ISSN 2300-3170

Zeszyty Naukowe Wyższej Szkoły Agrobiznesu w Łomży – nr 84

WYŻSZA SZKOŁA AGROBIZNESU W ŁOMŻY

nr 84

ZESZYTY NAUKOWE

Wydawnictwo Wyższej Szkoły Agrobiznesu w Łomży

2021

Wydawnictwo Wyższej Szkoły Agrobiznesu w
Łomży

Seria:

Zeszyty Naukowe

Nr 84

NAUKI ROLNICZE,

LEŚNE, WETERYNARYJNE I PRZYRODNICZE

Redaktor prowadzący: **prof. zw. dr hab. Zofia Benedycka**

Łomża 2021

WYŻSZA SZKOŁA AGROBIZNESU W ŁOMŻY ACADEMY OF AGROBUSINESS IN LOMZA

NAUKI ROLNICZE,

LEŚNE, WETERYNARYJNE I PRZYRODNICZE

ZESZYTY NAUKOWE
WYŻSZA SZKOŁA AGROBIZNESU W ŁOMŻY

Skład wykonano z gotowych materiałów dostarczonych przez Autorów. Wydawca nie ponosi odpowiedzialności za dostarczony materiał graficzny.

ISSN 2300-3170

Wydawnictwo Wyższej Szkoły Agrobiznesu w Łomży 18-402 Łomża, ul. Studencka 19
tel. +48 (86) 216 94 97, fax +48 (86) 215 11 89
e-mail: rektorat@wsa.edu.pl

SPIS TREŚCI

ZESZYTY NAUKOWE WSA w Łomży 84, s. 7-18
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Horodyska Olesia
Podilskyi State Agrarian and Engineering University

THE MODERN SYSTEMS OF SOURCING ENERGY – AGRICULTURAL BIOGAS FROM A FARM

Summary

Plant resistance to extreme environmental conditions is a complex of features that depends on the magnitude and exposure duration to high temperatures and drought both in the structural (anatomical and morphological) and functional (physiological and biochemical) terms, as well as on the implementation degree of the genotype individual genetic program. In this regard, the plant resistance study to unfavorable environmental factors, in particular drought, is one of the most important problems of agricultural production and is of great practical and theoretical importance.

By the method of hybridization based on the use of samples from the collection of the genus Fagopyrum Mill, a valuable source material was obtained on the drought resistance basis with high yielding and improved technological indicators of grain quality adapted to Podillia conditions. 13 varieties were selected, direct and reciprocal saturating crosses were carried out; a comparison of the new source material with the standard variety Victoria and the original parental forms was carried out; drought tolerance assessment was carried out; on the basis of a comparative assessment, economically important indicators of buckwheat hybrids grain were established: the growing season, productivity and technological indicators of grain quality.

The express-assessment efficiency of buckwheat breeding material on the basis of drought resistance by germination of seeds in osmotic solutions with a sucrose concentration of 13.9% has been established.

The varieties Skorostyhla 86, Smuglianka, Kazanka, Alenushka, and Veselka are donors for the new source material on the basis of drought resistance. The hybrids created on their basis have a clear character of the manifestation of this trait under various assessment methods.

It was determined that the higher drought resistance in comparison with the parental forms and the standard variety Victoria have hybrid combinations Kazanka x Smuhlianka (47%), (Kazanka x Smuglianka) x Smuglianka (47.3%) (Skorostyhla 86 x Solianska) x Solianska (64 8 %) (Alyonushka x Veselka) x Veselka (81.7%).

These hybrids of buckwheat have a 5-12 days shorter growing season, higher drought resistance (by 35.4-81.7%), higher by 0.2-0.36 t / ha grain yield compared to the standard variety Victoria. The grain of these numbers is characterized by high technological properties; for processing into cereals, its chemical composition and food safety indicators comply with regulatory requirements..

Keywords: agriculturalbiogas, biogas plant, OZE, biomass, energyplants, Podlaskie area, Rybolyvillage.

Introduction

Successful buckwheat hybrids breeding for conditions of insufficient moisture depends on the availability of source material with high rates of a number of valuable morphobiological traits, drought resistance, as well as the creation of hybrids that differ in the growing season length [2, 7, 3].

Today, there are many physiological methods for assessing the drought tolerance of field crops. The simplest indirect methods for mass assessment of relative drought resistance are based on the grain germination determination and seedling growth in osmotic solutions that simulate a moisture lack.

The first such methods were proposed and tested on wheat seeds in sucrose solutions of 5, 10, 15, 20 and 40% concentration[8]. The number of germinated seeds was counted daily and the roots and seedlings were measured. The results were recorded on 10th day. The number of germinated seeds is in direct proportion to the drought tolerance degree of the variety - the more resistant the variety, the higher the percentage of seeds germinated at high sucrose concentrations and the longer the roots and seedlings.

The higher the percentage of seed germination in the sucrose solution, the more drought-resistant the sample is.

The ability of grains to germinate under these conditions reflects, on the one hand, the hereditary property to germinate with a relatively small water amount, and on the other hand, the presence of a high absorbing (suction) force, which ensures the rapid absorption of the required water amount. A high absorbing force also determines the formation of a more powerful primary root system, is important for the entire plant life, especially in drought conditions, that is, the properties of seedlings significantly affect the formation of drought resistance in an adult plant [10].

Most varieties are populations in which one seed is capable of germinating at a higher osmotic pressure, others at a lower osmotic pressure. Therefore, the more the first seeds in the population, the higher the percentage of their germination at an average concentration of hoe wasps and vice versa [9].

The most effective way to eliminate the drought influence is the selection of drought-resistant varieties. The basis for its creation is an adaptive source material for the selection of which effective and, if possible, simple techniques are required, allowing to evaluate a large number of samples in a short time (Chekalin 2008) [11].

The greatest decline in buckwheat yields is caused by soil and air droughts. In some regions of the country, scientists are trying to create heat-resistant and drought-resistant varieties of buckwheat, adapted to local growing conditions (Alekseeva 2004) [1]. However, such work is constrained by insufficient study of the buckwheat gene pool on these grounds, the lack of objective and production methods for the assessment and selection of drought-resistant forms.

In the scientific work “On the assessment of buckwheat drought resistance” (Lakhanov 1992).He proved that the most accessible method for determining drought resistance is the grains evaluation to germinate in physiological drought conditions[6]. First of all, he determined the relationship between the concentration of osmotic substance and the seed germination degree and discovered the genetic heterogeneity of the culture for this trait [4,5]. A significant difference in the possibility of grains to germinate in the osmotic substance was found when the osmotic pressure of the sucrose solution was 10-12 atm. There are also known modifications of this method for many vegetables, grains and legumes.

Material and research methods

Purpose of the study: based on the use of the world buckwheat gene pool collection, to assess and create a new initial breeding material based on drought resistance, adapted to the conditions of Podillia.

To achieve this goal, the following tasks were solved:

- to research and characterize various varieties of buckwheat from the collection of the world gene pool, to choose the optimal output forms;
- carry out simple and reverse crosses and get buckwheat hybrids.;
- to establish, on the comparative assessment basis, economically important indicators of grain of buckwheat hybrids (drought resistance, growing season, productivity and technological indicators of grain quality);

Field research 2019-2020 was carried out in the selection crop rotation of the Research Institute of cereal crops of the Podilskyi State Agrarian and Engineering University.

Testing, material assessment, analysis of plants, yield and grain quality were carried out in accordance with the generally accepted methodology of state variety testing. The material was studied under the conditions of screen isolation, created using the tetraploid form of buckwheat. The width of the screen strips was 10.8 m.

The sowing method was wide-row with a row spacing of 45 cm. All nurseries sowed with a SKS-6-10 cassette seeder. Sowing was carried out on May 6-27.

Results and discussion

We have evaluated the created hybrid combinations on the drought resistance basis, both by the method of eye assessment in accordance with the classifier of the buckwheat genus (Table 1), and by the method proposed for the main grain crops.

The assessment of the drought resistance of the buckwheat hybrid material was carried out by eye according to the classifier of the genus Fagopyrum Mill on a seven-point scale in the most critical periods of drought:

- very weak - 1 point;
- weak - 3 points;
- average - 5 points;
- high - 7 points..

Table 1. Level of field drought tolerance of buckwheat hybrid material, points

Origin	Field assessment of drought resistance		
	2019 р.	2020 р.	average
Smuhlianka × Kazanka	3	3	3
Kazanka × Smuhlianka	5	7	5
(Smuhlianka × Kazanka) × Kazanka	7	5	5
(Kazanka × Smuhlianka) × Smuhlianka	3	5	3
Skostuhla 86 × Solianska	5	3	5
Solianska × Skostuhla 86	5	3	5
(Skostuhla 86 × Solianska) × Solianska	7	7	7
(Solianska × Skostuhla 86) × Skostuhla 86	5	3	3
(Alyonushka × Veselka) × Veselka	1	1	1

According to the eye assessment results of breeding material on the drought resistance basis, it was found that hybrid combinations obtained from crossing the varieties Alenushka, Veselka, Kazanka, Smuhlianka, Solianska, Skostuhla 86 had very weak and weak drought resistance. The rest of the hybrid combinations had an average and high level of this indicator.

It has been practically proven that the accuracy of an estimate increases when several estimates give the same result. In parallel with the eye measurements, we preliminarily carried out a laboratory assessment of the breeding material on the drought resistance basis.

As a result of the studies, it was found that the hybrid combinations obtained from crossing the varieties Kazanka and Smuhlianka were characterized by a high drought resistance of 41.2 - 53.0% (Fig. 1). Combinations Smuhlianka ´ “Kazanka and Kazanka” ´ Smuglianka over the years of research had relatively high rates of 40.3 - 47%..

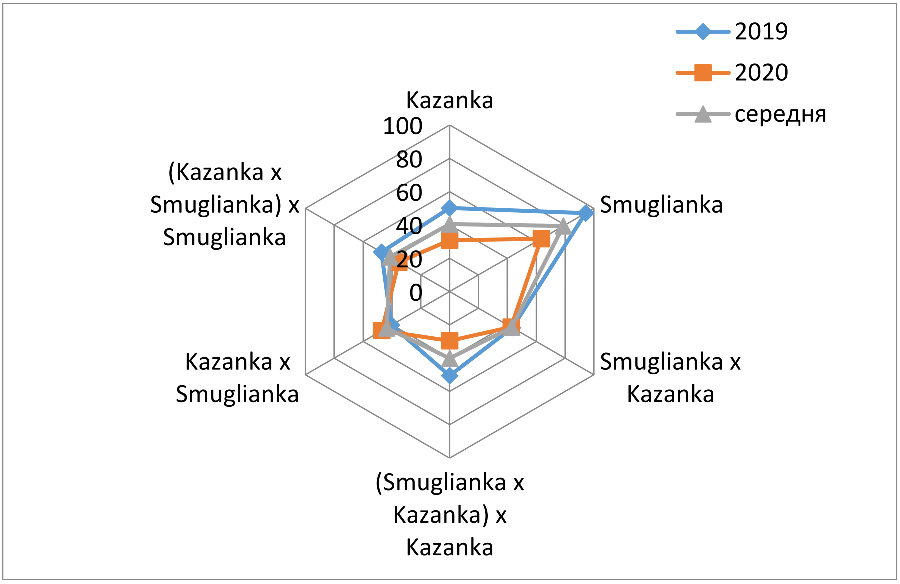

Fig. 1. Distribution of parental forms of Kazanka and Smuglianka and numbers of buckwheat of hybrid origin based on drought resistance.

This is explained by the fact that the proportion of parental forms is 1/2 and this trait was controlled by the polymeric genes action of the Kazanka variety, which indicates its heterozygous condition in this variety (50.2-30.8%). In hybrid combinations (Smuglianka "Kazanka)" Kazanka and (Kazanka "Smuglianka)" Smuglianka in 2019 was controlled by the combined action of heterozygotes, hence the high drought resistance rates of 50.5-47.3%. In terms of evaluating hybrid combinations in 2020. under the influence of unfavorable weather conditions, the effect of recessive genes of the Smuglyanka cultivar was manifested, as evidenced by the average indicators of this trait.

Hybrid combinations HC1, obtained from crossing the varieties Skorostyhla 86 and Solianska, 2019 had high rates for this trait, and in 2020 in the data (Fig. 2).

