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RESEARCH ARTICLE

The formation of indicators of the quality of buckwheat grain depending on the elements of technology

Oleksandr Mashchenko[1]*, Lyudmyla Kriuchko[1], Roman Bordun[2], Anatoliy Podhaietskyi[1], Ivan Sobran[1], Gennadiy Davydenko[1], Valentina Toryanik[3], Maksym Hnitetskyi[1], Roman Kuz'menko[1]

[1]Sumy National Agrarian University, Herasyma Kondratieva Street, 160, Sumy, 40021, Ukraine
[2]Institute of Agriculture of the Northern East of National Academy of Agrarian Sciences of Ukraine, Parkova Street, 3, v. Sad, Sumy region, 42343, Ukraine
[3]Sumy State Pedagogical University named after A.S. Makarenko, Romenska Street, 87, Sumy, 40002, Ukraine

***Corresponding author:** Oleksandr Mashchenko, Sumy National Agrarian University, Herasyma Kondratieva Street, 160, Sumy, 40021, Ukraine; Email: andb201727@ukr.net

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Abstract

The purpose of the research was to determine the response of buckwheat varieties of different morphotypes to sowing dates and methods and to evaluate the influence of these factors on the formation of productivity indicators and qualitative characteristics of buckwheat. To find out the agrobiological features of the growth and development of buckwheat plants depending on the action and interaction of the researched elements of cultivation technology. Based on the results of the research, it was established that the grain quality indicators of both varieties of buckwheat depended to a greater extent on the genetic properties of the variety, to a lesser extent on the terms and methods of sowing. This made it possible to reveal a complex reaction in unstable weather conditions during the growing season and years of research that influenced their change. Buckwheat by–products in the form of straw and chaff make it possible to obtain valuable fodder, for the Slobozhanka variety in feed units from 1.86 t/ha to 2.29 t/ha, and for the Yaroslavna variety – forage units from 2.05 t/ha to 2.27 t/ha. Thus, buckwheat, in addition to grain, provides farms with a fodder base in the amount of 6.2 t/ha to 7.6 t/ha of straw, which in terms of nutrition is close to the hay of perennial grasses, and in terms of mineral composition to leguminous grasses.

Keywords: Buckwheat, Productivity, Variety, Elements of technology, Agrophytocenosis, Balanced agriculture, Nutrition

Introduction

Buckwheat is considered the main grain crop of Ukraine, but its productivity is at a low level, while this crop has a fairly high biological potential. In recent years, the basic principles of agriculture have been revised. Attention to the development of the scientific foundations of sustainable renewable agrotechnological balanced agriculture has increased (Radchenko al., 2018; Trygub et al., 2022).

Alternative methods of agricultural management are relevant, in particular, increasing the level of productivity of agricultural crops by optimizing the elements of varietal agricultural technology in the technology of their cultivation:

timing and methods of sowing, etc. Accordingly, the development of ways to create optimal conditions for obtaining the highest possible level of productivity of buckwheat crops, in particular, the improvement of existing cultivation technologies and the introduction of new effective agricultural measures, taking into account the hydrothermal conditions of the region, is an urgent problem. Increasing plant productivity can be achieved not only by breeding methods, but also by improving cultivation technology. Many scientific data indicate the dependence and influence of sowing dates and methods on the formation of elements of productivity of buckwheat plants in conditions of unstable moisture supply and fluctuating air and soil temperature indicators (Efimenko, 1992; Trygub et al. 2022; Hryhoriv et al. 2023). Constant improvement and optimization of sowing times and methods in crop cultivation technologies contributes to increasing plant productivity, grain quality and by–products (Campbell, 2003).

Obtaining a full–fledged buckwheat harvest is possible only with scientific justification of the application of agrotechnical measures developed in specific agro–climatic conditions. Due to further changes in the climate and a decrease in the level of moisture supply in critical periods of crop development, it is necessary to look for new ways of increasing the yield with high quality indicators under the appropriate vegetation conditions that have developed (Sangma & Chrungoo, 2010; Hryhoriv et al. 2022).

The quality of buckwheat is determined by the grain size, uniformity, filminess and shape of the grains, as well as uniformity, ease of shelling, strength and color of the kernel. The nutritional qualities of buckwheat groats are determined by the duration and coefficient of boiling, the structure, color and taste of the porridge (Lyashenko et al. 2022).

Factors that affect the quality of buckwheat grain are, first of all, the variety and growing conditions. The early May sowing period provides a high grain quality, while the late May sowing period provides a lower one. Dry years have a greater impact on grain quality than wet years. Grain size is determined by the weight of 1000 grains. A grain weighing 30 g or more is considered very large, large from 25 g to 30 g, medium from 23 g to 25 g, small from 20 g to 23 g, and very small less than 20 g. The high weight of the seed is due to its size and the fullness of the grain.

