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PARAMETERS OF FORMATION OF BUCKWHEAT PRODUCTIVITY BY DETERMINANT VARIETIES SELECTION OF THE INSTITUTE OF AGRICULTURE OF NORTHERN EAST OF NAAS OF UKRAINE

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Resolution of the problem. Sowing buckwheat (*Fagopyrum esculentum* Moench.) is a valuable grain crop that is a staple in the diet of Ukrainians. Especially in difficult times, buckwheat croup was the most demanded food product. This is explained by its chemical composition and high calorie content. The grain contains mono- and polyunsaturated fatty acids, it contains a high content of lecithin and miliacin (up to 4,5 %), vitamins B1, B2, B6, pantothenic acid, folacin, choline, vitamin E. The kernel contains up to 11,3 % of dietary fiber, which is 37,7 % of the daily human need [1].

But today, regardless of the strategic importance of the culture, the cultivated area under it in Ukraine has stabilized at the level of 80 thousand hectares, which is slightly more than 50 % of the necessary area to fully meet the internal needs of the country's population. One of the reasons that led to a significant decrease in buckwheat crops (by 76 % compared to 2000) is its lower profitability compared to the main export-oriented crops (sunflower, corn, soy) [2].

Buckwheat is primarily a bee-pollinated crop. The conditions that arise during the flowering and pollination of crops by honey bees are fundamental in the formation of the grain harvest. The completeness of bee pollination, in addition to the temperature factor, is determined by the features of the development of the reproductive organs of the culture: the number of flowers, their location and completeness of opening, the duration of the flowering period. Agricultural plant productivity is also influenced by agrotechnical measures such as: variety assortment, sowing rate, sowing scheme, fertilizers, etc. Such factors change the conditions of existence of buckwheat plants in the agrocenosis, accordingly, the characteristics of the growth and development of buckwheat plants of different morphotypes change [3].

Thus, one of the directions in buckwheat breeding is the selection of elite plants according to the appropriate habit of the plant with subsequent selection. As a rule, we are talking about the creation of determinant (low-growing) varieties that provide an increase in the yield of buckwheat grain per hectare compared to the usual morpho-type due to the optimization of the elements that form their productivity in agrobiocenosis.

Analysis of recent research and publications. The advantages of determinant varieties over ordinary (indeterminant) in the production of buckwheat grain are determined by the following laws.

It should be understood that limiting the height of the plant leads to a decrease in the work of the main shoot in the formation of generative organs. However, the results of selection work in the direction of determinism of buckwheat determined the possibility of increasing the power of the main shoot due to the selection of a plant with an increased number of vegetative nodes and inflorescences on it. Limitation of branching, as one of the indicators of determinism, conducted on the basis of the selection of plants with a reduced branching zone in the branches of the first order, which had a positive effect on the size of the tassel. Selection for a large tassel is determined by the size of the zone of green buds at the ends of the tassels. Plants with numerous elementary inflorescences in a tassel are used as the basis for selection according to this indicator [4].

Conducting the selection process in the specified direction provides grounds for creating highly productive starting selection material and varieties with large inflorescences. Before the creation of determinant varieties, this had only a theoretical basis, since at that time selection, based on the inverse biological correlation inherent in plants of indeterminant populations between the increase in the length of the panicles over 3 cm and the percentage of realization of flowers into fruits, was conducted in the opposite direction. This regularity in ordinary varieties led to a decrease in grain size in case of exceeding the specified parameters of the length of the tassels. However, the use of specific variability in determinant populations gives hope for further progress in buckwheat breeding in the direction of creating high-yielding varieties with large inflorescences.

It should be noted that the timing of most selections coincides with the phase of budding and the beginning of flowering. At this time, the determinants have a well-defined structure of the main shoot and the number of vegetative

nodes of tassels on the shoot. Carrying out the work within the specified period allows you to avoid cutting off flowers and ensures targeted pollination. In the phase of full flowering, selection is carried out for limited branching, while the branches are already well developed, therefore, during this period, it is necessary to cut off the flowers and fruits that have formed earlier [5].