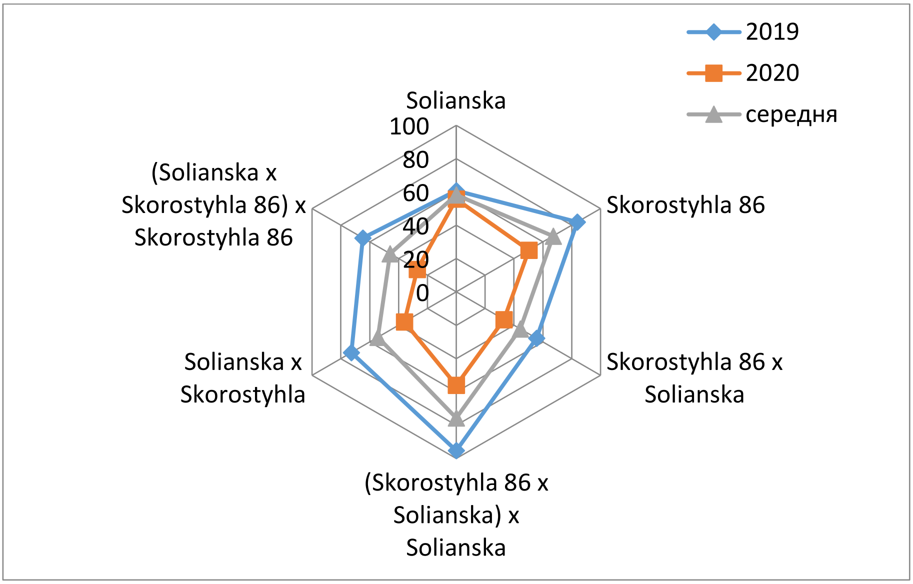

Fig. 2. Distribution of parental forms Solyansk and Skorospelya 86 and numbers of buckwheat of hybrid origin based on drought tolerance

Combinations under the weather conditions influence revealed recessive genes of parental varieties, as evidenced by the drought resistance average indicators. Hybrids (Skorostyhla 86 x Solianska) x Solianska and (Solianska x Skorostyhla 86) x Skorostyhla 86 over the years of research had a significant variation from 27.1-95.3%. This is due to the fact that the proportion of parental forms in these hybrid combinations is 1/3, that is, recessive genes of parental varieties had a significant influence on its manifestation.

Similar results were obtained when evaluating hybrid combinations 2020 (Fig. 3). The hybrid combinations Veselka x Alyonushka, (Alyonushka x Veselka) x Veselka have higher drought resistance compared to the parental forms and the standard variety Victoria. The rest of the studied hybrid combinations, although they exceed the standard variety Victoria in terms of drought resistance, however, they show lower indicators compared to the parent varieties selected from the buckwheat genus collection for this trait.

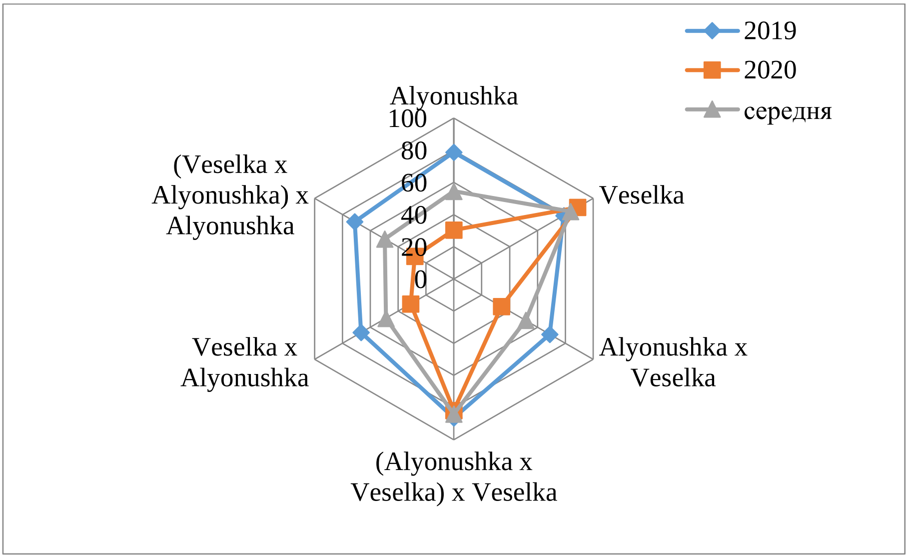

Fig. 3. Distribution of parental forms Alyonushka and Veselka and numbers of hybrid origin based on drought tolerance

The results of the breeding material assessment according to the method proposed and tested on the main grain crops make it possible to distribute parental forms and breeding material based on drought resistance.

We studied the inheritance of the duration of the growing and interphase periods in the studied hybrid combinations. We studied the inheritance of the vegetation duration in buckwheat hybrids in two periods: vegetative (seedlings - flowering) and generative (flowering - ripening).

The character of inheritance of the studied periods in hybrids was significantly different. As a result of the inheritance of the length of the vegetative period, in buckwheat hybrids from HC1 and HC2, the vast majority of hybrids had an intermediate inheritance of 50% in 2020. And in hybrids HC1F1 and HC1F2 there was a tendency towards predominance of early maturity. 59-64.2% of hybrids deviated towards early maturing parental varieties, or reached their level. The number of hybrids that bloomed at a time close to the late-maturing parental varieties was less The behavior of the hybrids in the generative period was somewhat different. Most hybrids HC1F1 and HC1F2 exceeded the original parental forms by 48.7-70%. As a result of research, the total duration of the growing season in hybrids decreased, and a greater number of them leaned towards the early maturing parental varieties. The number of hybrids that approached the late maturing parental forms was insignificant.

Productivity is the interaction result of the entire set of morphological and physiological signs and properties that determine the characteristics of the growth and development of plants in the cenosis. The main features include: photosynthetic indicators of the herbage, the duration of the growing season, the nature of the interaction in the herbage of cultivated plants with each other and weeds, the development peculiarities of vegetative and generative organs, the reaction of plants to favorable factors and their resistance to unfavorable environmental factors, pathogens, condition, etc. ... The criteria for evaluating the source material were yield and grain quality, taking into account the origin.

The yield of the studied samples and the standard variety over the years of research ranged within 1.34-1.7 t / ha, the duration between the phase and the growing season decreased to 75-90 days (Table 2).

Table 2. Yield and grain quality of the best selection numbers of buckwheat

Origin	Vegetation period, days	Crop capacity		Technological quality of grain		
		t / ha	± to St.	mass of 1000 grains, g	alignment,%	filminess, %
Вікторія	90	1,34	-	26,1	76,5	21,9
(Solianska × Mig) × Mig	75	1,51	0,17	30,9	91,5	21,9
(Smuhlianka × Kazanka) × Kazanka	77	1,55	0,22	29,4	90,6	21,9
(Kazanka × Smuhlianka) × Smuhlianka	77	1,7	0,36	30,3	92,7	22,1
Alyonushka × Veselka	75	1,34	0	29,6	90,5	22,7
Veselka × Alyonushka	78	1,50	0,16	30,1	89,7	22,1
Alyonushka × Veselka) × Veselka	80	1,50	0,16	30,1	91,4	22,7
Veselka × Alyonushka) × Alyonushka	80	1,54	0,20	30,5	90,7	22,5
HIP_{05}			0,14			

The hybrid numbers in 2020 were characterized by a long growing season. The beginning of flowering was noted at 23-25 days, however, the phases of fruit browning were long - 30-35 days of ripening - 30 days. Most breeding numbers significantly exceeded Victoria in terms of grain quality.

In terms of the growing season duration, the new breeding material was characterized by its reduction in comparison with the standard variety Victoria by 7-17 days. It should be noted that the 2020 weather conditions were more favorable for the formation of a high yield of buckwheat plants. The breeding numbers (Veselka × Alyonushka) × Alyonushka, (Smuglianka × Kazanka) Kazanka, (Kazanka × Smuhlianka) × Smuhlianka had a higher yield and improved technological indicators of grain quality in comparison with the standard variety Victoria.

All studied breeding numbers were characterized by high technological indicators of grain quality in comparison with the standard - 1000 grain weight, uniformity. Due to the higher mass and evenness, the cereal yield also increased.

The overwhelming majority of breeding numbers had a high percentage of frequency and only in numbers (Solianska x Mig) x Mig this indicator was almost at the standard level.

Conclusions

So, having carried out a preliminary assessment of breeding material with a drought resistance sign, the following preliminary conclusions can be drawn:

1. The assessment increases accuracy with the use of not only eye, but also laboratory assessment methods. This makes it possible to more accurately and fully carry out a comprehensive assessment on this basis.
2. For additional assessment on the basis of drought resistance, use the technique proposed for grain crops - the ability of plants to germinate in osmotic solutions.
3. Hybrid combinations (Kazanka x Smuhlianka), ((Kazanka x Smuhlianka) x Smuhlianka), (Skorostyhla 86 x Solianska) x Solianska), ((Alyonushka x Veselka) x Veselka).
4. The varieties Skorospelyaya 86, Smuhlianka, Kazanka, Alenushka, and Veselka are

available as donors for creating a new source material based on drought resistance. Creations based on them have a clear manifestation of this feature, regardless of the assessment methods.

5. Hybrid combinations Veselka × Alyonushka) × Alyonushka, (Smuhlianka × Kazanka) × Kazanka, (Kazanka × Smuhlianka) × Smuhlianka exceeded the standard variety Victoria in yield by 0.20-0.36 t / ha, uniformity - 14-16 , 2%, weight of 1000 grains - 4.2-4.8 g, ply fraction - 0.6-0.8%.

Bibliography

1. Alekseeva E.S., Elagin I.N., Taranenko L.K, [and others] Buckwheat culture. - Selection and seed production of buckwheat. - Kamianets-Podilskyi: Medobory, 2005. - Part 2. - 240 p.
2. Alekseeva O.S. History of buckwheat breeding in Ukraine. Genetics and selection in Ukraine at the turn of the millennium - K .: Logos, 2001. - Vol. 3. - P. 86-98.
3. Vilchynska L.A., Horodyska O.P. The use of the collection of the genus Grechkov in breeding programs NDIKK. Breeding and genetics of agricultural plants: traditions and prospects: to the 100th anniversary of the Breeding and Genetics Institute - National Center for Seed Science and Variety Studies: abstracts of the International Scientific Conference. - Odessa, 2012. - P. 136-137.
4. Vilchynska L.A. Horodyska O.P. The source material in the selection of buckwheat for drought resistance. Problems and prospects of innovative development of world agriculture. - Saratov, 2013. - P. 207-210
5. Horodyska O.P, Vilchynska L.A. Evaluation of buckwheat breeding material on the basis of drought resistance. Bulletin of Lviv National Agrarian University: agronomy. - Lviv: Lviv nat. agrarian University, 2010. - № 14 (2). - C 207-214
6. Lakhanov A.P. On the assessment of buckwheat for drought resistance // Breeding and seed production, 1992. - P 9-10.
7. Rarok V. A.,. Rarok A.V, Kovis V.H. Directions and prospects of buckwheat breeding. Collection of sciences. PDATU Ave. - Kamianets-Podilskyi, 2013 - Issue. 21. - P. 28-31.

8. Methodical recommendations. Complex method of early diagnosis of drought and heat resistance of soft spring wheat / [comp. OI Gamzikova, LG Gudinova]. - Novosibirsk, 1981. - 25 p.
9. Fesenko A.N. New methods of selection of buckwheat Fagopyrum esculentum Moench: author's ref. dis. for the degree of Doctor of Biol. Science. - St. Petersburg, 2009. - 44 p.
10. Fesenko A.N, Fesenko N.V. , G. Martynenko G.E. [et al.] Morphogenetic method of buckwheat selection (methodical recommendations). M., 2008. - 24 p.
11. Chekalin M.M. Tyshchenko V.M., Batashova M.E. Selection and genetics of individual cultures: a textbook. - Poltava: FOP Govorov S.V., 2008. - 368 p.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 19-30
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Luidmyla Vilchynska
State Agrarian and Engineering University In Podillia

BREEDING BUCKWHEAT IN PODILLIA AND THE USAGE OF ITS RESULTS IN THE EDUCATIONAL PROCESS

Summary

Diversified higher education institutions of training various degrees specialists in the field of knowledge 20 "Agricultural science and food" harmoniously combine educational, scientific, methodological and organizational activities. In the ZVO PDATU, one of the structural units where scientific work is effectively carried out is the Research Institute of cereal crops named after A. Alekseeva. Breeders have created 38 buckwheat varieties over a 50-year history from its foundation. A list of varieties from the moment of creation to the present is given, indicating their creation, as well as the institutions that worked together on their creation.

The register analysis of plant varieties of Ukraine suitable for distribution for 2021 was carried out and it was found that 7.25% of varieties belong to the NDIKK maned by. A. Alekseeva PDATU. The economic characteristics of the varieties Stepova, Elena, Kamianchanka, Volodar are described. The necessity of using the collection of the genus buckwheat in breeding programs has been proved. NDIKK named by. A. Alekseeva PDATU is a practical base for laboratory studies, educational and industrial practice, a place for performing bachelor's, master's, postgraduate, doctoral studies by applicants for higher education.

