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THE NITRATE CONTENT IN BERRIES OF LOW BUSH BLUEBERRY (*VACCINIUM ANGUSTIFOLIUM* AIT.) OF THE HARVEST OF THE SECOND YEAR COMMERCIAL FRUITING

In the second year of commercial fruiting the nitrate content in berries of low bush blueberry was 13.5 mg/kg. As compared to 2011 (the first commercial harvest) it number decreased in 4.3 times. In the conditions of the same amount of applied mineral fertilizers the different content of nitrate in berries of two harvest years can be explain by change in regulations of feeding, manifestation of effect of "dilution" of nitrates in actively being formed with age biomass of cultivated plants and features of weather conditions. In 2012 crop year, the content of nitrate did not depend on the time of harvest, the average weight of fruit and plant genotypes. Storage of berries of a crop of 2011 within 12 months in a freezer at a temperature of minus 16 (+ / –2) °C resulted in a decrease in nitrate concentrations in 2.8 times of their initial quantity.

Introduction. The results of the introduction of new for Belarus species low bush blueberry indicate the availability of its commercial cultivation on the developed upland peat deposits in the North of Belarus [1].

An important nitrate monitoring of the gathered berries becomes very topical due to the fact that a prerequisite for effective cultivation of the species is the use of complex mineral fertilizer [2].

Researches of 2011 (the first commercial harvest, fixed at three years cultivation), have shown that the content of nitrates in fruits at plant cultivating under conditions of annual application of nitrogen-containing mineral fertilizers is 58.2 mg/kg [3]. Maximum permissible concentration (MPC) of nitrates established for berries in the amount of 60 mg/kg [4] was not exceeded, but their number was very close to its boundary.

The aim of the research in 2012 vegetative season was to determine dependence of the nitrate accumulation in berries of low bush blueberries upon agricultural background conditions in which plants grow, their heredity, harvesting and average weight of berries. The level of xenobiotic content in a year stored berries of 2011 harvest was also determined.

Object and methods of reseach. The object of the research is the plants of the four forms of low bush blueberry under the symbols 13, 16, 23, 24, cultivated on the plantation, located in the developed bog peat Deposit "Dolbenishky".

The main agro-technical activity is application of complete mineral fertilizer ("Rastvorin grade A") in a radius of 25 cm from the center of bushes in the spring (15.04.09, 06.05.10, 20.04.11, 22.03.12) and summer (20.07.10, 29.06.11) in the total of 5 g of the drug in the first year and 10 g in the second, third and fourth years.

In the trial No. 1, plants of 16-th form were used and the content of nitrates in their berries was determined at using mineral fertilizers during all four years of cultivation (variant I) and only in the first two years after laying plantations (variant II).

In the trial No. 2 we determined the tendency of nitrate accumulation in berries of low bush blueberry depending on the timing of the harvest, average weight of berries and plant heredity. For this purpose bushes of forms 13, 23 and 24, were divided into two variants (Table. 1). Variant I – berries gathered in the first taking of storage harvesting (16.07.12). Variant II – berries gathered in the second taking of storage harvesting (06.08.12).

In the trial No. 3 nitrate content in 2011 harvest berries, which were kept in a plastic bag in the freezer of domestic refrigerator for 12 months at a temperature of minus 16 (+ / –2) °C was measured.

The berries were selected according to the technical normative legal acts [5]. Each variant of trials No. 1, 2 and 3 was presented by a mixed sample of berries gathered from 8–10 plants.

The yield according to taking storage was established by gathering and weighing berries from every bush. Total yield of one bush was determined by summing the weight of berries, gathered for each reception. The average mass of one berry is defined as the arithmetic mean value of the mass of 100 berries, chosen at random from the set of the bushes, which represent a certain variant of the trial.

Table 1

The content of nitrates in fruits low bush blueberries depending on the timing of collection, the average weight of berries and heredity of plants

Form	Variant trial No. 2	Harvest capacity by reception	Total harvest capacity	Average mass of berry	Nitrate content, mg/kg
13	I	278	457	0.51	13.29[a]
	II	179		0.48	13.01[a]
23	I	45	242	0.23	13.79[a]
	II	197		0.22	13.52[a]
24	I	198	576	0.83	15.10
	II	378		0.74	12.25[a]

Note. Data marked with the same letter indices, not statistically reliable.

Nitrate content was determined by using ionometric technique (GOST 29270), based on extracting them from the analyzed material by means of solution of aluminium potassium sulphate and subsequent measurement of the concentration in the obtained extract using nitrate ion-selective electrode [6]. Measurement was carried out on ionometer I-160M. To calculate the mass fraction of nitrate in berries mg/kg the following formula was used [7]:

$$X = \frac{\left(V + \frac{W \cdot H}{100}\right) \cdot 10^{-pC_{NO_3}} \cdot 62 \cdot 10^6}{1000 \cdot H},$$

where V – volume of extracting solution, sm^3; W – mass fraction of water in the sample, %; H – weight of the sample taken for analysis, g; 100 – conversion factor of % in a fraction of a unit; $10^{-pC_{NO_3}}$ – the concentration of nitratein the extract, mol/dm^3; 62 – molar mass of nitrate ion, g; 10^6 – conversion factor of ppm^{-1}; 1000 – conversion factor of 1 dm^3 in 1 cm^3.

The arithmetic mean of three parallel dimensions was taken as the final result.

Statistical data processing was carried out in Excel spreadsheets with regard to the methodological guidelines of P.F. Rokitsky and B.A. Dospekhov [8, 9].

