3. Results and discussion

3.1. The qualitative characterization of small fruit

The biochemical analysis of the studied metabolic parameters such as dry matter, soluble solids, total, invert sugars and sucrose, titratable acidity, ascorbic acid, anthocyanins, polyphenols, etc. during the two-year study period of highbush blueberry fruit is presented in Tables 1, 2 and Figure 1.

The dry weight in the first experimental year of the tested blueberry cultivars ranged from 10.94% ('Patriot') to 11.33% ('Toro'). The studied index had higher values in the second experimental year, when increased from 14.53% ('Bluecrop') to 15.78% ('Patriot'), and no definite trend in its content was observed among the different cultivars. In both years the coefficient of variation of the indicator was low.

In the analyzed samples belonging to the genus *Vaccinium*, dry matter by Re % was highest in the cultivar 'Toro' (9% in 2023) and 'Bluecrop' (11.50% in 2024). In the first experimental year, its average content among the cultivars was 7.67%, and in the second, 10.83%. The coefficients of variation were 16.41% (2023) and 7.05% (2024), respectively.

The carbohydrate content of blueberries is represented by different types of sugars (total sugar, invert sugar and sucrose). In the first experimental year, sucrose was absent in all three varieties analysed, and very low ammounts were found in the following year (0.01%-0.06%).

No significant differences were observed in the total sugars content of the fruits analysed. For the two-year period, the varieties with the higher sugar content were 'Bluecrop' and 'Toro'. The average content of total sugars in the studied cultivars was 7.14% in 2023 (7.79% in CV) and 8.37% in 2024 (4.79% in CV). A similar trend is observed for invert sugar values.

The pleasant sensory characteristics of blueberries are due to the balanced composition of sugars and acids, whichin the present studywere mainly represented by malic acid (0.60-0.74%) and ascorbic acid (8.80-12.32%).

Tannin content was higher in the first experimental year (0.206-0.299%) (CV - 5.51%) compared to the second (0.150-0.187%) (CV - 12.23%), with no significant differences between cultivars.

The intensely colored berries of blueberries are rich sources of anthocyanins. The cultivar with the highest anthocyanin content in both experimental years was 'Patriot' (161.50 mg/% in 2023 and 85.56 mg/% in 2024). The other varieties analyzed occupied an intermediate position. The average value of the indicator between the varieties was 112.2 mg/% (2023) and 55.53 mg/% (2024). The coefficient of variation was very high in both experimental years (44.95% - 2023 and 52.54% - 2024).

Regarding blueberry pectin content, the highest values determined for *Vaccinium* genus were found in the 'Bluecrop' cultivar 1.26% (2023) and 0.90% (2024). In the first experimental year, its average content among cultivars was 1.11% and significantly lower in the second year (0.69%).

The total polyphenol content in the analyzed samples ranged from 259.04 mg/100 g to 365.30 mg/100 g (2023), with an intervarietal average of 299.14 mg/100 g, and from 191.63 mg/100 g to 312.93 mg/100 g (2024), with an average of 246.44 mg/100 g (Fig. 1). It is noteworthy that clearly the highest values in the two experimental years were recorded in the 'Patriot' variety. The coefficient of variation was average in the first year (19.30%) and high in the second year (24.95%).

Aliman et al. (2020) evaluated the fruit weight and biochemical composition of four cultivars of cultivated blueberries, 'Earliblue', 'Bluegold', 'Bluecrop', and 'Goldtraube', and found 'Bluecrop' to be the most suitable standard for the conditions of Bosnia and Herzegovina.

The comparative results of fruit biochemical composition of three introduced blackcurrant cultivars ('Byurlovskaya', 'Ometta' and 'Ben Lomond') are presented in Tables 3, 4 and Fig. 2.

Comparing the fruits of plants of the genus *Ribes* and the genus *Vaccinium*, we find that blackcurrant fruits had higher dry matter content compared to the fruits of cultivated blueberries. In the first experimental year, the values of the indicator ranged from 20.45% ('Ben Lomond') to 25.32% ('Byurlovskaya') (CV =10.70%), and in the second there was a slight decrease the range being between 20.24% (cv. 'Byurlovskaya') and 22.34% (cv. 'Ometta') (CV = 5.23%).