Keywords: buckwheat, selection, collection of the genus Buckwheat, practical base, applicants for higher education.

Introduction

Training of applicants for higher education requires a harmonious combination of educational, scientific, methodological and organizational components from diversified higher education institutions.

The Law of Ukraine “On Higher Education” in Article 28 [1] describes the types of higher educational institutions, where multi-sectoral universities are understood as an institution of higher education, conducts innovative educational activities at various degrees of higher education (including Doctor of Philosophy), conducts fundamental and / or applied scientific research, is a leading scientific and methodological center, has a developed infrastructure of educational, scientific and scientific-production units, promotes the dissemination of scientific knowledge and carries out cultural and educational activities. Educational activities in the Western Military District are provided by scientific and pedagogical workers who, at their main place of work, carry out educational, methodological, scientific (scientific and technical, artistic) and organizational activities. In the annual structure of the pedagogical summer workload of a scientific and pedagogical worker, scientific work accounts for 30-40%.

It has been practically proven that the basis of any cultivation technology is a biological factor in the genetic potential realization of which all the efforts of the producer are directed. The basis for the creation of any variety is selection work [2].

Breeding is an evolutionary process limited by time and space. It opens up boundless spaces for the breeder's imagination, especially if the work is based on the use of a collection of crops [3].

Buckwheat is a unique cereal crop with a waste-free cultivation and use technology.

Breeding and seed work with buckwheat in Podillia is the result of traditional genetic research to improve plants. In Ukraine, to create new buckwheat varieties, classical breeding methods based on hybridization, induced mutations, and selection are used [4].

The main directions of breeding work with buckwheat:

1) Increase in productivity and product quality;

2) Resistance to biotic (pests and diseases) and abiotic environmental factors;

3) Suitability for cultivation using intensive technology with full mechanization of all processes [5].

Other breeding institutions carrying out the selection of buckwheat in Ukraine include: National Scientific Center "Institute of Agriculture of the National Academy of Agrarian Sciences of Ukraine", Limited Liability Company Scientific and Production Small Enterprise "Antariia", Sumy Institute of Agroindustrial Production of the Ukrainian Academy of Agrarian Sciences, All-Russian Scientific Research Institute of Legumes and Groats (Orel, Russia), Poltava State Agrarian Academy.

Purpose of research

Breeding work analysis with buckwheat in Podillia and the research results introduction into production and educational process.

Creation, evaluation, introduction into production and transfer to the state variety testing of new varieties was carried out on the methodology basis for the suitability of cereal crops varieties for distribution [6].

Research results

The foundation for a comprehensive study of buckwheat as a culture in Podillia was the research started by A.S. Alekseeva at the Ternopil selection and experimental station (1950-1955), and then at the Scientific Research Institute of the Western Regions of Ukraine (1956-1971).

The first varieties selected from local populations were characterized by low technological indicators of grain quality: low weight of 1000 grains, uniformity, low viscous, mid-season in terms of ripening.

Later, the course for large-fruited was supported, which led to some lengthening of the growing season in new varieties and changes in individual traits and properties. In particular, an increase in the mass of 1000 grains led to an increase in the grain evenness and the toughness.

Later, in connection with the election of A.S. Alekseeva, through a competition to the Kamianets-Podilskyi Agricultural Institute (KPAI), the source material for selection was transferred to the institute [7].

The Buckwheat Research Laboratory at the KPAI was established by order of the USSR Ministry of Agriculture No. 276 dated August 22, 1972. The main areas of research: theoretical research on the selection and buckwheat seed production, the creation of varieties, technology improvement of buckwheat cultivation and collection.

In December 1978, by decision No. 63 of the collegium of the State Committee for Science and Technology under the Council of Ministers of the USSR, the Buckwheat Research Laboratory was turned into a problem research laboratory of the KPAI (order of the Ministry of Agriculture of the USSR No. 58 dated 02.14.1979) with the following areas of scientific activity: creation of high-yielding, early ripening and cold-resistant buckwheat varieties, development and improvement of the buckwheat cultivation technology for the forest-steppe and Polissia zones of the Ukrainian SSR.

The reorganization of the KPAI into the Podilskyi State Agrarian and Engineering Academy in 1995 made it possible to create on the basis of the laboratory the Research Institute of Cereal Crops (NDIKK) (Order No. 9 of the Ministry of Agriculture and Food of Ukraine dated January 16, 1997). The Institute provided the following main directions: scientific research on genetics, breeding and buckwheat seed production, the formation of a world collection of germplasm of the genus Fagopyrum, the development of agrotechnical methods, the waste-free technology creation for growing and processing buckwheat, the introduction of scientific advances in production, effective assistance to producers in obtaining organic food in a difficult economic situation [7].

Different generations of breeders worked in the breeding process, who made their own changes to the methods of breeding and seed-growing work with the crop, gained valuable experience, produced a certain specificity characteristic only for the varieties NDIKK PDATU. By 2000, certain varieties of buckwheat were created on the cooperation basis with other breeding institutions, both in Ukraine and the neighboring countries - Moldova.

Years of experience in the world collection formation of germplasm of the genus Fagopyrum, its use in breeding programs allowed it to be entered into the state register of scientific objects that make up the National Heritage (Resolution of the Cabinet of Ministers dated September 22, 2004 No. 1241).

The composition of the NDIKK named by. A. Alekseeva PDATU includes two laboratories:

1) buckwheat gene pool (fig. 1);

2) selection and seed production of buckwheat.

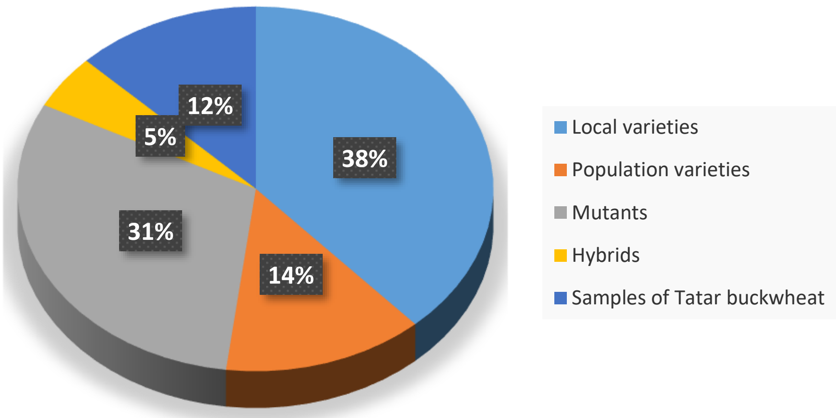

Figure. 1. The structure of the collection of the genus Fagopyrum Mill
Source: the study was carried out by scientific and pedagogical workers of the Department of Plant Growing and Forage Production on the basis of the NDIKK im. A. Alekseeva PDATU.

The main directions of scientific research of the NDIKK them. A. Alekseeva, in addition to the above, are: introduction, preservation and study of the gene pool of the buckwheat genus Fagopyrum Mill; development of effective waste-free, environmentally friendly technologies for growing and processing products; combination of scientific and educational processes to ensure the preparation of highly qualified applicants for higher education in the field of knowledge 20 "Agricultural science and food".

For study, preservation of collection samples in the NDIKK named by. A. Alekseeva created a special storage facility with a controlled microclimate, and since the collection belongs to a working one with a short-term storage period for samples, a separate part is moved once every three years. Specialists of the gene pool of the genus Fagopyrum Mill are working on the creation of unified descriptions for collection samples. For almost 50 years of work in breeding buckwheat in NDIKK PDATU, various methods have been used from simple good from local varieties of populations to complex crosses, the use of experimental mutagenesis and resistance selections of various types of complexity [8].

During this time, 38 varieties of buckwheat have been created and introduced into production (Table 1).

Table 1. List of varieties, methods of their creation

№ п/п	Variety	Creation method	Year	
			transfer to DS	zoning
1.	Radekhivska polipshena		1962	1964
2.	Victoria	MD+RGD	1964	1969
3.	Gloria	GP+RD	1968	1973
4.	Aurora	GP+BMD	1971	
5.	Aelita	tips.mut.+RD	1972	1978
6.	Lada	tips.mut.+RD	1972	1979
7.	Orbita	chem.mut.+RD	1973	
8.	Victoriia Podilska	RD	1974	1981
9.	Podolianka	tips.chem.mut.+RGD	1977	
10.	Selena	chem.mut.+RD	1979	
11.	Astoriia	SC+RD	1981	
12.	Diadema	SC+RD	1982	
13.	Haleia[8]	tips.mut.+RD	1982	1986
14.	Eneida	chem.mut.+BRD	1984	
15.	Kosmeia	tips.mut. 15 M_8+RD	1987	
16.	Luibava[3]	MD	1989	1992
17.	Veselka[4]	chem.mut.+RGD	1990	
18.	Omeha[3]	IS+KHSP	1990	
19.	Zelenokvitkova 90	tips.chem.mut.+RGD	1990	1995
20.	Nika	tetra+RGD	1991	
21.	Kara-Dah	tips.mut. 4 M_5+IS	1991	1996
22.	Kozachka[5]	GP+MD	1992	
23.	Podilska[6]	RGP	1992	
24.	Stepova[7]	GP+RG	1993	1998
25.	Zelenokvitkova 93	tips.chem.mut.+RGD	1994	
26.	Yana	RGD	1995	
27.	Mriia	chem.mut.	1995	
28.	Rada	KHSP+radio.cutter.	1996	
29.	Roksolana[9]	tips.mut.+RGD	1996	2000
30.	Malikovska	tips.mut.+RGD+MD	1998	
31.	Rubra	IS	2001	

32.	Elena	IS	2002	2005
33.	Malynka	SC+RD	2007	2010
34.	Perlyna Podillia	SC+RD	2008	2011
35.	Kvitneva	SC+RD	2009	2012
36.	Kamianchanka	SC+RD	2016	2019
37.	Volodar	RGD	2017	2020
38.	Determinat -Podilskyi	RGD	2018	

Legend: Methods for good:

MD - mass selection; RGD - family and group selection; RD - family selection; BMD - multiple mass selection; BRD - multiple family selection; IS - individual selection; KHSP. - economic coefficient; GP - hybrid population; SC - backros, saturating crosses; tips. mut. - radiation mutagenesis; chem. mut. - chemical mutagenesis; 15. M8 - number of years of exposure and selection generation; radio cutter. - radio resistance

institutions:

1- Research Institute of Agriculture and Livestock of the Western Regions of Ukraine; 2 Research Institute of Agriculture and Livestock of the Western Regions of Ukraine; 3 Institute of Agriculture UAAS; 4 Nikolaev regional agricultural experimental station; 5- All-Russian Research Institute of Legumes and Groats; 6- Yaltushkovskaya Experimental Station of the Research Institute of Sugar Beet UAAN; 7- research station of rice (m. Kherson); 8- Research Institute of Irrigated Agriculture UAAN; 9 - Agrarian University of Moldova.

Source: the study was carried out by scientific and pedagogical workers of the Department of Plant Growing and Forage Production on the basis of the NDIKK im. A. Alekseeva PDATU.

The founder of the NDIKK, professor, doctor of agricultural sciences. Sciences A.S. Alekseeva created a scientific school of scientists on selection, seed production and buckwheat cultivation technology (Fagopyrum). Applicants for academic degrees under the leadership of Oleny Semenivna defended 27 candidate and four doctoral dissertations.

In 2006, unfortunately, Olena Seminivna Alekseeva passed away.

Since 2014, NDIKK PDATU has been named after the founder, Professor, Doctor of Agricultural Sciences A.S. Alekseeva. The work of A.S. Alekseeva - selection, lives to this day. We, the students of her scientific school Fagopyrum, extended scientific work on culture on the scientific research topic: “Scientific and theoretical substantiation of the methods of breeding and seed production of buckwheat” according to the state registration number 0119U002417 of 05/21/2019.

Within the framework of this topic, we have created new varieties of edible buckwheat: Malynka, Perlyna Podillia, Kvitneva, Kamianchanka and valuable varieties, transferred to the National Center for Plant Genetic Resources of Ukraine (Kharkov) to obtain a certificate for registration.

One of the promising areas of breeding work with culture is the introduction of Tatar buckwheat into culture. The breeders of the ZVO PDATU transferred the Tatar buckwheat variety Kalyna No. 18657001 [9, 10].