Among the other advantages of determinant varieties, which contribute to the realization of the genetic potential of productivity in buckwheat, there is a complex feature – resistance to lodging. It is determined by the limitation of the height of the plant and the peculiarities of its anatomical structure. The decrease in plant height is characteristic of genotypes of the determinant morphotype, which are characterized by the limitation of shoot and branch growth. Such plants are characterized by the redistribution of plastic substances that contribute to the formation of biomass and increase the grain weight in the structure of the total biomass. This is explained by the change in the indicators of photosynthetic acceptors in the determinant genotypes.

The determinant form can also be used as a model for the formation of new mechanisms of fruiting homeostasis. The low growth of the shoots means that the selection for increasing the seeding of flowers will go in the direction of ecological protection of the fruiting process. The effectiveness of this process is largely determined by the ability to mutate genes that control the most important species characteristics [6].

The Institute of Agriculture of the Northern East of the National Academy of Agrarian Sciences of Ukraine is the basic breeding center for determinant buckwheat in Ukraine. In this scientific institution, research is constantly being conducted to study biometric parameters of buckwheat plants, both already registered varieties (depending on technological elements) and selection material and their impact on productivity.

The basis of the work on the creation of new varieties by the breeders of the Institute of Agriculture of the Northern East NAAS use a selection scheme based on the works of N.V. Fesenko. The specified scheme is based on both the recessive and monogenic nature of the inheritance of determinism and the regularity of the inheritance of a number of other morphological and economic features [7,8].

Based on the recessive monogenic inheritance of determinants, the selection scheme is divided into the following main stages:

– selection of parental components, hybridization;

– growing F1 hybrids under screen isolation;

– negative selection for determinant in the F_2 hybrid combination;

– repeated family-group or mass selection [9].

The determinant model was improved according to the principle of constructive segmentation. The selection is mainly based on the characteristics that make up the metameric organization of plants: the number of nodes in the branching zone of the shoot and inflorescences on it, the number of nodes in the branching zone of branches, elementary inflorescences in the panicle.

Thus, the creation of new determinant varieties of buckwheat with the involvement of collection forms based on the study of the parameters of their productivity formation and subsequent selection remains extremely important and relevant.

The purpose of research. The purpose of our research was to study the level of manifestation of productivity elements based on biometric parameters of plant growth and development of determinant varieties of buckwheat selected by the Institute of Agriculture of the Northern East NAAS.

Research materials and methods. Experiments on the relationship between biometric and yield parameters of determinant varieties of buckwheat were carried out in the conditions of the northeastern Forest Steppe of Ukraine in the short-rotation field crop rotation of the Institute of Agriculture of the Northern East of the NAAS. The article presents the results of research for 2019–2021.

In the experiment, three determinant varieties were studied: Sumchanka, Krupinka and Ivanna. In order to study the biometric parameters of plants, which distinguish determinant varieties from ordinary ones and have an influence on the formation of productivity elements, a variety of the indeterminant morphotype Slobozhanka was taken as a control. All the listed varieties are the result of the breeding work of scientists of the Institute of Agriculture of the Northern East of the NAAS and belong to high-yielding varieties included in the State Register of plant varieties suitable for distribution in Ukraine.

The scheme of the experiment had the following form: the control variant – the Slobozhanka variety, the studied variants – the Sumchanka, Krupinka and Ivanna varieties.

The seeds were sown using a SKS-6-10 selection seeder in a cassette version (feeding area 3x45 cm). Varieties were sown on 3-row plots with a registered area of 6.75 m^2 in three repetitions. The establishment of experiments, evaluation of materials, analysis of plants and harvest was carried out in accordance with generally accepted methods [10]. The research results were processed using statistical analysis methods [11].

Research results. The study and comprehensive evaluation of the original breeding material made it possible to successfully use it in breeding programs and create six varieties of the determinant morphotype (Sumchanka, Krupinka, Ivanna, Yuvileyna 100, Yaroslavna, Selyanochka). Plants of the determinant type are characterized by complete growth (the main shoot and branches end in a simple inflorescence – a tassel). This trait is controlled by a recessive gene.

The results of the basic characteristics of the habit of buckwheat plants of the studied varieties and their comparison with the variety of the indeterminant morphotype Slobozhanka are shown in Table *Стpахоліс* 1.