Dry refractive matter ranged from 13.00% ('Byurlovskaya') to 18.50% ('Ometta') in 2023 and from 13.00% ('Ben Lomond') to 18.50% ('Ometta') in 2024. The average across varieties was 14.83% (CV = 21.41%) in the first year and 15.33% (CV = 18.54%) in the second year, respectively. For the two-year experimental period, the cultivar with the highest CV value was 'Ometta'.

The highest content of total sugars in the first experimental year was found for variety 'Byurlovskaya' (7.35%), and in the second year for 'Ometta' (9.78%) and 'Ben Lomond' (8.02%) cultivars. The average value of the indicator for 2023 was 5.68% (CV = 25.40%), while a significantly higher level was determined for 2024 (8.32%, CV = 15.99%).

The invert sugar content of the fruits analyzed in the firs experimental year was relatively low, with an average of 2.93% among the varieties. In the following year the value increased to 7.68%, which was nearly double the level recorded in the previous year. The invert sugar content of the 'Ometta' fruits was noticeably higher (9.06%).

In contrast to the total and invert sugar contents, the sucrose content showed different behavior in the analysis, as its level was higher in the first year. The highest sucrose concentrations were determined in 'Byurlovskaya' (3.94%) and 'Ben Lomond' (2.33%) with an average of 2.61%.The results obtained in the second experimental year were approximately similar to the values of the *Vaccinium* varieties.

With regard to acid content, no significant differences were observed between the analysed fruits of plants of the genus *Ribes* and the genus *Vaccinium*, grown under semi-mountainous conditions in the experimental area. The blackcurrant cultivars included in the study in the first experimental year had lower acidity (0.34%) compared to the second year, when the acid content ranged from 0.80% ('Ben Lomond') to 1.14%('Ometta').

The ascorbic acid content of the studied fruits of blackcurrant cultivars was higher in the second experimental year (2024) compared to the genus *Vaccinium* during the two-year period. The values ranged from 26.40% ('Ometta') to 42.24% ('Byurlovskaya') with CV = 25.32%. Similar results were reported by Ozola and Duma (2020). They found that the highest levels were found in black currant, ranging from 40.25 to 44.71 mg/% and the lowest ones were determined in highbush blueberry, ranging from 7.43 to 9.98 mg/%.

For all three studied cultivars tannins reached higher levels in the second experimental year, with the highest value recorded in the currant variety 'Ometta' (0.281%).

Members of both genera were rich sources of anthocyanins and the content of individual cultivars within the genera varied considerably. In this aspect, in fruits of the genus *Ribes*, an increased anthocyanin content was observed in the second experimental year (290.37 mg/% for cultivar 'Ben Lomond' 290.37 mg/%). The fruit samples of highbush blueberries analysed showed that the 'Patriot' cultivar stood out with the highest anthocyanin content of 161.50 mg/% (2023) and 86.56 mg/% (2024), respectively.

The amount of pectin in blackcurrant fruit was also determined. In the first year of the studies it ranged from 0.45% ('Byurlovskaya') to 1.08% ('Ben Lomond') (CV = 41.32%). In the second year, the pectin content was significantly higher and ranged from 1.02% ('Ben Lomond') to 2.25% ('Byurlovskaya'), again with a very high coefficient of variation of 36.82%. The average pectin content between cultivars was 1.69% (2024), and compared to the *Vaccinium* genus samples for 2023, they were higher at 1.11% (2023). No definite varietal dependence was observed in its content in the fruits during the experimental period.

The polyphenol content in the fruits of the analysed blackcurrant cultivars ranged from 47.65 mg/100 g ('Ometta') to 51.54 mg/100 g ('Byurlovskay') in 2023. In the second experimental year, the indicator had higher values, ranging between 246.22 and 774.33 mg/100 g, respectively in 'Ometta' and 'Ben Lomond'.

A similar trend was observed by Ozola and Duma (2020), comparing total polyphenols in fruits from representatives belonging to the genus *Ribes* and genus *Vaccinium,* finding 513.54 mg/ 100 g and 228.63 mg/100 g, respectively.