Analysis of the register of plant varieties of Ukraine suitable for distribution for 2021 indicates that 7.25% of the 29 buckwheat varieties included in it fall on the selection of the NDIKK named by. A. Alekseeva PDATU. These are such varieties as Stepova, the year of registration of the variety –1999, Elena – 2005, Kamianchanka – 2019, Volodar – 2020 [11].

Brief economic characteristics of varieties: All recommended varieties are diploid, belong to the subspecies Vulgare, variety aliata, indeterminate type of growth.

Variety Stepova: created by the method of family good with a hybrid population of varieties Haleia and Kosmeia.

Authors: A.S. Alekseeva, V.I. Ros, V.A. Rarok. Mid-to-early stigma. The growing season 78-80 days begins to bloom on the 22nd day. Plant height 95-99 cm. Nodes per stem 10-12, branches 2-3, incl. 1st order 1-2, inflorescences 15-18. The plant form is usual. Flowers and buds are medium-sized pale pink. Fruits are medium-sized, rounded with poorly visible wings, the top is elongated, brown with a barely noticeable pattern. The mass of 1000 grains is 25.4-28.0 g, the grain virility is 54%, the percentage of grain is 21.2%, the cereal yield is 72.0-73.0%. The yield is high. The maximum yield is 42.0 c / ha, the variety gave in 1993 at the Vasylkivskyi cultivar plot of the Kyiv region. It is characterized by drought resistance and suitability for cultivation in irrigated agriculture.

Variety Elena - created by the method of individual selection by combining 11 components based on the number of inflorescences and the index of individual seed productivity from 6 medium-sized populations and the Lileia variety.

Authors: A.S. Alekseeva, V.A. Rarok, Z.I. Peluiko, A.V. Bliandur, A.V. Kvashchuk, M.M. Malyna.

Plants of middle mice, high yielding; ecologically plastic with a vegetation period of 75-85 days, resistant to lodging, with high photosynthetic potential. The variety belongs to the varieties of high quality grain (grain size 21-22%, grain evenness 87.3-94.5%, cereal yield 75.0-77.5%). Potential yield: 20.1-36.0 c / ha under production conditions.

Variety Kamianchanka - created by breeders of PDATU by the method of hybridization based on the use of samples from the collection of the genus Fagopyrum Mill.

Authors: V.V. Ivanyshyn, R. Yu. Gavrylianchyk, L.A. Vilchinska, A.P. Gorodyska, A.A. Kaminna.

The growing season of the new variety is 87-90 days. The anthocyanin coloration of the cotyledons is weak, the main color is green. The cotyledons are small, reniform, the hypocotyl is medium. The leaf blade is wavy, arrowhead, has a green color, medium in size. The flowers are white, medium-sized in the Kamianchanka variety; the perianth is placed separately, the shape of the tepals is elongated. The Kamianchanka variety has flowers with a strong aroma. Shoots have a fragmented, low intensity anthocyanin coloration. The color of the nodes is light green, the first two green have medium and strong pubescence. Mass flowering occurs in 26-32 days. Plants are taller than 100-110 cm. The length of the branching zone is 31-40 cm, the fruit-forming zone is more than 71 cm. The number of nodes in the branching zone is more than 4. The background color of the pericarp during ripening is light gray with existing marbling without wax deposits. The fruit is rhombic, with small wings, the ribs are sharp, the edges are convex, the top is sharp, the base is barely expressed.

The yield of the new variety with a standard moisture content of 14% is on average 2.2 t / ha, the protein content is 13.2%, the yield rate is 22.1%, the cereal yield is 92.0%, the weight of 1000 seeds is 30.4 g; according to the ripeness group, the variety belongs to the second ripeness group; suitability for mechanized harvesting is 9 points; resistance to powdery mildew and ascochitosis - 9 points; resistance to peronosporosis - 8 points.

Variety Volodar - created by the method of multiple selection of components on the basis of inflorescence graininess and an economic coefficient from the Victoria variety.

Authors: V.V. Ivanyshyn, V.M. Burdyha, A.V. Rarok.

Weight of 1000 grains, g - 28.7-29.4; yield, t / ha - 1.86-2.32; plant height, cm - 88.3-115.5; protein content,% - 14.2-14.9; flavor,% - 20.5-21.4; cereal yield,% -74.1-74.6; size,% - 30.7-32.5%; resistance to shattering, d. - 7; resistance to: lodging, drought, powdery mildew, bacteriosis, peronosporosis, etc. - 8; resistance to buckwheat fleas, D. - 9.

Recommended varieties for cultivation on various forms farms of ownership. In parallel, we carried out a production test of new varieties in the conditions of the farms of Ternopil and Khmelnytskyi regions.

NDIKK named by A. Alekseeva PDATU is a practical basis for conducting laboratory studies, educational and industrial practice by applicants for higher education in academic disciplines: breeding and seed production, plant growing, genetic plant resources, qualification examination of plant varieties, varietal certification, inspection supervision and control in seed production, scientific theoretical substantiation of technologies for growing agricultural crops, production process in technologies for growing crops, as well as a place for performing bachelor's, master's, postgraduate, doctoral studies.

Conclusions

1. Long-term scientific experience and potential of NDIKK named by. A. Alekseeva PDATU is given the opportunity to provide high and stable buckwheat yield with improved technological indicators of grain quality, resistance to the action of biotic and abiotic factors.
2. The combination of practical, scientifically based methods and skills in educational work will prepare highly qualified applicants for higher education at different levels..

Bibliography

3. Закон України «Про вищу освіту» / Law of Ukraine «On Higher Education» http://zakon4.rada.gov.ua/laws/show/1556-18.
4. Васильківський С. П., Кочмарський В. С. Селекція і насінництво польових культур: підручник. ПрАТ Миронівська друкарня, 2016. 376 с. / Vasylkivskyi S. P., Kochmarskyi V. S. Selection and seed-growing of field crops: a textbook. PrAT Myronivska printing house, 2016. 376
5. Тараненко Л. К., Яцишен О. Л. Принципи, методи і досягнення селекції гречки (Fagopyrum esculentum Moench). Вінниця: ТОВ Нілан-ЛТД, 2014. 224 с. / Taranenko L. K., Yatsyshen O. L. Principles, methods and achievements of buckwheat selection (Fagopyrum esculentum Moench). Vinnytsia: LLC Nilan LTD,

2014. 224 s.
6. Vilchynska L. A., Horodyska O. P. Buckwheat selection in south western forest steppe conditions of Ukraine. Relevant issues of development and modernization of the modern science: the experience of countries of eastern Europe and prospects of Ukraine. [in English] Riga. Baltija Publishing, 2018. P. 52-75. doi: https://doi.org/10.30525/978-9934-571-26-8_4.
7. Alekseeva O. S. (1970) Methody, resultaty i perspective selecziinoi roboty z grechkoi [Methods, results and perspectives of selection work with buckwheat]. Orel: (in Russia).
8. Методика проведення експертизи сортів рослин групи зернових, круп'яних та зернобобових на придатність до поширення в Україні / за ред. С. О. Ткачик. Вінниця: Корзун Д. Ю., 2016. 82 с. / Tkachyk S. O. (2016). Metodyka provedennia ekspertyzy sortiv roslyn hrupy zernovykh, krupianykh ta zernobobovykh na prydatnist do poshyrennia v Ukraini [Method for DUS examination of grain, cereal and leguminous varieties in Ukraine]. Vinnytsia: FOP Korzun D. Yu. URL: http://sops.gov.ua/pdfbooks/Metodiki/8.pdf.
9. Alekseeva O. S. (2001) Історія селекції гречки в Україні [History of buckwheat selection in Ukraine]. Kiev: Logos.
10. Вільчинська Л. А., Диянчук М. В. Використання колекції роду Fagopyrum Mill. у селекційних програмах. Фактори експериментальної еволюції організмів. 2020. Том 27. С. 221–225. / Vilchynska L. A., Diyanchuk M. V. (2020). Using the collection of the genus Fagopyrum Mill. in breeding programs. Factors of experimental evolution of organisms. 2020. Vol. 27. pp. 221–225. https://doi.org/10.7124/FEEO.v27.1330
11. Гаврилянчик Р. Ю. Перспективи введення в культуру гречки татарської в Україні. Збірник наукових праць Подільського державного аграрно-технічного університету. Кам'янець-Подільський. 2015. Вип. 23. С. 45–54. / Havrylianchyk R. Yu. (2015). Prospects for tartar buckwheat introduction into culture in Ukraine. Zbirnyk science works of the State Agrarian and Engineering University in Podillia, 23. pp. 45–54.
12. Вільчинська Л. А., Хоменко Т. М., Ночвіна О. В. Господарсько-біологічна оцінка сорту гречки татарської Калина. Сортовивченння та сортознавство.

Plant varieties studyng and Protection. 2020. Том 16. № 4. С. 349–354. / Vilchynska L. A., Khomenko T. M. & Nochvina O. V. (2020). Economic and biological assessment of Tartary buckwheat variety ‘Kalyna’. Plant varieties studying and protection, 16(4). pp. 349–354. https://doi.org/10.21498/2518-1017.16.4.2020.224050

13. Державний реєстр сортів рослин, придатних для поширення в Україні на 2021 рік / Dergavnyi reestr sortiv roslyn, pridatnych dlya poshyrenya v Ukraine na 2021 r [State register of plant varieties, suitable for distribution in Ukraine]. Elekrotronik resurs [Electronic resource]. Available at: (http://www.minagro.gov.ua/rating/files/r3.pdf (accessed March 28, 2021)

ZESZYTY NAUKOWE WSA w Łomży 84, s. 31-48
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Vasyl Puiu
State Agrarian and Engineering University in Podillia

YIELD OF SUNFLOWER SEEDS DEPENDING ON THE USE OF MINERAL FERTILIZERS AND BIOLOGICAL PRODUCTS

Summary

The results of the influence of nitrogen-phosphorus fertilizers in combination with Vitavax 200 FF, Helafit Seeds and Helafit Combi on the yield of sunflower in the Forest-Steppe of western Ukraine for 2018-2020 are presented.

It was found that pre-sowing treatment of seeds with the chemical pesticide Vitavax 200 FF caused a decrease in plant density by 2.2 thousand/ha (4.1%), and the complex biological product Helafit Seeds, on the contrary, to some extent stimulated plant growth and development.

Sunflower plants formed a powerful leaf surface, which reached its maximum value in the flowering phase. This indicator gradually increased from 30.9 thousand m2/ha on the control without fertilizers to 40.0 thousand m2/ha on the background of N30P45 + Helafit Combi and to 44.2 thousand m2/ha on the background of N60P90 + Helafit Combi.

The combined use of nitrogen-phosphorus fertilizers and the drug Helafit Combi caused a prolongation of the photosynthetic activity of the leaves for 6-8 days and provided an increase in the photosynthetic potential of sunflower plants by 64.7-95.8%. Under these conditions, the highest yield of dry biomass was achieved – 8.2-8.8 t/ha and the highest seed yield – 3.03-3.11 t/ha. Analysis of crop structure elements showed that the increase in seed productivity was due to an increase in the number of seeds in the flower head (34.1%) and the weight of seeds from one flower head (41.3%).

The best economic indicators were provided by the joint use of N30P45 and the drug Helafit Combi: the profit was UAH 19,120 / ha, the cost of 1 ton of seeds – UAH 4,690, the level of profitability – 134%. Increasing the rate of fertilizer to N60P90 negatively affected the economy of sunflower cultivation.

Key words: sunflower, fertilizers, drugs, photosynthetic potential, biomass, yield, seeds, economic efficiency.

Introduction

Ukraine is the world leader in sunflower oil production (32%) and its largest exporter (56%). In 2020, its exports amounted to 6.9 million tons, and revenue – 5.3 billion dollars. USA [1]. In general, Ukraine exports sunflower oil to more than 90 countries, the main buyers are from Asia, Europe, and Africa.

The sown area of annual sunflower (Helianthus annuus L.) in Ukraine exceeded the mark of 6 million hectares [2], as it is one of the most profitable and highly liquid crops. As sunflower crops move north, the duration of the plant vegetation lengthens to 80-130 days [3], and the sum of effective temperatures is 1600-1800 °C for early-ripening varieties and 2000-2300 °C for late-ripening varieties.

The rapid growth of sunflower soils refutes a number of ideas that have been created over the last century. Namely: it is the worst precursor, which should be used to divert the steam field; in crop rotations it is possible to return sunflower to the previous place not earlier than in 7-9 years; the crop is very sensitive to herbicides and therefore weed control is a very complex and ineffective operation; late ripening causes limitation of the area of its cultivation; low yield (1-2 t/ha). In fact, sunflower is the main precursor for winter barley and winter wheat, in crop rotations it can be grown in 3-4 years, and the created CLEARFIELD technology allows you to easily control the entire spectrum of weeds, many hybrids have a growing season of up to 105 days, and real seed productivity hybrids is 2.5-3.5 t/ha [4, 5].