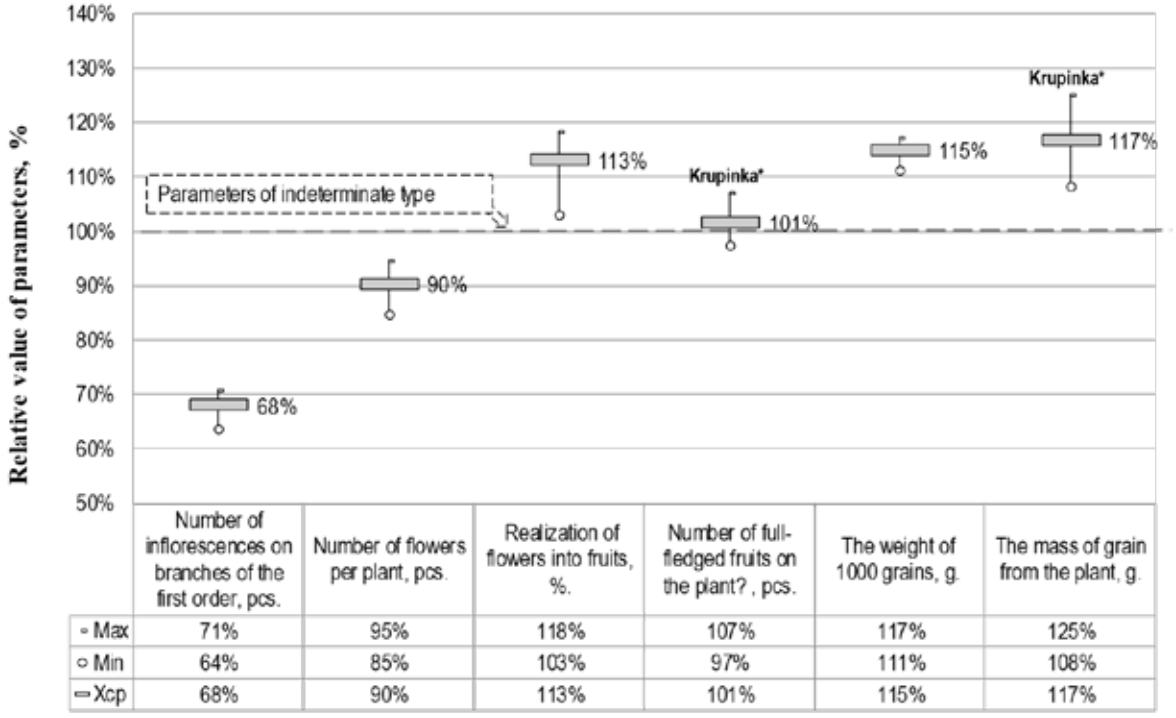
The obtained data indicate that, in general, plants of determinant varieties have an average height of 11 % lower than the normal variety. The shortest stems were noted in plants of the Sumchanka variety, the height of which, depending on the conditions of the year, was 96–100 cm. On average, the plants of the Krupinka variety were five centimeters taller than the Sumchanka variety. Plants of the Ivanna variety exceeded 110 cm.

Despite the lower height, the assimilation area of the leaf surface of the determinant varieties exceeded the indi-

cators of the indeterminant variety by 26 % on average. The largest leaf surface area was recorded in the Krupinka variety – 1940 cm^2, which is 28 % more than the control variant. Indicators of the relative foliage of the plant, the area per 10 cm of growth, indicate a significantly greater advantage of determinant varieties. The maximum indicator of the indicated parameter was determined by the experiment in plants of the Sumchanka variety – 193 cm^2/10 cm, this exceeded the value of the indeterminant variety by 48 %, while the indicator of the total leaf area exceeded the indicator by 28 %. On average, according to the specified parameter, the determinant varieties prevailed over the control variant by 33–47 %. Therefore, the advantages of the researched varieties in the formation of the assimilation area led to the improvement of the parameters of the leaf supply of flowers. This indicator in determinant varieties was on average 40 % higher than the indeterminant variety Slobozhanka. It should be noted that the vegetation period of determinant varieties was 5–11 days shorter than that of the usual variety.

Features of the formation of generative organs indicate an advantage in the implementation of the productivity of plants of determinant varieties over ordinary ones (pic. 1) against the background of a much smaller number of inflorescences on branches of the first order.