The observed differences in the individual parameters of the biochemical composition of the fruits of the studied blueberry and blackcurrant varieties during the experimental period are probably due to their biological characteristics.

3.2. Botanical composition and qualitative characterization of the grass stands of the studied fruit varieties in the interrows

Botanical composition of natural grass stand in inter-rows of blueberry and blackcurrant plantations

Natural grass stands in the interspaces are a loosely defined mix of plant species defined as cereals, legumes and various grasses (Fig. 3).

Average over the study period, in the inter-rows of blueberry plantations, perennial cereals (*Holcus lanatus, Agropyron repens, Agrostis capillaris, Poa pratensis, Poa sylvicola, Lolium perenne, Agrostis gigantea, Festuca pratensis, Agrostis capillaris, Agrostis alba, Dactylis glomerata*) and leguminous (*Vicia sativa, Trifolium pratense, Trifolium repens*) meadow grasses predominated by 20.0 and 1.1%, respectively, compared to those in blackcurrant plantations.

The correlations of the studied biochemical parameters in the two orchards with the botanical composition of the inter-row grasses are presented in Tables 5 and 6.

The percentage of cereal grasses in the inter-row strips of black currant was strongly negatively correlated with the amount of sucrose (r = -1.000) and ascorbic acid (r = -0.998). In *Vaccinium corymbosum* L., cereal species composition correlated positively with total sugars (r = 0.666), inverted sugars (r = 0.669) and acids (as malic) (r = 0.975).

Legume components have the ability to fix atmospheric nitrogen and enrich soil mineral composition with the much needed element for root growth in fruit crops (Gurin et al., 2021). Consequently, a positive correlation was found in blackcurrant plantations between their proportion in the inter-row with the parameters: dry weight matter (r = 0.710), refractometric solids (r = 0.998), total sugars (r = 0.691), inverted sugar (r = 0.999), acids (as malic) (r = 0.972), tannins (r = 0.991) and pectin (r = 0.782). In blueberry, the relative proportion of nitrogen-fixing species was shown to be positively correlated with sucrose (r = 0.640) and ascorbic acid (r = 0.987) content and strongly negatively correlated with the amount of total sugars (r = -0.967), inverted sugar (r = -0.969) and acids (as malic) (r = 0.963) in the crop fruit.

During the study period, the various grasses group in the black currant stand occupied over 45% of the natural grass volume, and in the blueberry stand, approximately 24%. The species in the group (*Galium mollugo, Potentilla fruticosa, Rumex acetosa, Lactuca serriola, Verbena officinalis, Geranium dissectum, Fragaria vesca, Lysimachia nummularia*) were found to be positively correlated with the concentration of tannins (r = 0.749) in blueberries and with the content of sucrose (r = 0.973) and ascorbic acid (r = 0.982) in blackcurrants. The percentage of diverse grasses in the interrows of the fruit species studied was shown ($P < 0.05$) to be strongly negatively correlated with the concentration of acids (as malic) (r = -0.886) in the fruit of blueberry cultivars and with the amount of inverted sugar (r = -0.809) and refractory solids (r = -0.817) in the fruit of blackcurrant cultivars.

3.3. Qualitative characterization of the grassland in the interrows of blueberry and blackcurrent plantations

The composition of grassland in the interrows of orchards influences the bacterial structure and nutrient accumulation in the soil. This may explain that the biomass in the inter-row strips of blackcurrant plantations was higher in crude protein (8.79%), crude fat (1.87%) mineral matter (7.11%), calcium (1.29%) and phosphorus (0.34%, Table 7).

The high percentage of perrenial forage grassland in the blueberry stands was correlated to the higher concentration of crude fibre (39.36%) and nitrogen-free extractives (39.24%) in the dry matter of the sward.

Inter-row grazing systems in orchards have been found to significantly increase the amount of organic matter, total nitrogen, as well as the activity of soil enzymes involved in the hydrolysis of plant polysaccharides (cellulose and hemicellulose) (Zheng et al., 2018; Li et al., 2022).