According to the results of 2019, the yield of sunflower in Ukraine reached 2.6 t/ha, and the gross harvest – 14.5 million tons [2]. The highest yields were recorded in the farms of Ternopil (3.6 t/ha), Khmelnytskyi (3.5 t/ha) and Vinnytsia (3.3 t/ha) regions. The current record is a yield of 6.21 t/ha with an oil content of 52% (2016, Kabardino-

Balkaria). Yield 5.5 t/ha in terms of standard humidity was obtained by the RISE company in Poltava region; 5.33 t/ha – by the BAYER company (Mykolaiv region, 2014) [4].

The sunflower harvest is limited by numerous factors, the main ones being moisture and mineral nutrition. Most black soil fields in the main areas of sunflower cultivation in Ukraine are deficient in nitrogen. Therefore, if due to lack of moisture the yield cannot be higher than 3 t/ha, then fertilizers should be given only for such yields [6]. Phosphorus deficiency dramatically changes the quantitative and qualitative indicators of yield [7, 8]. It is well known that plants need phosphorus at the very beginning of the growing season [4, 6, 8, 9], so, given the low supply of phosphorus, it should be made before or during sowing. Phosphorus in combination with various growth-regulating chemicals is called a plant "antidepressant" [10, 11]. Potassium, although consumed in large quantities by sunflower, does not give significant increases on black soil fields, due to the high level of security support [12, 13, 14]. Therefore, the most effective for sunflower are nitrogen and phosphorus fertilizers, which directly determine the level of yield.

The leading research centers of NAAS of Ukraine (V.Ya.Yuryev Institute of Plant Breeding, Breeding and Genetics Institute, Institute of Oilseed Cultures) have created a number of new varieties and oil use hybrids with a potential yield of more than 5 t/ha. Given that the level of use of the biological potential of sunflower is the lowest among oilseeds and does not even reach 50% [15], there is a set of issues, whose solution will positively affect the formation of agrocenosis of sunflower crops. Among them, the use of nitrogen and phosphorus fertilizers and foliar fertilization of plants with complex multifunctional biological products are important [16].

Purpose, subject and research methods

Given the expansion of sunflower in the western part of the Forest-Steppe of Ukraine and even in Polissya with a high level of production intensification, the development of advanced technologies taking into account the factor of greening in the realization of the genetic potential of its varieties becomes especially important. Therefore, in order to expand the organic component of the sunflower production process, we resorted to the use of biological combined drugs Helafit Seeds and Helafit Combi on sunflower yields for the reason that they can significantly increase yields at low additional costs and more efficient use of nitrogen and phosphorus fertilizers, allowing to reduce the norms of their use.

The purpose of the study is to establish the productivity of sunflower plants depending on the use of nitrogen and phosphorus fertilizers in combination with Vitavax 200 FF, Helafit Seeds and Helafit Combi. To achieve this goal it was planned to establish the density of standing plants, the dynamics of leaf area and photosynthetic potential, seed yield and elements of crop structure, and determine the economic efficiency of these fertilizers and drugs.

The working hypothesis is an increase in sunflower seed productivity by 25-30% due to the use of nitrogen-phosphorus fertilizers in combination with the Helafit Combi.drug.

Subject of research is the Armageddon variety sunflower; Vitavax 200 FF chemical disinfectant, Helafit Seeds biological product, Helafit Combi multicomponent biological product; and mineral fertilizers – ammonium nitrate, superphosphate.

Helafit Combi was created at the Biotechnology Research Institute [17]. It contains: a complex of microelements in the negligent form (Fe, Mg, Mn, Mo, Cu, B), spores and cells of microbial culture – producers of the genera Bacillus Subtilus and Pseudomonas with fungicidal functions, multifunctional stimulators and growth regulators (auxins, cytokinins, gibberellins, betaine, humic and fulvic acids, amino acids). The drug acts as an anti-stressor, which increases the resistance of plants to extreme heat and drought. Residues of the drug do not accumulate in the soil and products, they do not inhibit the activity of beneficial microflora.

In order to implement the research program during 2018-2020, field two-factor experiments were staged in the fields of crop rotation No 1 of the "KOLOSOK-2" Ltd company in Kitsman district of Chernivtsi region.

The two-factor field experiment included 12 variants. The scheme and method of placement of experimental plots are shown in Fig. 1.

The size of the sowing area is 308 m2 (5.6 m × 55 m); the report area occupied 210 m2 (4.2 m × 50 m).

When constructing the scheme of field experiments, we abandoned the use of potash fertilizers because the black soil supply with potassium on the farm is high.

On the day of sowing, Armageddon sunflower seeds were treated with the Vitavax 200 FF chemical disinfectant and the Helafit Seeds.biological product.

Helafit Combi complex biological product was applied by spraying sunflower plants in the phase of 5-6 leaves at a dose of 2 l/ha.

To study the effect of mineral fertilizers and preparations on plant growth and development, field experiments were accompanied by appropriate records and observations.

Field germination of seeds was determined in the phase of full germination by counting the number of similar plants on 10 m2 sites (14.3 m × 0.7 m).

The density of plants was calculated in the same way in the following phenophases: phase 3-4 of true leaves, the beginning of flower head formation, flowering and before harvesting.

Linear plant growth was monitored by measuring plant height in the main phases. We measured the length of 10 plants in 6-fold repetition.

The area of leaves and photosynthetic potential of crops was determined by A.A. Nechiporovych’s method of modified by other scientists [18].

Harvesting was carried out by the method of combine threshing from the area of the report area. A Claas combine with a four-row attachment for harvesting sunflowers was used. The bunker crop was converted to basic humidity (8%) taking into account the presence of impurities.

<table>
<tr><td>V1</td><td rowspan="4">R1</td><td rowspan="8">F1</td><td rowspan="4">R3</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
<tr><td>V4</td><td>V4</td></tr>
<tr><td>V1</td><td rowspan="4">R2</td><td rowspan="4">R4</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
<tr><td>V4</td><td>V4</td></tr>
<tr><td>V1</td><td rowspan="3">R1</td><td rowspan="3">F2</td><td rowspan="3">R3</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
</table>

<table>
<tr><td>V4</td><td></td><td rowspan="5"></td><td></td><td>V4</td></tr>
<tr><td>V1</td><td rowspan="4">R2</td><td rowspan="4">R4</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
<tr><td>V4</td><td>V4</td></tr>
<tr><td>V1</td><td rowspan="4">R1</td><td rowspan="8">F3</td><td rowspan="4">R3</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
<tr><td>V4</td><td>V4</td></tr>
<tr><td>V1</td><td rowspan="4">R2</td><td rowspan="4">R4</td><td>V1</td></tr>
<tr><td>V2</td><td>V2</td></tr>
<tr><td>V3</td><td>V3</td></tr>
<tr><td>V4</td><td>V4</td></tr>
</table>

Figure 1. Layout of plots in the experiment (F1 – without fertilizers; F2 – N30P45; F3 – N60P90; V1, V2, V3… – variants of the experiment (V1 – water, control; V2 – Vitavax 200 FF; V3 – Helafit Seeds; V4 – Helafit Combi); R1, R2, R3…– repetitions.
Source: Compiled by the author.

The degree of reliability of the differences between the yields of the experimental variants was determined by the method of variance analysis.

The economic assessment focused on determining the cost of production, profit, profitability of production at market prices in 2020.

Research results

As a result of the surveys conducted in 2018-2020, the stocking density of sunflower plants ranged from 50 to 55 thousand plants per 1 ha with the corresponding feeding area (Table 1).

Table 1. Density of plants and feeding area of sunflower on the 30th day after full germination, depending on the use of drugs

Year	Indicators	Variant		
		Without processing – control	Vitavax 200 FF	Helafit Seeds
2018	Plant feeding area, cm^2	1841	1894	1801
	Standing density, thou/ha	53,0	51,2	54,9
2019	Plant feeding area, cm^2	1737	1775	1690
	Standing density,thou/ha	52,5	50,2	53,9
2020	Plant feeding area, cm^2	1804	1884	1785
	Standing density,thou/ha	53,7	51,4	55,4
Average	Plant feeding area, cm^2	1794	1851	1759
	Standing density,thou/ha	53,1	50,9	54,7

Source: Compiled by the author.

We found an inhibitory effect of the Vitavax 200 FF chemical pesticide, which caused a decrease in plant density by more than 2 thousand/ha, while the Helafit Seeds bioprotector not only did not have such a negative effect, but also to some extent stimulated plant growth.

The leaf apparatus plays a crucial role in crop formation. It is the leaves that perform the function of photosynthesis and it is here that the processes of organic matter formation take place. Some experts even suggest making a yield forecast based on the leaf surface of crops [19, 20]. Many researchers [12, 20, 21, 22] point to the negative impact of overdeveloped assimilation apparatus, which leads to high intraspecific competition of plants in the early stages of organogenesis.

Sunflower develops a fairly strong leaf surface, which reaches 50-80 thousand m2/ha [12, 23]. However, this size of the leaf surface lasts a short time, because the lower leaves dry quickly and their total area decreases.

Sunflower leaves are formed before the formation of the flower head, i.e. within 35-40 days 18-20 leaves are formed on each plant [24]. They have a round plate with an average diameter of 21 cm. Therefore, the leaf area of one plant is theoretically: $S = \pi R2 = 3.14 \times 110.2 = 346$ cm2. If all plants have 20 leaves, then their total area is 0.692 m2, and per 1 ha at a density of 50 thousand plants – 34.6 thousand m2/ha. It is clear that fluctuations in this indicator can be significant, but the level of leaf area of 35-40 thousand m2/ha should be still considered real.

The research program provided for monitoring the dynamics of leaf surface growth and calculateing the photosynthetic potential of plants.

It is known that on rarified crops insufficient leaf area is formed and part of the sun's rays is not used by the assimilation apparatus. They enter the soil, increasing the intensity of moisture evaporation and significantly increasing the temperature of the aboveground air layer. In thickened crops, an extremely large area of the assimilation surface is formed, which leads to shading of some leaves by others. In addition, the shaded part of the leaves is essentially redundant, because it uses a lot of nutrients. Therefore, in each soil-climatic zone for each variety (hybrid) of plants, the optimal value of the leaf area should be determined, the formation of which provides the greatest productivity.

In our experiments, the average area of leaves was determined between two phases of culture development – from the beginning of flower head formation to flowering. The performed analyzes and corresponding calculations showed that the total area of a leaf surface reaches a maximum in a flowering phase, and further there is a gradual process of its drying.

As a result of research, we noted a significant impact of the use of drugs and fertilizers on the formation of the leaf surface. It was found that this indicator was the lowest in the phase of "beginning of flower head formation" in unfertilized areas and, depending on the drugs, was at the level of 20.4-22.3 thousand m2/ha (Table 2).

The highest rate of leaf surface area in all variants of the experiment was observed during flowering. Thus, in non-fertilized versions where Vitavax 200 FF and Helafit Seeds were applied, the leaf area was 31.9 and 32.0 thousand m2/ha, respectively. With the introduction of the complex preparation Helafit Combi the indicator increased by 12.3% and was equal to 34.7 thousand m2/ha. In the "end of seed filling" phase, a decrease in the leaf surface area was observed in all variants of the experiment. This figure ranged from 25.5 to 29.0 thousand m2/ha.

The application of mineral fertilizers contributed to the increase of leaf area from 30.9 to 40.4 thousand m2/ha, and the dose of N30P45 provided an increase in leaf area by 18.1%, and twice the dose led to a further increase by another 12.6%, indicating a higher half-dose efficacy. The drugs also proved to be an effective element in the growth of leaf area. In this respect, the best results were provided by the application of Helafit Combi –

compared to the control, the leaf area was 12.3% higher, while Vitavax 200 FF and Helafit Seeds provided growth of only 3.2-3.6%.

Table 2. Dynamics of the leaf surface area of sunflower depending on the application of fertilizers and drugs (average for 2018-2020), thousand m2/ha

Rate of mineral fertilizers (Factor A)	Preparation (Factor B)	Phase of cultural development		
		beginning of flower head formation	flowering	end of seed filling
No fertilizers	Control	19,3	30,9	25,5
	Vitavax 200 FF	20,6	31,9	26,0
	Helafit Seeds	20,4	32,0	25,8
	Helafit Combi	22,3	34,7	29,0
$N_{30}P_{45}$	Control	25,1	36,5	31,0
	Vitavax 200 FF	27,1	38,5	31,7
	Helafit Seeds	27,7	38,3	32,4
	Helafit Combi	31,3	40,0	36,5
$N_{60}P_{90}$	Control	32,2	40,4	36,5
	Vitavax 200 FF	34,0	41,7	36,9
	Helafit Seeds	33,6	41,6	36,7
	Helafit Combi	37,0	44,2	38,3

Source: author's research.