Many researchers believe that seed size is not a rational factor in obtaining a high yield, although plant productivity increases with an increase in seed mass. The largest grain is represented by fractions 4.5 mm; 4.2 mm; 4.0 mm. At late times of sowing, the grain of the first fraction is much larger than at early times. Grain size is important. Small and flat grains are classified as clogging impurities (Jiang, 2007; Long et al. 2018; Hryhoriv et al. 2021; Karbivska et al. 2023).

At the factories, during processing of buckwheat, the kernel is obtained an unbroken kernel freed from the fruit shells, which does not pass through a sieve with holes of 1.6 mm × 20 mm, and less often buckwheat flour from the separation of the small kernel. The first class includes grain that has 77% pure kernel, the second at least 74% and the third at least 71%.

Buckwheat fruits have voids in the corners of the faces, which is important for the technology of cereal production. In seeds of large fractions, mainly two corners are incomplete, and small ones have convex faces without voids. Large fruits are easier to shred, and the core is less likely to crumble, which significantly increases the yield of the grain and its quality. Ease of shering is higher in grains at early sowing dates, fragility at late sowing dates.

An important technological indicator of buckwheat is the filminess of the grain, which affects the output of the groats and its technological qualities. Thin–film grain contains 18%–20% of films, medium–film – 20–25, and coarse–film – 25–28%. Coarse grain has the highest film density. But, despite this, it is more valuable for the production of groats. The dates and methods of sowing affect the film frequency depending on the weather conditions during the growing season. In dry years, the filminess of the grain increases, which is related to the degree of ripeness of the fruits. Application of fertilizers, as a rule, reduces the filminess of the grain (Lü et al. 2019; Kovalenko et al. 2023).

Evenness of the grain, which is understood as its uniformity in size, is also a very important technological indicator. Aligned in size seeds give friendly and uniform seedlings, and friendly development and maturity depend on this. Therefore, seed alignment plays a major role in seed evaluation. However, many years of research by some scientists have shown that grain with high alignment is still inferior in terms of technological indicators to varieties that have less aligned but larger grain (Radchenko al., 2018; Szparaga et al. 2019; Lyashenko et al. 2022).

The most even grain is obtained at optimal sowing times under conditions of sufficient moisture. Evenness increases when the feeding area increases. The study of the chemical composition of the grain showed that the main factor affecting the nutritional value of buckwheat groats is the growing conditions. The chemical composition of plants depends on the amount and intensity of sunlight. The content of protein compounds in grain is affected by temperature, soil moisture and the level of perfection of technological elements. A higher content of protein compounds is observed at late sowing times in larger grains (Campbell, 2003; Jiang, 2007; Sangma & Chrungoo, 2010; Zieliński et al. 2021; Lyashenko et al. 2022).

Materials and Methods

The research was conducted in the educational, scientific and industrial complex of the Sumy National Agrarian University. The research field is located in the Sumy district of the Sumy region, Ukraine, geolocation data 50°52.742 N latitude, 34°46.159E longitude, 137.7 m above sea level (50°52'46.6"N 34°46'07.8"E Map date ©2023 Google). The research area is characterized by long term average indicators: average annual daily air temperature +7.4°C; annual precipitation 593 mm. Transition of average daily temperatures through the +10°C mark: downwards the 3rd decade of September, upward the 2nd decade of April. The sum of active (> +10) temperatures for April–September is 2768°C. The general characteristic of the studied period (2021–2023) was lower temperatures and more precipitation in spring (compared to the long–term average). The soil of the experimental field is represented by typical chernozem, the arable layer of which is characterized by the following main indicators: humus content 4.1%, pH 6.3, the amount of absorbed bases 31 mg eq., the content of mobile forms of phosphorus 11.3 mg/100 g of soil, exchangeable potassium – 9.2 mg/100 g of soil, the content of easily hydrolyzed nitrogen according to Kornfield 11.2 mg/100 g of soil. The experiments were conducted according to the methods described by Dospekhov (1985), Pidoprygora and Pisarenko (2003).

Scheme of the experiment: factor (A) Buckwheat varieties of different morphotypes (breeding varieties of the Institute of Agriculture of the Northeast): Slobozhanka indeterminate (ordinary) morphotype, Yaroslavna determinant morphotype; factor (B) Sowing time: early (first decade of May); optimal (third decade of May); factor (C) Methods of sowing: continuous (row), wide row. Statistical processing of the obtained results was carried out using the Statistica program (Tsarenko et al. 2000).