The natural grassland in the interrows of blackcurrant had a higher content of fully digestible and digestible by animals polyoside - hemicellulose (by 6.82%) and partially digestible polyoside - cellulose (by 6.16%).

This trend is also maintained for the fibre components (NDF, ADF and ADL), as the main feed quality indicators and energy source for ruminants. Compared to blueberry plantations, the values of neutral-detergent fibre, acid-detergent fibre and acid-detergent lignin in naturally grassed blackcurrant intercrops were higher by 13.09%, 6.27% and 0.11%, respectively.

According to the data in the study, there was no significant difference in the *in vitro* dry matter digestibility of grassland in the two fruit crops (60.25% in blueberry plantation and 60.36% for blackcurrant plantation).

4. Conclusions

The qualitative characterization of small fruit shows that the biochemical composition of cultivars of blackcurrant ('Byurlovskaya', 'Ometta', and 'Ben Lomond') and blueberry ('Bluecrop', 'Patriot', and 'Toro') varies considerably within individual genera. Higher values of dry matter by weight are found in the *Ribes* genus (20.24-25.32% for ‘Byurlovskaya’ variety).

The highest content of total polyphenols in highbush blueberries for the two-year experimental period was found in the 'Patriot' cultivar (365.30 mg/100g and 312.93 mg/100g). 'Ben Lomond' cultivar fruits had the highest anthocyanin levels in the second year (290.37 mg/%).

The relative proportion of cereal varieties in the interrows of *Vaccinium corymbosum* L. was found to correlate positively with the content of total sugars (r = 0.666), invert sugar (r = 0.669) and acids (as malic) (r = 0. 975); the amount of legumes with sucrose content (r = 0. 640) and ascorbic acid (r = 0. 987), and the amount of diverse grasses positively correlated with tannins concentration (r = 0. 749).

In *Ribes nigrum* L., the percentage of cereal meadow grasses in inter-row strips was strongly negatively correlated with the amount of sucrose (r = -1.000) and ascorbic acid (r = -0.998). Legume species were positively correlated with dry weight matter (r = 0.710), refractometric solids (r = 0.998), total sugars (r = 0. 691), inverted sugar (r = 0.999), acids (as malic) (r = 0.972), tannins (r = 0.991) and pectin (r = 0.782), and varietal grasses with sucrose content (r = 0.973) and ascorbic acid (r = 0.982).

The composition of grassland in the interrows of orchards influences the bacterial structure and nutrient accumulation in the soil. The biomass in the inter-row strips of blackcurrant has a higher content of structural fibre components (NDF, ADF and ADL) and crude protein.

The high proportion of perennial forage grassland in the blueberry interrows determined the higher concentration of crude fibre and nitrogen-free extractives in the dry matter of the grassland. The results of the qualitative analysis of the natural grassland in the interrows of the two orchards allow its use as forage in the feeding of ruminants kept at the Research Institute of Mountain Stockbreeding and Agriculture, Troyan.

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Fruit Growing Research, Vol. XLI, 2025 DOI 10.33045/fgr.v41.2025.10
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Tables and figures

Table1. Biochemical analysis of highbush blueberry varieties - 2023

Indicators / Varieties	Dry weight matter, %	Refractometric solids, %	Total sugars, %	Inverted sugar, %	Sucrose, %	Acids (as malic), %	Ascorbic acid, mg /%	Tannins, %	Anthocyanins, mg/%	Pectin, %
Bluecrop	11.30	7.50	7.01	7.01	-	0.60	10.56	0.299	60.71	1.26
Patriot	10.94	6.50	6.66	6.66	-	0.60	12.32	0.224	161.5	0.93
Toro	11.33	9.00	7.75	7.75	-	0.67	8.80	0.206	114.39	1.14
Mean	***11.19***	***7.67***	***7.14***	***7.14***	***0***	***0.623***	***10.56***	***0.22***	***112.2***	***1.11***
SE	***0.13***	***0.73***	***0.32***	***0.32***	***0***	***0.023***	***1.02***	***0.01***	***29.12***	***0.10***
St Dev	***0.22***	***1.26***	***0.56***	***0.56***	***0***	***0.04***	***1.76***	***0.01***	***50.43***	***0.17***
Minimum	***10.94***	***6.50***	***6.66***	***6.66***	***0***	***0.60***	***8.80***	***0.21***	***60.71***	***0.93***
Maximum	***11.33***	***9.00***	***7.75***	***7.75***	***0***	***0.67***	***12.32***	***0.23***	***161.5***	***1.26***
CV, %	***1.94***	***16.41***	***7.79***	***7.79***	***0***	***6.48***	***16.67***	***5.51***	***44.95***	***15.05***

