Dependence of the rutin content in buckwheat plants on the sowing method, variety and seeding rate

V I Nikitina¹, V V Vagner² and O V Martynova¹

¹Krasnoyarsk State Agrarian University, 90 Mira Avenue, 660049, Krasnoyarsk City, Russia
²Experimental production farm «Kuraginskoe», branch of the Federal state budgetary scientific institution «Federal research center Krasnoyarsk scientific center of the Siberian branch of the Russian Academy of Sciences», Krasnoyarsk territory, Kuraginskoe, Russia

E-mail: vi-nikitina@mail.ru

Abstract. The quantitative content of flavonoids was determined in terms of rutin in buckwheat plants selected during the mass flowering phase in an experiment to study some techniques of technology: seeding rates (1.2 and 2.5 million germinating grains per 1 ha); seeding methods (ordinary with the row width of 15 cm and cross-row with the row width of 30 cm); varieties («Zemlyachka», «Zhdanka»). The amount of rutin in buckwheat plants according to the experiment variants was in the range of 2.3 - 5.1 %. A more significant contribution to the content of flavonoids in terms of rutin belonged to the seeding rate – 60.6%, the share of the variety influence was only 4.6%. On average significant differences in the amount of rutin were not shown by the methods of sowing for the studied varieties.

1. Introduction
Buckwheat (Fagopyrum Esulentum Mill.) is a valuable grain crop. Products from it occupy an important place in the human diet and are one of the best sources for balanced vegetable protein. Along with this it is used as a medicinal, forage and honey crop.

In crop production in the Krasnoyarsk territory buckwheat occupies limited areas (1.06 %) and does not play a significant role in the economy of grain farming. The limiting factors for its cultivation in local conditions are difficulties in harvesting, imperfect technology of its cultivation, low yield. An important technique for increasing the yield and improving the seeds quality is to choose the optimal method of sowing with the establishment of a reasonable seeding rate. There are different opinions on the methods of sowing and seeding rates for buckwheat. Some scientists claim that it gives high yield when cultivated in an ordinary way with a seeding rate of 2 to 4.5 million germinating grains per hectare. Others recommend buckwheat sowing in a wide-row way with a seeding rate of 1 to 3.5 million germinating grains per hectare, while others recommend cross-row, furrow seeding methods [1-8].

Buckwheat is of great interest as a source of bioflavonoids, among them rutin (vitamin P) is particularly popular on the market, which is widely used in medicine, but has no industrial production in Russia.

The agricultural industry is interested in cultivating varieties with the high content of rutin. The technological conditions (sowing period, seeding rate, doses of fertilizers, trace elements, biologically
active substances) that affect the content of rutin in buckwheat plants are identified [9, 10]. Results have been obtained that samples with high rutin content can serve as a marker for the most harmful buckwheat diseases, as rutin participates along with other flavonoids in the adaptation of plants to adverse growing conditions [11-13]. Therefore, an urgent issue is to clarify the influence of elements from cultivation technology on the rutin amount in buckwheat plants in the forest-steppe zone of the Krasnoyarsk territory.

2. Source material and research methodology
The experiments were carried out in the experimental production farm "Kuraginskoe" in the Kuraginsky district of the Krasnoyarsk territory.

We studied 2 methods of seeding: an ordinary one with the row width of 15 cm and a cross-row one with the row width of 30 cm with a seeding rate for each variant: 1.2 and 2.5 million germinating grains per 1 hectare. We took 2 varieties of buckwheat as the source material: «Zemlyachka» (State scientific institution «Bashkir research Institute of agriculture», Ufa); «Zhdanka» (the experimental production farm «Kuraginskoe», Krasnoyarsk territory). The experience was repeated four times, the area of plots was 250 m².

Selection of plant samples was carried out in the phase of mass flowering of buckwheat.

The method described in the article by Anisimova M. M., Kurkina V. A., Ezhkova V. N. was used to determine the content of rutin [14].

Flavonoids were determined as complexes with aluminum chloride. The calculation was carried out using the calibration graph method, and rutin was used as the standard substance. When determining the mass fraction of flavonoids in experimental versions, two series of samples were prepared – with and without aluminum chloride (comparison solutions), i.e. a differential version of spectrophotometry was used, which allowed to exclude the influence of concomitant substances on the analysis results. The optical density was measured using a KFK-3 photocolorimeter at the wavelength of 415 nm.

The mass fraction of the P-active flavonoids sum in the studied extracts in terms of rutin in mg/ 100g (X) was calculated using the formula:

\[ X = \frac{cP_{o}10^{5}}{M}, \]

where

- \( c \) – the amount of rutin in the analyzed aliquot of the extract corresponding to the measured optical density according to the calibration graph, g/25 cm³;
- \( P_{o} \) – dilution factor;
- \( 10^{5} \) – conversion factor in mg/ 100 g;
- \( M \) – weight of extract, g.

3. Research result
To build a calibration graph of the optical density dependence on the amount of rutin in the test solution we prepared solutions: experimental and comparison. In a measuring flask of 25 ml 0.2; 0.4; 0.6; 0.8; 1.0; 1.2 ml of rutin solution were transferred. In this case the amount of rutin in 25 cm³ of the determined solution was equal to: 200, 400, 600, 800, 1000, 1200 mcg/25 cm³ respectively. For the calibration curve the content was recalculated in microkilograms/1 cm³: 4.0; 8.0; 12.0; 16.0; 20.0; 24.0.