Results and Discussion

The results of observations on the formation of buckwheat grain quality indicators are shown in (Tab. 1). The Slobozhanka variety was significantly affected by the first (early) period of sowing, especially wide–row sowing, where the weight of 1000 grains were 31.5 g, the nature of the grain was 642 g/l, the uniformity of the grain was 94%, and the film density was 24.8%.

Table 1. Formation of buckwheat grain quality indicators (average for 2021–2023)

Sowing method	mass of 1000 pieces, g	fullness of grain, g/l	grain alignment, %	filminess, %
The sowing period is early				
Slobozhanka variety				
Continuous (control)	31	640	91	25.3
Wide–row	31.5	642	94	24.8
Yaroslavna variety				
Continuous (control)	36.2	650	90	25
Wide–row	36.6	654	92	24.3
The sowing period is optimal				
Slobozhanka variety				
Continuous (control)	30	638	90	25
Wide–row	30.3	640	92	25
Yaroslavna variety				
Continuous (control)	35.1	648	90	25.6
Wide–row	35.7	652	88	26

If the sowing date was late, we observed a deterioration of the quality indicators for this variety, but to a small extent. Wide–row sowing had quality indicators at the level of row (continuous) sowing of the first season.

According to the Yaroslavna variety, in both periods and with different row widths, grain quality indicators were high: the weight of 1,000 grains was 36.6 g, the nature of the grain was 654 g/l (early sowing period, wide–row sowing), grain uniformity was the highest with wide–row sowing and the same for both sowing dates 92%, and film frequency 26.0% for wide–row sowing of the optimal sowing date. In both cases, wide–row sowing was better than continuous sowing.

Hence, grain quality indicators of both varieties of buckwheat depended to a greater extent on the genetic characteristics of the variety, timing and methods of sowing made it possible to reveal a complex reaction under conditions of unstable weather conditions during the growing season and years of research that influenced their change.

Straw (buckwheat), hay, chaff, green mass can be fed to animals, but in small quantities. In the stall period, it is useful to include crushed and steamed buckwheat or its mixture with other feeds in the diet of animals, because it is rich in mineral salts and vitamins. Buckwheat should not be fed to beef cows and calves.

Buckwheat straw is well eaten by animals in mixtures with straw of perennial leguminous grasses, peas, sugar beet pulp, as well as with corn in milk–waxy maturity, pumpkins. Buckwheat straw, according to the Chernihiv research chemical station, contains 1 in 0.30 feed units and 24 g of digestible protein, 15.7 g of calcium, 1.4 g of phosphorus and 29 mg of carotene (Radchenko al., 2018; Trygub et al., 2022). Data on the total amount of nutrients in our experiment are shown in (Tab. 2).

Table 2. Buckwheat straw yield and its nutritional value (average for 2021–2023)

Sowing method	straw yield, t/ha	yield of fodder units, t/ha	yield of digestible protein, kg
The sowing period is early			
Slobozhanka variety			
Continuous (control)	7.05	2.12	1.62
Wide–row	7.62	2.29	1.75
Yaroslavna variety			
Continuous (control)	7.17	2.15	1.65
Wide–row	7.56	2.27	1.74
The sowing period is optimal			
Slobozhanka variety			
Continuous (control)	6.75	2.03	1.55
Wide–row	6.21	1.86	1.43
Yaroslavna variety			
Continuous (control)	6.68	2	1.54
Wide–row	6.83	2.05	1.57

Analyzing the obtained research results, it can be stated that buckwheat is a valuable fodder crop. It's by products, in the form of straw and chaff, make it possible to obtain valuable fodder, for the Slobozhanka variety in feed units from 1.86 t/ha to 2.29 t/ha, and for the Yaroslavna variety forage units from 2.05 t/ha to 2.27 t/ha.

Thus, in addition to grain, buckwheat provides farms with a fodder base in the amount of 6.2 to 7.6 t/ha of straw, which in terms of nutrition is close to the hay of perennial grasses, and in terms of mineral composition to leguminous grasses.

Conclusions

Based on the results of the research, it was established that the grain quality indicators of both varieties of buckwheat depended to a greater extent on the genetic properties of the variety, to a lesser extent on the terms and methods of sowing. This made it possible to reveal a complex reaction in unstable weather conditions during the growing season and years of research that influenced their change.

Buckwheat by–products in the form of straw and chaff make it possible to obtain valuable fodder, for the Slobozhanka variety – in feed units from 1.86 t/ha to 2.29 t/ha, and for the Yaroslavna variety – forage units from 2.05 t/ha to 2.27 t/ha.

Thus, buckwheat, in addition to grain, provides farms with a fodder base in the amount of 6.2 to 7.6 t/ha of straw, which in terms of nutrition is close to the hay of perennial grasses, and in terms of mineral composition to leguminous grasses.

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