Table 2. Biochemical analysis of highbush blueberry varieties - 2024

Indicators / Varieties	Dry weight matter, %	Refractometric solids, %	Total sugars, %	Inverted sugar, %	Sucrose, %	Acids (as malic), %	Ascorbic acid, mg /%	Tannins, %	Anthocyanins, mg/%	Pectin, %
Bluecrop	14.53	11.50	8.60	8.40	0.01	0.67	12.32	0.187	28.65	0.90
Patriot	15.78	11.00	7.91	7.66	0.06	0.67	12.32	0.150	86.56	0.56
Toro	14.83	10.00	8.61	8.46	0.02	0.74	12.32	0.187	51.38	0.60
Mean	***15.05***	***10.83***	***8.37***	***8.17***	***0.03***	***0.69***	***12.32***	***0.17***	***55.53***	***0.69***
SE	***0.38***	***0.44***	***0.23***	***0.26***	***0.02***	***0.02***	***-***	***0.01***	***16.85***	***0.11***
St Dev	***0.65***	***0.76***	***0.40***	***0.45***	***0.03***	***0.04***	***-***	***0.02***	***29.18***	***0.19***
Minimum	***14.53***	***10.00***	***7.91***	***7.66***	***0.01***	***0.67***	***12.32***	***0.15***	***28.65***	***0.56***
Maximum	***15.78***	***11.50***	***8.61***	***8.46***	***0.06***	***0.74***	***12.32***	***0.19***	***86.56***	***0.90***
CV, %	***4.34***	***7.05***	***4.79***	***5.45***	***88.19***	***5.83***	***-***	***12.23***	***52.54***	***27.06***

Table 3. Biochemical analysis of several currant varieties in 2023

Indicators / Varieties	Dry weight matter, %	Refractometric solids, %	Total sugars, %	Inverted sugar, %	Sucrose, %	Acids (as malic), %	Ascorbic acid, mg /%	Tannins, %	Anthocyanins, mg/%	Pectin, %
Byurlovskaya	25.32	13.00	7.35	3.20	3.94	0.34	12.32	0.088	30.65	0.45
Ometta	23.66	18.50	4.85	3.20	1.57	0.34	8.80	0.109	9.68	1.05
Ben Lomond	20.45	13.00	4.85	2.40	2.33	0.34	12.32	0.088	13.87	1.08
Mean	***23.14***	***14.83***	***5.68***	***2.93***	***2.61***	***0.34***	***11.15***	***0.10***	***18.07***	***0.86***
SE	***1.43***	***1.83***	***0.83***	***0.27***	***0.70***	***-***	***1.17***	***0.01***	***6.41***	***0.21***
St Dev	***2.48***	***3.18***	***1.44***	***0.46***	***1.21***	***-***	***2.03***	***0.01***	***11.10***	***0.36***
Minimum	***20.45***	***13.00***	***4.85***	***2.40***	***1.57***	***0.34***	***8.80***	***0.09***	***9.68***	***0.45***
Maximum	***25.32***	***18.50***	***7.35***	***3.20***	***3.94***	***0.34***	***12.32***	***0.11***	***30.65***	***1.08***
CV, %	***10.70***	***21.41***	***25.40***	***15.75***	***46.31***	***-***	***18.23***	***12.76***	***61.42***	***41.32***