Thus, taking into account the peculiarities of the habit of plants of deterministic varieties, the number of inflorescences on the branches of the first order was lower by 32 %, and the total number of flowers per plant by 10 % compared to the indeterminant variety. However, this regularity, on the contrary, led to a positive result of the productivity of the studied varieties. First of all, the percentage of realization of flowers into fruits increased from 12,6 % in the control to 14,9 % in the Sumchanka variety, and the average indicator of the determinant varieties exceeded the indeterminant variety by 13 %. Secondly, with an almost equal number



Pic. 1. Comparison of the parameters of plant productivity formation of different varieties of determinant to indeterminant morphotype, average for 2019–2021

Table 1

General characteristics of the habit and duration of the growing season of plants in different varieties of buckwheat, average for 2019–2021

№	Indicator	Variety			
		Slobozhanka	Sumchanka	Krupinka	Ivanna
1	Plant height, cm	116±2,4	98 ±1,6	103±1,9	110±1,5
2	Leaf area, cm²	1518±164	1893±218	1940±261	1915±216
3	Leaf area for 10 cm of height, cm²	130,86	193,16	188,35	174,09
4	Leaf supply of flowers	0,55	0,81	0,77	0,73
5	Vegetation period, days	85±3,6	74±3,1	78±2,8	80±3,6

of full-fledged fruits on the plant, the determinant varieties formed a mass of grain that exceeded the control variant by an average of 17 %, due to an increase in the mass of 1000 grains by 8–25 %.

After examining the correlation between the studied plant parameters of the determinant varieties of buckwheat and its individual productivity, it was established that the number of full-fledged fruits per plant (r=0.97) and the weight of 1000 grains (r=0,91) are the main influencing factors on the formation of grain mass. Among the factors that are not directly a component of the grain mass, the most influential was the realization of flowers into fruits (r=0.83). In turn, a high factor of influence on the percentage of realization of flowers of the leaf supply parameter of flowers was established (r=0.89). The total leaf surface area had an average effect on grain mass (r=0.55). The height of the plant had a negative effect on productivity (r=-0.56). It should be noted the high positive dependence of the duration of the growing season on the height of the plant (r=0.96) and the number of flowers (r=0.99).

Thus, the realization of the advantages of determinant varieties due to the reduction of energy costs for the elongation of the stem and the formation of the total number of flowers on the plant, the formation of inflorescences with larger flowers, made it possible to form an almost equal number of grains, but much larger compared to the usual (indeterminant morphotype).

Conclusions

1. The specific features of the habit of determinant plants were determined, which consisted in the formation of low-growing bushes with a well-developed assimilation area, which increased the leaf coverage of plant flowers by 40 % compared to indeterminant ones.

2. It has been established that the formation of generative organs and their location on plants of determinant varieties differs significantly from the usual morphotype. As a result, despite a certain advantage in the number of flowers on plants of the indeterminant variety, their location and size allowed the formation of the same number of grains through greater implementation of flowers into full-fledged fruits.

3. Biometric features of determinant varieties made it possible to form a mass of grain on the plant, which exceeded the usual variety by 8–25 %.

4. The basic influencing factor on the productivity of buckwheat plants is the number of full-fledged fruits per plant (r=0.97) and the weight of 1000 grains (r=0.91)

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Straholis I. M., Berdin S. I., Kabanets V. V. Parameters of formation of buckwheat productivity by determinant varieties selection of the Institute of Agriculture of Northern East of NAAS of Ukraine