Each sample was filled with 4 ml of aluminum chloride solution. Then the comparison solution was prepared according to the same scheme.

The following results were obtained on the KFK-3 photocolorimeter at the wavelength of 415 nm, on the basis of which a calibration graph was constructed (figure 1).

| Concentration of rutin solution (c), mg/ml | 0.2  | 0.4  | 0.6  | 0.8  | 1.0  | 1.2  |
|------------------------------------------|------|------|------|------|------|------|
| Optical density (D):                      | 0.062| 0.224| 0.347| 0.488| 0.593| 0.673|
Figure 1. Calibration graph of the optical density dependence on the rutin amount in the solution.

In the analysis of experimental samples a 10-fold dilute extract solution was used as a comparison solution.

The content of flavonoids in terms of rutin in the studied variants was determined by a calibration schedule based on standard rutin solutions, using a coefficient obtained from the linear dependence equation \( y = 0.614x - 0.032 \). The optical density in the analyzed samples for the variants was in the range from 0.150 to 0.288 nm.

The content of flavonoids in buckwheat plants in terms of rutin varied from 2.3 to 5.1 %. There were differences in the amount of rutin for varieties, both in the seeding rate and seeding methods (figure 2).

Figure 2. Content of flavonoids in terms of rutin by experiment variants, % (The smallest significant difference (SSD) \( \sigma = 0.18 \)).

There are no significant differences between the variety «Zemlyachka» and «Zhdanka» in the content of rutin for ordinary sowing with a seeding rate of 1.2 million germinating grains per 1 ha. In other versions of the experiment there are significant differences in the content of rutin. Higher indicators for the content of flavonoids in terms of rutin in the «Zhdanka» variety were found in the ordinary method of seeding with a seeding rate of 2.5 million germinating grains per 1 ha, then in the cross-row seeding.
with a seeding rate of 1.2 million grains. The «Zemlyachka» variety had a significant excess in the content of rutin over «Zhdanka» with a cross-row method of sowing with a seeding rate of 2.5 million germinating grains per 1 ha. If we analyze only the methods of sowing buckwheat grains regardless of the variety, then there was no significant difference between them. The largest share of influence on the content of flavonoids in terms of rutin belonged to the seeding rate – 60.6%, the contribution of the variety was only 4.6%. The higher percentage of rutin in buckwheat plants was obtained at a seeding rate of 2.5 million grains per 1 ha.

4. Conclusion

Preliminary research results showed that some elements of cultivation technology, such as the seeding rate and variety affected the content of rutin in buckwheat plants. Its amount in buckwheat plants ranged from 2.3 to 5.1 % depending on the variety and seeding rates.

References

[1] Krotov A S 1963 Buckwheat (Moscow: Agricultural publication) p 254
[2] Yakimenko A F 1991 About methods of sowing buckwheat Grain crop. 2 17-8
[3] Kumskova N D 2004 Buckwheat (Blagoveshchensk) 19-104
[4] Korotchenkov Y A 2007 Methods of sowing, fertilizing and efficiency of fallow in the buckwheat cultivation on dark gray forest soils of the Central Chernozem region: abstract of the dissertation for the candidate of agricultural sciences (Kursk) 15
[5] Goncharov A D 2008 Furrew method of buckwheat cultivation and its effectiveness in the forest-steppe of the Ob region: abstract of the dissertation for the candidate of agricultural sciences (Novosibirsk) 21
[6] Kozil V N 2011 Agrotechnical methods of buckwheat cultivation in the middle forest-steppe of the Altay Bulletin of the Altai state agrarian University 11 8-11
[7] Filin V V and Egorova G S 2012 Influence of seeding methods on buckwheat yield in the conditions of the north-west of the Volgograd region Proceedings of the Nizhnevolzhsky agrouniversity complex: science and higher professional education 4(28) 1-6
[8] Vazhov V M 2013 Buckwheat in the fields of Altay: monography (Moscow; Penza: Publishing house of the Academy of natural science) 187
[9] Klykov A G 2000 Study of the source material of buckwheat in order to create varieties with high content of rutin: abstract of the dissertation for the candidate of agricultural sciences (Blagoveshchensk) 17
[10] Klykov A G 2013 Biological resources of species of Fagopyrum Mill. (Buckwheat) in the Russian Far East (taxonomy, chemical composition. Possibilities of use, cultivation): abstract of the dissertation for the doctor of biological sciences (Viadivostok) 40
[11] Alekseeva E S, Shevchuk V K and Shevchuk T E 1991 Selection of buckwheat for resistance to pathogens (Moscow: Agro-industrial publishing house) 79
[12] Zaprometov M N 1993 Phenolic compounds: distribution, metabolism and functions in plants (Moscow: Science) 272
[13] Gneusheva I A 2014 Biotechnological processing of buckwheat production waste and obtaining valuable products: abstract of the dissertation for the candidate of technical sciences (Voronezh) 15
[14] Anisimova M M, Kurkin V A and Ezhkov V N 2010 Qualitative and quantitative analysis of flavonoids in buckwheat grass Proceedings of the Samara scientific center of the Russian academy of sciences 12 1(8) 2011-4