Table 4. Biochemical analysis of several currant varieties in 2024

Indicators / Varieties	Dry weight matter, %	Refractometric solids, %	Total sugars, %	Inverted sugar, %	Sucrose, %	Acids (as malic), %	Ascorbic acid, mg /%	Tannins, %	Anthocyanins, mg/%	Pectin, %
Byurlovskaya	20.24	14.50	7.17	6.79	0.32	0.94	42.24	0.262	47.60	2.25
Ometta	22.34	18.50	9.78	9.06	0.69	1.14	26.40	0.281	59.82	1.80
Ben Lomond	20.70	13.00	8.02	7.19	0.58	0.80	29.92	0.243	290.37	1.02
Mean	***21.09***	***15.33***	***8.32***	***7.68***	***0.53***	***0.96***	***32.85***	***0.26***	***132.60***	***1.69***
SE	***0.64***	***1.64***	***0.77***	***0.70***	***0.11***	***0.10***	***4.80***	***0.010***	***78.97***	***0.36***
St Dev	***1.10***	***2.84***	***1.33***	***1.21***	***0.19***	***0.17***	***8.32***	***0.020***	***136.77***	***0.62***
Minimum	***20.24***	***13.00***	***7.17***	***6.79***	***0.32***	***0.80***	***26.40***	***0.240***	***47.60***	***1.02***
Maximum	***22.34***	***18.50***	***9.78***	***9.06***	***0.69***	***1.14***	***42.24***	***0.280***	***290.37***	***2.25***
CV, %	***5.23***	***18.54***	***15.99***	***15.78***	***35.85***	***17.80***	***25.32***	***7.250***	***103.15***	***36.82***

Table 5. Correlations between some biochemical parameters of blueberries and the botanical composition of the inter-row grass stand

	Dry weight matter	Refractometric solids	Total sugars	Inverted sugar	Sucrose	Acids (as malic)	Ascorbic acid	Tannins	Anthocyanins	Pectin	Grasses	Legumes	Miscellaneous grasses
Dry weight matter, %	1												
Refractometric solids, %	-0.930	1											
Total sugars, %	-0.693	0.909	1										
Inverted sugar, %	-0.689	0.907	1.000	1									
Sucrose, %	0.983	-0.982	-0.814	-0.811	1								
Acids (as malic), %	-0.148	0.500	0.816	0.819	-0.327	1							
Ascorbic acid, mg /%	0.622	-0.866	-0.996	-0.996	0.756	-0.866	1						
Tannins, %	-0.872	0.631	0.250	0.245	-0.766	-0.356	-0.159	1					
Anthocyanins, mg/%	0.992	-0.877	-0.596	-0.592	0.952	-0.021	0.518	-0.926	1				
Pectin, %	-0.957	0.784	0.454	0.450	-0.887	-0.145	-0.369	0.976	-0.986	1			
Grasses	0.077	0.294	0.666	0.669	-0.108	0.975	-0.732	-0.556	0.203	-0.362	1		
Legumes	0.487	-0.773	-0.967	-0.969	0.640	-0.936	0.987	0.004	0.373	-0.214	-0.833	1	
Miscellaneous grasses	-0.328	-0.041	-0.454	-0.458	-0.149	-0.886	0.535	0.749	-0.445	0.588	-0.967	0.665	1

P <0.05

Table 6. Correlations between some biochemical parameters of blackcurrant and botanical composition of the grasses in the interrows.

	Dry weight matter	Refractometric solids	Total sugars	Inverted sugar	Sucrose	Acids (as malic)	Ascorbic acid	Tannins	Anthocyanins	Pectin	Grasses	Legumes	Miscellaneous grasses
Dry weight matter, %	1												
Refractometric solids, %	0.668	1											
Total sugars, %	1.000	0.648	1										
Inverted sugar, %	0.678	1.000	0.658	1									
Sucrose, %	0.117	-0.661	0.143	-0.651	1								
Acids (as malic), %	0.856	0.957	0.842	0.960	-0.413	1							
Ascorbic acid, mg /%	0.074	-0.693	0.100	-0.683	0.999	-0.452	1						
Tannins, %	0.800	0.981	0.784	0.984	-0.503	0.995	-0.540	1					
Anthocyanins, mg/%	-0.999	-0.631	-1.000	-0.641	-0.166	-0.830	-0.123	-0.769	1				
Pectin, %	0.994	0.745	0.991	0.753	0.009	0.907	-0.034	0.860	-0.988	1			
Grasses	-0.134	0.648	-0.160	0.638	-1.000	0.398	-0.998	0.488	0.182	-0.026	1		
Legumes	0.710	0.998	0.691	0.999	-0.616	0.972	-0.650	0.991	-0.675	0.782	0.603	1	
Miscellaneous grasses	-0.116	-0.817	-0.090	-0.809	0.973	-0.613	0.982	-0.689	0.067	-0.222	-0.969	-0.782	1