Purpose. The purpose of our research was to study the level of manifestation of productivity elements based on biometric parameters of plant growth and development of determinant varieties of buckwheat selected by the Institute of Agriculture of Northern East NAAS. **Methods**. The research was conducted during 2019–2021. The object of the research was three determinant and one indeterminant (control variant) buckwheat varieties selected by the Institute of Agriculture of the Northern East NAAS. Field and laboratory methods of research involved determination of biometric parameters of buckwheat plants and elements of their productivity. The establishment of experiments, the determination of biometric parameters, the analysis of the obtained results, and the mathematical and statistical processing were carried out in accordance with generally accepted methods. **Results**. As a result of the study, the superiority of determinant varieties over indeterminant varieties was established in terms of parameters related to the leaf surface. Indeterminant varieties form a greater number of flowers and the number of inflorescences on branches of the first order, however, the peculiarities of the structure of the determinant varieties (increased assimilation area, placement of flowers on the plant, etc.) led to an increase in the percentage of realization of flowers into grains by 13 %. The latter made it possible to obtain an equal number of full-fledged grains on the plant in comparison with the control variant, and due to the formation of larger seeds in the determinant varieties, to exceed the individual productivity of the control variant by 17 %. **Conclusions**. The features of the habit of determinant plants were identified, which consist in the formation of low-growing bushes with a well-developed assimilation area, which increased the leaf supply of plant flowers by 40 % compared to indeterminant ones. It was established that the formation of generative organs and their location on plants of determinant varieties is significantly different from the usual morphotype. Despite a certain advantage in the number of flowers on plants of the indeterminant variety, their location and size allowed the formation of the same number of grains through greater implementation of flowers into full-fledged fruits. Thus, the biometric features of the determinant varieties made it possible to form a mass of grain on the plant, which exceeded the usual variety by 8–25 %. The basic factor influencing the productivity of buckwheat plants is the number of full-fledged fruits per plant (r=0.97) and the weight of 1000 grains (r=0.91).

Key words: buckwheat, selection, determinant variety, indeterminant variety, biometric indicators, individual productivity.

Страхоліс І. М., Бердін С. І., Кабанець В. В. Особливості формування продуктивності гречки детермінантними сортами селекції Інституту сільського господарства Північного Сходу НААН України

Мета. Метою досліджень було вивчення впливу біометричних параметрів росту та розвитку гречки на рівень прояву елементів продуктивності у детермінантних сортів селекції Інституту сільського господарства Північного Сходу НААН. **Методи**. Дослідження проводили протягом 2019–2021 років. Об'єктом дослідження виступали три детермінантних та один індетермінантний (контрольний варіант) сорти гречки селекції Інститут сільського господарства Північного Сходу НААН. Польові та лабораторні методи досліджень передбачали визначення біометричних параметрів рослини гречки та елементів її продуктивності рослини гречки. Закладку дослідів, визначення біометричних параметрів, аналіз рослин проводили відповідно загальноприйнятій методиці Держсортовипробування. Результати досліду було оброблені статистичними методами (дисперсійний та кореляційний). **Результати**. В результат дослідження габітусу рослини встановлена перевага детермінантних сортів над індетермінантними за параметрами, що пов'язані з листовою поверхнею. Індетермінантні сорти формують більшу кількість квіток та кількість суцвіть на гілках першого порядку, однак особливості будови детермінантних сортів (підвищена асиміляційна площа та інше розміщення квіток на рослині) призвели до збільшення відсоток реалізації квіток у плоди на 13 %. Останнє дозволило отримати рівну кількість повноцінних зерен на рослині в порівняні з контрольним варіантом, а внаслідок формування більш крупного насіння у детермінантних сортів, перевищити індивідуальну продуктивність контрольного варіанту на 17 %. **Висновки**. Визначені

особливості габітусу детермінантних рослин, які полягали у формуванні низькорослих кущів з добре розвиненою асиміляційною площею, яка збільшувала листозабезпеченість квіток рослин на 40 % в порівнянні з індетермінатними, та коротшим на 9,5 % періодом вегетації. Встановлено, що формування генеративних органів та їх розташування на рослинах детермінантних сортів значно відрізняється від контрольного варіанту. В результаті, не зважаючи на перевагу у кількості квіток на рослинах індетермінантного сорту, визначене розташування квіток дозволяло сформувати однакову кількість повноцінних плодів шляхом більшої реалізації їх у повноцінні плоди. Біометричні особливості детермінантних сортів дозволили сформувати масу зерна на рослині, яка перевищувала звичайний сорт на 8–25 %. На реалізацію переваги детермінантних сортів вливали їх біологічні особливості формування габітусу та генеративних органів. Найбільшу продуктивність у досліді сформували рослини сорту Крупинка внаслідок збільшеної листової поверхні (r=0,55) та реалізації квіток у плоди (r=0,83).

Ключові слова: гречка, селекція, детермінантний сорт, індетермінатний сорт, біометричні показники, індивідуальна продуктивність.