In combination with fertilizers, all the studied drugs led to a certain increase in the effect and increased the leaf area by 3-9%. But it is impossible to say that these increases in leaf area were significant, because they differed little from this figure on an unfertilized background. However, monitoring of leaf drying showed that plants treated with Helafit Combi retained the green color of the leaves longer. Particularly obvious was the prolongation of the leaf apparatus on fertilized areas together with Helafit Combi, where the advantage in the duration of photosynthetic activity of the leaves was 3-4 days.

The presence of such qualitative differences in the treated areas led to the realization that the area of the leaves is not a holistic indicator that characterizes the productivity of the photosynthetic apparatus, the duration of their activity is also important. Therefore, a much more significant indicator of the photosynthetic activity of crops is the photosynthetic potential (AF), which is the "number of working days of the leaf surface".

How the indicators of photosynthetic activity of sunflower change depending on the use of mineral fertilizers and drugs is set forth in Table. 3.

Table 3. Photosynthetic activity of sunflower depending on the use of fertilizers and drugs, the average for 2018-2020.

Rate of mineral fertilizers (factor A)	Preparation (factor B)	Leaf area, thou. m^2/ha	Duration of the period, days	Photosynthetic potential, thou. m^2/ha × days
No fertilizers	Control	25,1	38	954
	Vitavax 200 FF	26,3	38	999
	Helafit Seeds	26,2	38	996
	Helafit Combi	28,5	40	1140
$N_{30}P_{45}$	Control	30,8	41	1263
	Vitavax 200 FF	32,8	41	1345
	Helafit Seeds	33,0	41	1353
	Helafit Combi	35,7	44	1571
$N_{60}P_{90}$	Control	36,3	42	1525
	Vitavax 200 FF	37,9	42	1592
	Helafit Seeds	37,6	42	1579
	Helafit Combi	40,6	46	1868

Source: author's research.

It was quite expected to obtain a significant increase in photosynthetic potential when applying fertilizers and drugs. The lowest photosynthetic potential was recorded in unfertilized areas, where it was 0.95-1.14 million m2/ha × days, the highest – in the flowering phase in the version with the drug Helafit Combi and double fertilizer – at 1.87 million m2/ha × days. The difference between the extreme options reached 96%.

An integral indicator that characterizes the state of vegetative development of plants is the yield of aboveground biomass. Sunflower, like most other field crops, accumulates organic biomass unevenly during the growing season. Initially, the plants have a fairly slow period of biomass formation, then the process accelerates, and at the end of the growing season it slows down again. This dynamic is repeated every year, and therefore the process of vegetative development can be called genetically determined.

The results of our research showed that the highest yield of dry sunflower biomass was formed at the end of seed filling (Table 4)..

Table 4. Dynamics of accumulation of dry sunflower biomass depending on the use of fertilizers and drugs (average for 2018-2020), t/ha.

Rate of mineral fertilizers (factor A)	Preparation (factor B)	Phase of cultural development		
		beginning of flower head formation	flowering	end of seed filling
No fertilizers	Control	1,51	4,22	5,91
	Vitavax 200 FF	1,52	4,21	5,93
	Helafit Seeds	1,57	4,30	6,08
	Helafit Combi	1,64	4,52	6,55
$N_{30}P_{45}$	Control	1,89	5,41	7,41
	Vitavax 200 FF	1,88	5,45	7,50
	Helafit Seeds	1,95	5,60	7,63
	Helafit Combi	2,35	5,99	8,18
$N_{60}P_{90}$	Control	2,14	6,07	8,25
	Vitavax 200 FF	2,20	6,16	8,35
	Helafit Seeds	2,25	6,17	8,37
	Helafit Combi	2,40	6,51	8,80

Source: author's research.

Data of Table 4 indicate a positive effect of fertilizers and drugs on biomass accumulation. In terms of the rate of biomass accumulation, the unfertilized background was significantly inferior to the options with fertilizers. When mineral extractions were combined with drugs, the growth rate of biomass increased significantly, which indicates the possibility of increasing the efficiency of fertilizers by their joint use with drugs.

Seeds are the main product of sunflower, which is used as a raw material for oil production. The average yield of sunflower seeds in Ukraine in recent years has increased to 2.4-2.6 t/ha, and 20 years ago it did not exceed 1.3-1.4 t/ha.

The results of our studies showed that the use of nitrogen-phosphorus fertilizers and drugs helped to increase the seed productivity of sunflower (Table 5).

In the unfavorable 2020, there was a significant decrease in the overall level of sunflower yield, which was due to partial damage to plants by May frosts, subsequent changes in hot weather during periods of intense air temperature accompanied by downpours with floods that caused crop damage.

Table 5. Yield of sunflower seeds depending on the use of fertilizers and drugs, t/ha

Rate of mineral fertilizers (factor A)	Preparation (factor B)	Year			Average
		2018	2019	2020	
No fertilizers	Control	2,28	2,70	1,78	2,25
	Vitavax 200 FF	2,27	2,72	1,80	2,26
	Helafit Seeds	2,33	2,75	1,81	2,30
	Helafit Combi	2,50	2,96	1,94	2,47
$N_{30}P_{45}$	Control	2,71	3,10	2,24	2,68
	Vitavax 200 FF	2,77	3,13	2,23	2,71
	Helafit Seeds	2,80	3,21	2,29	2,77
	Helafit Combi	3,07	3,51	2,50	3,03
$N_{60}P_{90}$	Control	2,81	3,20	2,38	2,80
	Vitavax 200 FF	2,82	3,24	2,44	2,83
	Helafit Seeds	2,87	3,31	2,45	2,88
	Helafit Combi	3,14	3,57	2,63	3,11
$HIP_{0,05}$, t/ha		A – 0,20 B – 0,23 AB – 0,40	A – 0,23 B – 0,26 AB – 0,46	A – 0,16 B – 0,19 AB – 0,32	

Source: author's research.

It is likely that in 2019 the conditions for the implementation of the nutrient regime for sunflower plants will be better and it is not necessarily just weather conditions.

On average for 2018-2020, the application of N30P45 provided an increase in seed yield by 0.43 t/ha. Each year, the increments significantly exceeded the control version, which is mathematically proven. The application of mineral fertilizers in the norm of N60P90 contributed to a further increase in yield by another 0.12 t/ha, however, this increase is not significant, as it is inferior to the value of HIP0,05. This state of affairs suggests that increasing the rate of fertilizer to N60P90 is not rational, but the final answer will give an economic analysis.

With regard to drugs, field experiments have not confirmed the sufficient effectiveness of seed treatment. Their certain positive effect was noticeable during the initial stages of plant growth, but in terms of yield, seed treatment options did not have a statistical advantage over control. This applies to both the chemical pesticide Vitavax 200 FF and the biological product Helafit Seeds, because the additives from their use did not exceed the value of HIP0,05. Another thing – the use of multifunctional Combined drug Helafit Combi, which consistently gave significant gains. Against the background without fertilizers, its advantage averaged 9.8%, against the background of N30P45 – 13.1%; against the background of N60P90 – 11.1%. An even more significant effect of this drug was observed in the interaction with fertilizers. Thus, in comparison with the variant without fertilizers, the average effect on the background of N30P45 was 34.7%, on the background of N60P90 – 38.2%.

Thus, the obtained results more than convincingly showed that Helafit Combi is able to provide a high positive effect under various hydrothermal conditions and should be used in sunflower cultivation as an element to overcome the stresses associated with high temperatures and lack of moisture.

Analysis of the parameters of the generative organs of sunflower makes it possible to understand the structure of crop formation and find the indicators that are decisive for obtaining a particular level of seed yield. To establish changes in the morphostructure of plants, the following indicators were determined: flower head diameter, number of flower heads per unit area, number of seeds in the flower head, weight of 1000 seeds. When determining the number of seeds in the flower head, we recorded the total number and number of filled seeds.

Under less favorable meteorological conditions in 2020, the mass of 1000 seeds decreased. Uneven rainfall and elevated temperatures in the critical period of grain filling caused a significant decrease in the mass of 1000 seeds in all variants compared to 2019, which was characterized by better moisture and more even distribution of precipitation.

The average values of the structural elements of the crop over the years of research are given in Table. 6.

The recorded differences between the variants of the experiment cannot be identified as primary or secondary. Fertilizers and preparations improved all the elements of the structure, the only thing that went beyond the overall picture is the mass of 1000 seeds, which varied in a small interval. Thus, if we take the smallest and largest weight of 1000 seeds, the difference was only 2.3 g or 4.3%, which is not significant. Fluctuations in such indicators as the number of seeds in the flower head and the weight of seeds from one flower head were more noticeable. If we take the extreme values, the fluctuation in the number of seeds was 30.5%, and the weight of seeds from the flower head – 39.7%. This gives grounds to conclude that fertilizers and drugs affect, above all, the performance of the flower head.

Table 6. Elements of the structure of the sunflower harvest depending on the use of fertilizers and drugs, the average for 2018-2020

Rate of mineral fertilizers (factor A)	Preparation (factor B)	Diameter of flower head, cm	Quantity, items		Mass, g	
			Flower heads per 1 m^2, pcs.	Seeds in a flower head	Seeds from 1 flower head	1000 seeds
No fertilizers	Control	17,5	4,4	707	38,8	53,3
	Vitavax 200 FF	17,5	4,2	735	40,3	53,6
	Helafit Seeds	17,7	4,4	725	39,7	53,5
	Helafit Combi	18,4	4,6	751	41,7	54,1
$N_{30}P_{45}$	Control лъ	19,4	4,5	819	45,6	54,5
	Vitavax 200 FF	19,5	4,4	875	48,0	54,3
	Helafit Seeds	19,8	4,5	870	48,3	54,9
	Helafit Combi	20,5	4,6	903	50,3	55,3
$N_{60}P_{90}$	Control	20,1	4,4	894	50,9	54,8
	Vitavax 200 FF	20,3	4,3	911	52,5	55,2
	Helafit Seeds	20,3	4,6	890	51,8	55,4
	Helafit Combi	20,9	4,7	923	54,2	55,6

Source: author's research.

The number of flower heads per unit area depended on the seeding rate, which was the same for all variants, and therefore the differences are the result of exposure to pesticides, diseases and pests. The most noticeable was the negative effect on plant density of seed treatment with the chemical Vitavax 200 FF.

Thus, it is obvious that nitrogen-phosphorus fertilizers in combination with Helafit Combi significantly increased the seed yield of sunflower, increasing the number of seeds in the flower head and the weight of seeds from one flower head, but did not show a significant effect on the weight of 1000 seeds. The use of fertilizers causes a significant increase in production costs: the cost of 30 kg of active substance nitrogen and 45 kg of phosphorus exceeds UAH 2,200; when the rate is doubled, the costs increase to UAH 4,480/ha. Helafit Combi significantly outperforms mineral fertilizers, but it also increases production costs. Therefore, it is impossible to do without economic analysis.

At the average selling price of seeds of UAH 11,000/t, the net profit from 1 ha of unfertilized area is UAH 13,470, the level of profitability is 119% (Table 7).

Table 7. Economic efficiency of growing sunflower seeds depending on the use of fertilizers and drugs, the average for 2018-2020

Variant of the experiment	Seed yield, t/ha	Revenue from 1 ha, UAH	Costs of 1 ha, UAH	Net profit from 1 ha, UAH	Cost of 1 t of seeds, UAH	Level of profitability, %
No fertilizers	2,25	24750	11280	13470	5013	119
No fertilizers + Helafit Combi	2,47	27170	11760	15410	4761	131
$N_{30}P_{45}$	2,68	29480	13770	15710	5138	114
$N_{30}P_{45}$ + Helafit Combi	3,03	33330	14210	19120	4690	134
$N_{60}P_{90}$	2,80	30800	16050	14750	5732	92
$N_{60}P_{90}$ + Helafit Combi	3,11	34210	16460	17750	5293	108

Source: compiled by the author.

In the variant with the introduction of N30P45, production costs increased by 22.1%, net profit increased compared to the control variant by UAH 2,240/ha, and the cost of 1 ton of seeds and the level of profitability did not practically change.

The best economic indicators were provided by joint application of N30P45 fertilizers and Helafit Combi: seed yield reached 3.03 t/ha, profit was UAH 19,120/ha, cost of 1 ton of seeds was UAH 4,690, profitability level was 134%.