P <0.05

Table 7. Chemical composition and fibre structural components of cell walls, of natural herbage in the interrows of blueberry and cassis plantations, averaged over the study period (%)

Indicators	Blueberries	Blackcurrant
CP	7.93	8.79
FC	1.51	1.87
CF	39.36	37.00
Ash	6.00	7.11
NFE	39.24	36.68
Ca	1.15	1.29
P	0.28	0.34
NDF	52.44	65.53
ADF	31.47	37.74
ADL	6.57	6.68
Hemicellulose	20.97	27.79
Cellulose	24.90	31.06
INDMD by *Aufrere*	60.25	60.36

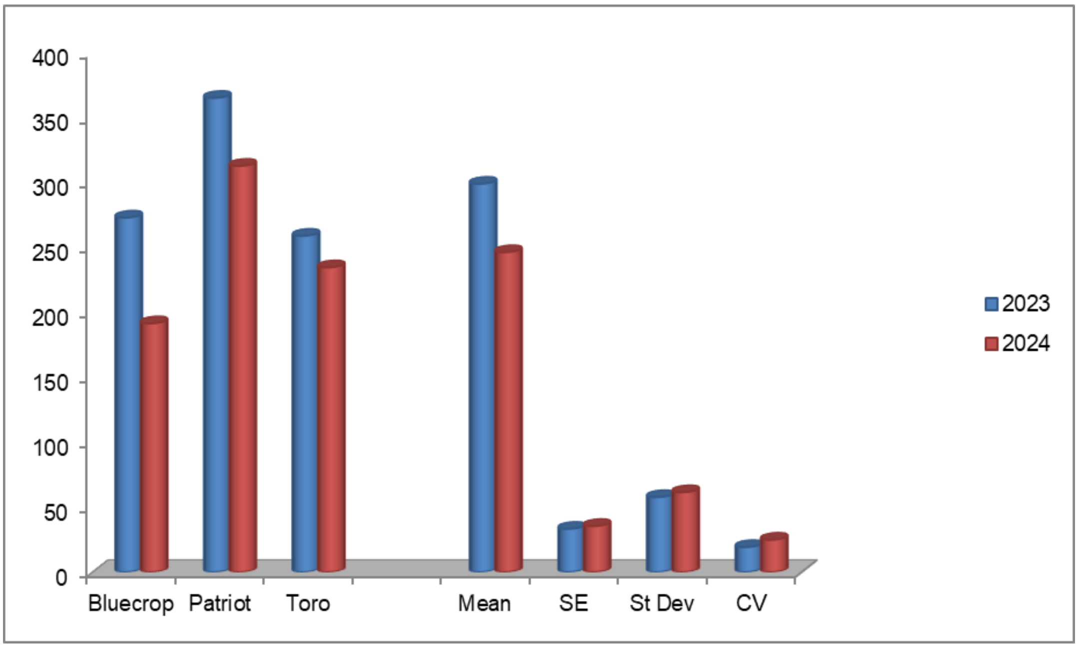

Fig. 1. Content of total polyphenols in fruits of different blueberry varieties (mg/100 g)