Main part. In variant I of trial No. 1 the quantity of nitrates was 13.79 mg/kg, in the variant II – 16.79 mg/kg Thus, the content of nitrates in berries gathered from the bushes treated with mineral fertilizer during 4 years, was even somewhat lower than one from the plants without applying them in the past two years. Absolutely the opposite picture is observed when characterizing berry productivity of the two variants. In the variant I average weight of berries, gathered from one Bush, amounted to 256 g, variant II was only 63 g. Taking into account the accepted scheme of planting 6,667 bushes on one hectare the yield of the second year of the commercial fruiting plants 16, cultivated with mineral fertilizers usage, is 1,706 kg, which is much higher than the yield of plants cultivated without them – 420 kg. It emphasizes the need to use fertilizers to obtain stable yields of low bush blueberry.

Besides, the degree of nitrate accumulation, under other equal conditions, is affected by the kind and geometric size of a berry. [10, 11]. The absence of reliable difference between the variants of trial No. 2, differing in time of gathering, average weight of berries and heredity of plants, allows us to speak about the lack of a stable dependence of nitrate accumulation upon these factors (table. 1).

Summarizing the results of two earlier described experiments, we can conclude that the average amount of nitrates contained in the seven samples of freshly gathered low bush blueberry 2012 harvest, is 13.5 mg/kg Thus, the content of the xenobiotic compared with the previous year has decreased by 4.3 times.

Taking into account the fact that the total number of added mineral fertilizers in the years of observations was the same, such substantial difference in amounts of nitrates i.e. 44.7 mg/kg in berries of harvest two years of observations can be explained by 1) the changes in the regulations of fertilizing in 2012, 2) the appearance of the effect of nitrate "dilution" by biomass of cultivated plants, and 3) the peculiarities of weather conditions.

The one step plant nutrition immediately after the thaw in the spring, as it was done in 2012, corresponds to the biology of plants – it is in this period that they are able to absorb, and mostly to use up all nitrogen containing mineral fertilizers before the beginning of fruiting. In 2011, when fertilizers are added in equal amounts: in the spring – the first step, and three weeks before berry gathering – the second step, nitrogen could not be fully used up by the plants which lower the rate of growth and, most likely, it was deposited in the berries in the form of nitrate. Thus, the change of the regulations of the plant nutrition can be considered as one of the main reasons for decrease in nitrate quantity in berries of low bush blueberries of harvest 2012.

Table 2

The average daily air temperature and precipitation per decade for the period from May to August in 2011 and 2012

Year	May			June			July			August		
	1	2	3	1	2	3	1	2	3	1	2	3
Average daily air temperature, °C												
2011	9.9	13.4	15.4	21.1	16.8	17.1	19.3	21.2	21.1	17.7	17.2	17.4
2012	13.0	13.1	15.5	13.1	16.8	15.7	21.5	16.1	20.8	18.4	16.2	15.0
Difference	3.1	–0.3	0.1	–8.0	0.0	–1.4	2.2	–5.1	–0.3	0.7	–1.0	–2.4
Amount of precipitation, mm												
2011	4	26.2	13	8.1	31	4.2	13.3	19.7	15.5	11	72.6	6.1
2012	2.6	27.9	2.5	34.5	42.8	54.7	52.6	39.5	0.3	20.6	12.8	36.4
Difference	–1.4	1.7	–10.5	26.4	11.8	50.5	39.3	19.8	–15.2	9.6	–59.8	30.3

The results of the trial No. 1 i.e. – lack of difference in the amount of nitrates I variant with spring fertilizing and control (variant II without using them) have proved it.

An important economic reason for applying mineral fertilizers in one step is an essential decrease in expenses on the maintenance of the plantations of low bush blueberry in a long-term period of cultivation of berry bushes.

Under the appearance of the effect of nitrate "dilution" we understand the absorption of their permanent quantity of 10 g by essentially differing in biomass plants in 2011 and 2012. All forms of low bush blueberry during the second year of the commercial fruiting have increased the amount of aboveground vegetative bush sphere compared with the first year by 1.3–2.4 times. The 84.6% of them have increased the average yield of the bushes by 1.1–5.6 times.

Another factor contributing to the sizeable difference in nitrate accumulation in berries may be differences in weather conditions during their formation and ripening for two years of observations (Table. 2). Vegetation period of 2011 year was characterized by higher temperatures and insufficient amount of precipitation, which also contributed to the accumulation of nitrates in fruits. Peculiarity of 2012 was the severity temperature range and increased rainfall. The latter, probably, also has the effect of dilution of nitrates, but already in the soil solution.

Information on the impact of the timing and methods of berry storage upon the level of nitrates is contradictory [12, 13]. In our case, the nitrate content in berries of harvest 2011 after storage for 12 months in the freezer decreased in 2.8 times.

Conclusion. Nitrate content in berries of low bush blueberry of harvest 2012 was 13.5 mg/kg Thus, in the second year of the commercial fruiting xenobiotic amount compared to 2011, decreased in 4.3 times. Taking into account the fact that the total number of added mineral fertilizers in the last two years was the same, a variation may be due to the different regulations of plant nutrition – one (2012) or two (2011) steps, the appearance of the effect of nitrate "dilution" by plant biomass and the peculiarities of weather conditions. Significant difference in the nitrate accumulation in berries, differing in terms of gathering, average weight, as well as heredity of plants and conditions of agricultural conditions in which they were growing was not found. Storing berries of harvest 2011 in a plastic bag in the freezer of domestic refrigerator at a temperature of minus 16 (+ / -2) °C for 12 months led to a decrease in the amount of nitrates in 2.8 times.

Considering the important role played by mineral fertilizers in obtaining stable yields of low bush blueberry, further research should be focused on the development of regulations of the nutrition-sensitive and age-specific needs of plants in the elements of mineral nutrition. At the same time it is necessary for gathered berries to meet the requirements for sanitary norms, rules and hygienic standards on the content of nitrates in them [4].

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