Increasing the rate of nitrogen-phosphorus fertilizers to N45P90 negatively affects the economics of sunflower cultivation.

Thus, in terms of net profit and level of profitability, sunflower outperforms all types of agricultural products, and under the conditions of its own processing, the farm still has a valuable feed – oilcake (meal). Among the priority areas of further research designed to increase the efficiency of sunflower cultivation, we see the study of the effects of mineral fertilizers in conjunction with complexes of trace elements with the participation of sulfur.

Conclusions

It was found that pre-sowing treatment of seeds with the chemical pesticide Vitavax 200 FF caused a decrease in plant density by 2.2 thousand/ha (4.1%), and the complex biological product Helafit Seeds, on the contrary, to some extent stimulated plant growth and development.

Sunflower plants formed a powerful leaf surface, which reached its maximum value in the flowering phase. This figure gradually increased from 30.9 thousand m2/ha on the control without fertilizers to 40.0 thousand m2/ha on the background of N30P45 + Helafit Combi and to 44.2 thousand m2/ha – on the background of N60P90+ Helafit Combi.

The combined use of nitrogen-phosphorus fertilizers and Helafit Combi drug caused a prolongation of the photosynthetic activity of the leaves for 6-8 days and provided an increase in the photosynthetic potential of sunflower plants by 64.7-95.8%. Under these conditions, the highest yield of dry biomass achieved was 8.2-8.8 t/ha and the highest seed yield equaled 3.03-3.11 t/ha. The increase in seed productivity was due to an increase in the number of seeds in the flower head (34.1%) and the weight of seeds from one flower head (41.3%).

The best economic indicators were provided by the joint use of N30P45 and the drug Helafit Combi: the profit was UAH 19,120/ha, the cost of 1 ton of seeds amounted to UAH 4,690, the level of profitability – 134%. Increasing the rate of fertilizer to N45P90 negatively affected the economy of sunflower cultivation.

The best economic indicators were provided by the joint use of N30P45 and the drug Helafit Combi: the profit was UAH 19,120/ha, the cost of 1 ton of seeds – UAH 4,690, the level of profitability – 134%. Increasing the rate of fertilizer to N45P90 negatively affected the economy of sunflower cultivation.

References

1. https://agropolit.com/news/19783-ukrayina-torik-eksportuvala-rekordniy-obsyag-sonyashnikovoyi-oliyi [Ukraine exported a record amount of sunflower oil last year].
2. Muzychenko O.O. (2004). Sonyashnyk ukrayins′kyy [Ukrainian sunflower]. *Propozytsiia*. Kyiv, No 10. Pp. 45-47.
3. Orlov O. (2020). Top chynnykiv, yaki limituyut′ vrozhaynist′ sonyashnyku [Top factors that limit the yield of sunflower]. *Agronomist*. Kyiv, No 2 (68). Pp. 112-

116.
4. Tekhnolohiya EkspresSan® – 10 rokiv uspishnoho zrostannya v Ukrayini [ExpressSun® technology – 10 years of successful growth in Ukraine]. *Agronomist*. Kyiv, 2017. No 1 (55). Pp. 156-157.
5. Orlov O. (2017). Pitaniye podsolnechnika i osobennosti primeneniya organicheskikh udobreniy [Nutrition of sunflower and features of application of organic fertilizers]. *Agronomist*. Kyiv, No 1 (55). Pp. 146-152.
6. Gospodarenko G.M. (2016). Udobrennya síl's'kogospodars'kikh kul'tur [Fertilization of agricultural crops]. Kyiv: SIK GROUP UKRAINE LLC. 276 p.
7. Yaroshko M. (2013). Znachennya fosforu u zhivlenní síl's'kogospodars'kikh kul'tur [The value of phosphorus in the nutrition of crops]. *Agronomist*. Kyiv, No 3. Pp. 30-32.
8. Nosko B.S., Khristenko A.O., Maksimova V.P. (1999). Problema fosforu v zemlerobstv Ukrainy [The problem of phosphorus in agriculture of Ukraine]. *Bulletin of Agricultural Science*. Kyiv, No 5. Pp. 13-16.
9. Kovalenko O., Kovbel A. (2013). Yelementi zhivlennya ta stresi pol'ovikh kul'tur [Nutrients and stresses of field crops]. *Propozytsiia*. Kyiv, No 5 (215). Pp. 78-79.
10. Litvinov D.V., Shmorgun O.V. (2017). Efektyvnistʹ zastosuvannya biopreparativ za riznykh system udobrennya sonyashnyku i kukurudzy na zerno [The effectiveness of biological products in different systems of fertilization of sunflower and corn for grain]. *Agronomist*. Kyiv, No 1 (55). Pp. 160-165.
11. Dobrovolskyi A.V., Domaratskyi E.A. (2017). Osoblyvosti realizatsiyi stymulyuyuchoyi diyi kompleksnykh preparativ roslynamy sonyashnyka na pochatkovykh etapakh orhanohenezu [Features of realization of stimulating action of complex preparations by sunflower plants at the initial stages of organogenesis]. *Agrarian Bulletin of the Black Sea Coast.* Odessa, Edition 84-2. Pp. 39-45.
12. Domaratskyi Ye.O. (2019). Ahroekolohichne obgruntuvannya systemnoho zastosuvannya bahatofunktsionalʹnykh rist rehulyuyuchykh preparativ pry vyroshchuvanni polʹovykh kulʹtur u Pivdennomu Stepu [Agroecological substantiation of system application of multifunctional growth of regulating drugs at cultivation of field cultures in the Southern Steppe]: Extended abstract of dissertation. Dr.sc.agr 06.01.09. Kherson, 2019. 42 p.

13. Rakitina T.N. (1975). Vliyaniye mineral'nykh udobreniy na urozhay i maslichnost' semyan podsolnechnika [Influence of mineral fertilizers on the yield and oiliness of sunflower seeds]. *Collection of research papers of the Odessa Agricultural Institute*. Odessa. Pp. 139-145.
14. Gubenko L. (2020). Pidbir-sortiv-ta-hibrydiv-soniashnyku [Selection of varieties and hybrids of sunflower]. *Agronomy Today*, *April 8*. Kyiv. URL: http://agro-business.com.ua/agro/ahronomiia-sohodni/item/17162.html.
15. Dobrovolskyi A.V. (2019). Efektyvnistʹ suchasnykh ristrehulyuyuchykh preparativ dlya biolohizatsiyi tekhnolohiy vyroshchuvannya sonyashnyku v pivdennomu Stepu Ukrayiny [Efficiency of modern restrictive drugs for biologization of sunflower growing technology in the southern steppe of Ukraine]: Extended abstract of dissertation. M Agr 06.01.09. Kherson. 23 p.
16. http://helafitou.ua. Mineralis Ukraine LLC [Helafit Group]. URL: offic@mineralis.com.ua.
17. Osnovy naukovykh doslidzhenʹ v ahronomiyi: Pidruchnyk [Fundamentals of scientific research in agronomy]: Textbook / V.O. Yeshchenko, P.G. Kopitko, V.P. Opryshko, P.V. Kostogriz; ed. by V.O. Yeshchenko. Kyiv: Action, 2014. 288 p.
18. Nychyporevych A.A. (1963). Fotosintez i voprosy produktivnosti rasteniy [Photosynthesis and plant productivity issues]. Moscow: AN SSSR Publishing House. Pp. 3-56.
19. Silchenok Z.T. (1962). Nekotoryye osobennosti rosta i razvitiya podsolnechnika v zavisimosti ot gustoty stoyaniya [Some features of growth and development of sunflower depending on standing density]. *Selection and Agrotechnics of Sunflower*. Voronezh. Pp. 37-45.
20. Bondarenko M.P. (2003). Vplyv ahrotekhnichnykh pryyomiv na urozhaynistʹ i yakistʹ nasinnya sonyashnyku v umovakh Pivdenno-Skhidnoho Lisostepu Ukrayiny [Influence of agrotechnical methods on yield and quality of sunflower seeds in the conditions of the South-Eastern Forest-steppe of Ukraine]: Extended abstract of dissertation. M Agr 06.01.09. Dnipro. 19 p.
21. Nikitchin D.I., Ryabota A.N. (1989). Gibridnyy podsolnechnik [Hybrid sunflower]. Kiev: Harvest. 88 p.
22. Domaratskyi E.A., SidIakina O.V., DobrovolskyI A.V. (2017). Biopreparat

novoho pokolinnya hrupy Khelafit u tekhnolohiyi vyroshchuvannya hibrydiv sonyashnyku na Pivdni Ukrayiny [Biological product of the new generation of the Helafit group in the technology of growing sunflower hybrids in the South of Ukraine]. *Tavrian Scienctific.Herald*. Kherson, Edition 98. Pp. 51-56.

23. https://www.agronom.co.ua/etapi-rostu-sonyashnika/ [Stages of sunflower growth].

24. https://zik.ua/news/2020/01/01/urozhainist_soniashnyka_v_ukraini_za_2019_rik_perevyshchyla_rezultaty_mynulykh_sezoniv_952862 [Sunflower yield in Ukraine in 2019 exceeded the results of previous seasons].

ZESZYTY NAUKOWE WSA w Łomży 84, s. 49-60
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Rita Klymyshena
State Agrarian and Engineering University in Podilia

GRAIN YIELD OF SPRING BARLEY DEPENDING ON THE EFFECT OF MINERAL FERTILIZATION

Summary

The purpose of research is to establish the effectiveness of foliar fertilization effect of spring barley plants with microfertilizers «Wuxal» for different variants of mineral fertilization on grain yield.

The experiment included variants: factor A – rates of mineral fertilizers: N0P0K0 (control), N30P45K45, N60P90K90; factor B – rates of microfertilizers provided their application three times during the onset of tillering phenophases in plants (Wuxal P Max), stem elongation (Wuxal Grain) and flowering (Wuxal Grain): 0 (control); 3.0 l/ha (1,0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7.5 l/ha (2.5 + 2.5 + 2.5); 9.0 l/ha (3.0 + 3.0 + 3.0).

Results. The influence of foliar fertilization of plants with microfertilizers «Wuxal» and mineral fertilizers on the level of grain yield of spring barley was established.

Conclusions. The effectiveness of mineral fertilizers and the application of foliar fertilization of spring barley plants with microfertilizers «Wuxal P Max» and «Wuxal Grain» is proved. The level of grain yield for experimental variants N0P0K0 – 4.41 t/ha, N30P45K45 – 6.19 t/ha and N60P90K90 – 7.18 t/ha. The efficiency of microfertilizers as a result of foliar fertalization of spring barley plants on the influence on the level of grain yield depended on the background of mineral nutrition. The optimal rate of microfertilizers use on the background of N30P45K45 is 4.5 l/ha with a single application of 1.5 l/ha during the phases: tillering – «Wuxal P Max», stem elongation and flowering – «Wuxal Grain»,

on the background of N60P90K90 – 6.0 l/ha with a single application of 2.0 l/ha during the above phases of development.

Key words: spring barley, mineral fertilizers, microfertilizers, grain yield, the least significant difference, Duncan test.

Introduction

The level of barley grain yield is an important indicator of economic nature as a result of the influence of various factors [1]. These factors are biotic and non-biotic. The first of them determine the varieties and hybrids of crops bred by breeders. Plants of varieties play the role of bioproducers, ie producers of organic matter. This is the basis of technology without which it is impossible to ensure the synthesis of organic matter. Accordingly, the technology, through the efforts of specialists is aimed at ensuring the efficient transformation of plants into the energy of sunlight into the chemical energy of organic matter. Organic substances accumulate in the form of grain, green mass, roots, etc. The amount of accumulated organic matter in the grain characterizes the efficiency of the technology, or according to the results of research, the impact of individual elements of technology, its components in compliance with the rule of single cancellation [2]. Therefore, barley grain yield is an important criterion for assessing the action of influencing factors that are included in the planned experiment [3]. Estimation through the criterion of grain yield in the relevant circumstances is characteristic of all studies in crop production, breeding, seed production, as evidenced by literature sources [4, 5, 6, 7, 8].

During the growth and development of barley plants, favorable conditions for providing them with moisture, heat, and mineral nutrition are important. These factors have a significant impact on the realization of the biological potential of the yield structure [9].

Increasing the barley grain yield for Ukraine remains an urgent issue, and technological factors play a significant role in solving this problem. One of the important components in the formation of highly productive crops is the level of mineral nutrition of plants. Regarding the effectiveness of mineral fertilizers in crop management, O.S. Gorash established in his research [10]. The author proved that with the increase of mineral fertilization rates the level of grain yield of spring barley Scarlet increased: in the control variant it was 4.81 t/ha, on the variant N30P45K45 – 6.46 t/ha; on the variant N60P90K90 – 7.72 t/ha; on the variant N60P120K120 – 8.01 t/ha and on the variant N90P120K120 – 8.64 t/ha.