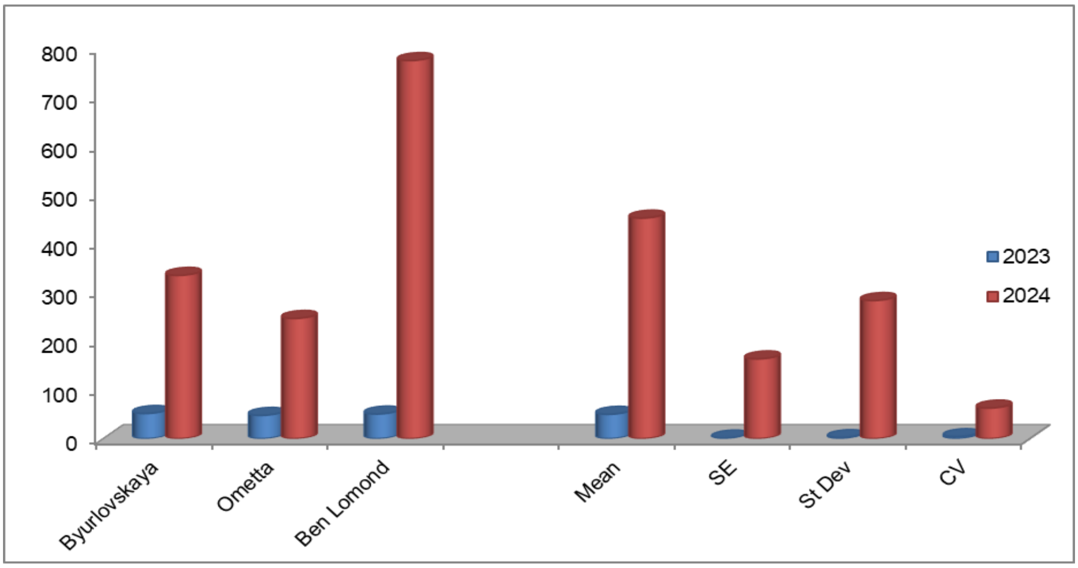

Fig. 2. Content of total polyphenols in fruits of different currant varieties (mg/100 g)

DOI 10.33045/fgr.v41.2025.10

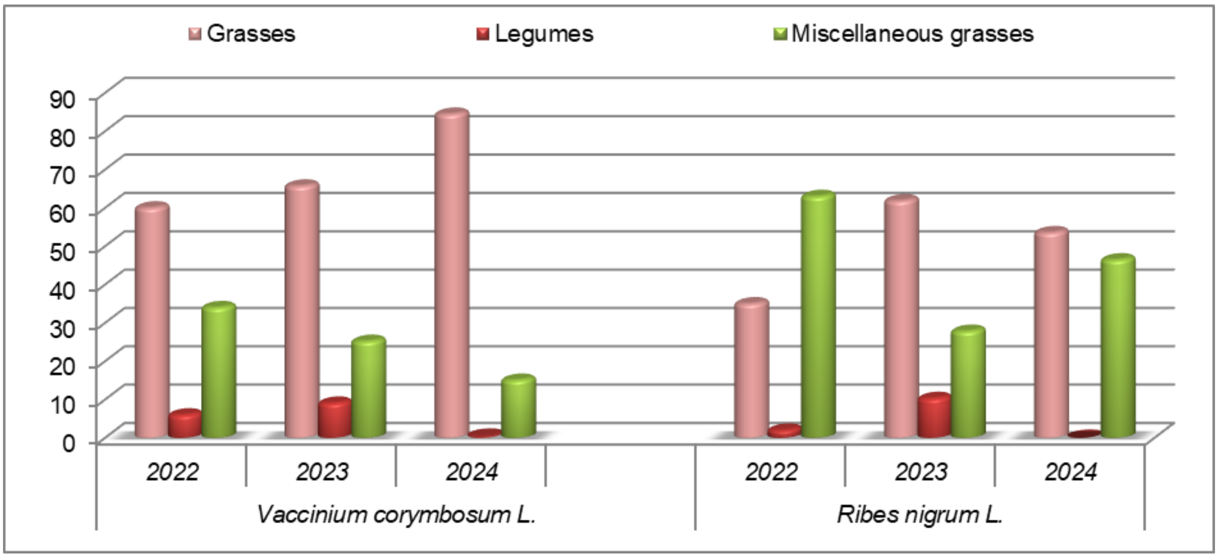

Fig. 3. Botanical composition (%) of natural grass stand in the inter-rows of blueberry and blackcurrant plantations (by group).