An important issue is also the study of foliar fertilization effect of plants with microfertilizers under different backgrounds of mineral nutrition to increase the yield and grain quality of spring barley. Because such research will complement the development of technologies for growing crops.

Purpose, subject and research methods

The purpose of research is to establish the effectiveness of foliar fertilization effect of spring barley plants with microfertilizers «Wuxal» for different variants of mineral fertilizers on grain yield.

The research was performed during 2014–2017 at State Agrarian and Engineering University in Podilia. The soil of the experimental plots is typical black soil.

The location of mineral fertilization areas is systematized in tiers, and the variants for the application of foliar fertilization of plants with microfertilizers are randomized. Number of repetitions – four times.

Experimental scheme: factor A – rates of mineral fertilizers application: N0P0K0 (control), N30P45K45, N60P90K90; factor B – rates of microfertilizers under the condition of their three-time application: 0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7.5 l/ha (2.5 + 2.5 + 2.5); 9.0 l/ha (3.0 + 3.0 + 3.0). Foliar feeding of plants was carried out during the active growing season: the first time – during the tillering phase with microfertilizer «Wuxal P Max», the second time – during the phase of stem elongation with microfertilizer «Wuxal Grain», the third time – at the beginning of the flowering phase with microfertilizer «Wuxal Grain».

Microfertilizers «Wuxal P Max» and «Wuxal Grain» are complex foliar fertilizers-suspensions of the German company «Unifer», which are used for foliar nutrition of plants. «Wuxal P Max» is characterized by a high content of phosphorus – 450 g/l and nitrogen – 150 g/l, as well as microelements – zinc (15 g/l), sulfur (5.25 g/l), iron (1.45 g/ l), copper (0.73 g/l), manganese (0.73 g/l), boron (0.29 g/l), molybdenum (0.014 g/l). «Wuxal Grain» contains macroelements of potassium - 144 g/l and nitrogen – 72 g/l, and microelements –

sulfur (85 g/l), manganese (28.8 g/l), zinc (21.6 g/l), copper (14.4 g/l), boron (1.4 g/l), molybdenum (0.29 g/l).

The variety of spring barley Sebastian was used for research.

Crop accounting was performed by continuous threshing. For mathematical analysis of the obtained research results, analysis of variance was used [11, 12].

Results of the research

According to the results of a two-factor experiment, the effectiveness of the rate of microfertilizers application in accordance with the rate of mineral fertilizers application, which provided different backgrounds of mineral nutrition, was established.

As a result of the performed researches during four years at three applications of microfertilizer «Wuxal» during the vegetation period of plants on crops of spring barley its influence on grain productivity depending on the rate of agent application is established (Table 1).

Table 1. Yield of spring barley grain depending on the impact of foliar fertilization of plants with microfertilizers «Wuxal» and application of mineral fertilizers, t/ha (2014)

Background of nutrition, factor A	Total rate of three-time applications of microfertilizer «Wuxal»*, l/ha (factor B)					
	0	3.0	4.5	6.0	7.5	9.0
$N_0P_0K_0$	4.05	3.99	4.15	4.45	4.41	4.55
$N_{30}P_{45}K_{45}$	6.01	6.00	6.40	6.36	6.46	6.39
$N_{60}P_{90}K_{90}$	6.74	6.78	6.81	7.13	7.19	7.08
$LSD_{0.05}$	A–0.20		B–0.29		AB–0.50	

**0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7,5 l/ha (2.5 + 2.5 + 2.5); 9,0 l/ha (3.0 + 3.0 + 3.0)*

In 2014, on the variant N0P0K0, ie on the background of natural soil fertility, the application rates of microfertilizer «Wuxal» 6.0 proved to be effective; 7.5 and 9.0 l/ha, which were equivalent in their significance. Against the background of mineral nutrition N30P45K45, the total rate of micronutrient use 4.5 l/ha was effective (during tillering – 1.5 l/ha, stem elongation – 1.5 l/ha and at the beginning of flowering – 1.5 l/ha). Grain yield in this variant was 6.40 t/ha, which is higher compared to the control by 0.39 t/ha and with the variant 3.0 l/ha – by 0.40 t/ha (LSD0.05 – 0.29). Application of higher rates of microfertilizer 6.0; 7.5 and 9.0 l/ha did not provide significant changes. Against the background of mineral nutrition N60P90K90 a significant increase in grain yield was found at the rates of foliar nutrition of barley plants with microfertilizer «Wuxal» 6.0 l/ha (during tillering – 2.0 l/ha, stem elongation – 2.0 l/ha and at the beginning of flowering – 2.0 l/ha). The yield level was 7.13 t/ha. Compared to the control, the indicator increased by 0.39 t/ha, to the variant of 3.0 l/ha – by 0.35 t/ha, to the variant of 4.5 l/ha – by 0.32 t/ha (LSD0.05 – 0.29). Increasing the rate of microfertilizer use to 7.5 l/ha and 9.0 l/ha did not lead to significant changes.

In 2015, against the background of mineral fertilizers without application of mineral fertilizers, the rate of application of microfertilizer 7.5 l/ha – 4.72 t/ha. Without the use of microfertilizers, the yield was 4.34 t/ha. The difference is 0.38 t/ha at the established LSD0.05 – 0.33 (Table 2). Against the background of nutrition N30P45K45, a significant increase in grain yield was obtained at the rates of microfertilizer use at foliar fertilization of 4.5 l/ha – 6.35 t/ha. The control variant provided a yield of 5.88 t/ha. The difference between the variants was 0.47 t/ha (LSD0.05 – 0.33). Increasing the rate of microfertilizers use to 6.0 l/ha; 7.5; 9.0 l/ha did not lead to significant results. Against the background of nutrition N60P90K90 the optimal rate of microfertilizer 6.0 l/ha is set. The grain yield was 7.65 t/ha. Compared with the control, the increase was 0.48 t/ha at LSD0.05 – 0.33.

Table 2. Yield of spring barley grain depending on the impact of foliar fertilization of plants with microfertilizers «Wuxal» and application of mineral fertilizers, t/ha (2015)

Background of nutrition, factor A	Total rate of three-time applications of microfertilizer «Wuxal»*, l/ha (factor B)					
	0	3.0	4.5	6.0	7.5	9.0
$N_0P_0K_0$	4.34	4.32	4.46	4.66	4.72	4.84
$N_{30}P_{45}K_{45}$	5.88	6.02	6.35	6.40	6.48	6.42
$N_{60}P_{90}K_{90}$	7.17	7.24	7.32	7.65	7.63	7.58
$LSD_{0.05}$	A–0.24		B–0.33		AB–0.58	

**0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7,5 l/ha (2.5 + 2.5 + 2.5); 9,0 l/ha (3.0 + 3.0 + 3.0)*

In 2016, the regularities on the effectiveness of foliar fertilization of plants with microfertilizer «Wuxal» are similar to those in 2014 and 2015. Against the background of mineral fertilizers without application, the total rate of microfertilizer was 7.5 l/ha (Table 3). The increase in the level of grain yield compared to the control variant was 0.32 t/ha (LSD0.05 – 0.27). Against the background of mineral nutrition N30P45K45 optimization of microfertilizer rate is aimed at the variant of 4.5 l/ha. Grain yield was 6.50 t/ha, in the case without microfertilizer – 6.13 t/ha, data difference – 0.37 t/ha (LSD0.05 – 0.27). Increasing the rate of microfertilizer application «Wuxal» in accordance with 6.0; 7.5 and 9.0 l/ha did not lead to significant changes. Against the background of mineral nutrition N60P90K90 the optimal rate of microfertilizer was 6.0 l/ha, at which the yield was set at 7.71 t/ha, at the control – 7.40 t/ha. The data difference between the variants was 0.31 t/ha at LSD0.05 – 0.27. The increase in the use of microfertilizers according to the rates of 7.5 l/ha and 9.0 l/ha did not contribute to a further significant increase in grain yield.

Table 3. Yield of spring barley grain depending on the impact of foliar fertilization of plants with microfertilizers «Wuxal» and application of mineral fertilizers, t/ha (2016)

Background of nutrition, factor A	Total rate of three-time applications of microfertilizer «Wuxal»*, l/ha (factor B)					
	0	3.0	4.5	6.0	7.5	9.0
$N_0P_0K_0$	4.45	4.36	4.52	4.68	4.77	4.93
$N_{30}P_{45}K_{45}$	6.13	6.20	6.50	6.50	6.64	6.48
$N_{60}P_{90}K_{90}$	7.40	7.36	7.42	7.71	7.75	7.85
$LSD_{0.05}$	A–0.19		B–0.27		AB–0.46	

**0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7,5 l/ha (2.5 + 2.5 + 2.5); 9,0 l/ha (3.0 + 3.0 + 3.0)*

In 2017, the results without the application of mineral fertilizers were similar to the data of 2014 (Table 4). When applying the total rate of microfertilizer 6.0 l/ha, the grain yield was 4.34 t/ha and was significantly higher compared to the data obtained in the control of 3.96 t/ha. Evaluation of the effectiveness of microfertilizers impact on the background of N30P45K45 in terms of grain yield refers to the variant of 4.5 l/ha. The yield level for which is set at 5.92 t/ha, in the case without the use of microfertilizer 5.52 t/ha at LSD0.05 – 0.31. Application of higher rates of microfertilizers 6.0 l/ha; 7.5 and 9.0

l/ha did not lead to significant changes. Grain yield was 5.95 t/ha; 6.03 and 5.88 t/ha, respectively. Regarding the cultivation of spring barley on the background of N60P90K90, the optimal rate of microfertilizers application was 6.0 l/ha. Further increase of the rate to 7.5 and 9.0 l/ha did not lead to significant changes.

On average for four years on the background of mineral nutrition N30P45K45 when using the total rate of 4.5 l/ha (during tillering – 1.5 l/ha, stem elongation – 1.5 l/ha and at the beginning of flowering – 1.5 l/ha) microfertilizers «Wuxal» grain yield was 6.29 t/ha. When growing barley on the background of mineral nutrition N60P90K90 according to the arithmetic average, the optimal total rate of microfertilizer application»Wuxal» is the rate of 6.0 l/ha (during tillering – 2.0 l/ha, stem elongation – 2.0 l/ha and at the beginning of flowering – 2.0 l/ha).

Table 4. Yield of spring barley grain depending on the impact of foliar fertilization of plants with microfertilizers «Wuxal» and application of mineral fertilizers, t/ha (2017)

Background of nutrition, factor A	Total rate of three-time applications of microfertilizer «Wuxal»*, l/ha (factor B)					
	0	3.0	4.5	6.0	7.5	9.0
$N_0P_0K_0$	3.96	3.92	4.12	4.34	4.36	4.47
$N_{30}P_{45}K_{45}$	5.52	5.71	5.92	5.95	6.03	5.88
$N_{60}P_{90}K_{90}$	6.56	6.61	6.74	6.90	6.93	6.86
$LSD_{0.05}$	A–0.22		B–0.31		AB–0.54	

**0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7,5 l/ha (2.5 + 2.5 + 2.5); 9,0 l/ha (3.0 + 3.0 + 3.0)*

On average, factor B – foliar fertilization of plants with microfertilizer «Wuxal» grain yield in the control variant was 5.69 t/ha, when applying the rate of 3.0 l/ha – 5.71 t/ha; 4.5 l/ha – 5.89 t/ha; 6.0 l/ha – 6.06 t/ha. When the rate of microfertilizer was increased to 7.5 l/ha, the grain yield was at the level of 6.12 t/ha. The subsequent increase in the rate to 9.0 l/ha did not provide a significant increase in yield, on average, this figure was 6.11 t/ha (Table 5).

The analysis of the data also proves that regardless of microfertilizers use «Wuxal» in the experiment the effect on the grain yield of spring barley in the rates of applied mineral fertilizers, which provided the root nutrition of plants. The parameters of the indicator ranged from 4.41 t/ha to 7.18 t/ha.

Table 5. Yield of spring barley grain depending on the impact of mineral fertilizer application rates and application rates of microfertilizer «Wuxal», t/ha (average for 2014-2017)

Background of nutrition, kg/ha a.s., factor A	Total rate of three-time applications of microfertilizer «Wuxal»*, l/ha (factor B)						Average factor A
	0	3.0	4.5	6.0	7.5	9.0	
$N_0P_0K_0$	4.20	4.15	4.31	4.53	4.57	4.70	4.41
$N_{30}P_{45}K_{45}$	5.89	5.98	6.29	6.30	6.40	6.29	6.19
$N_{60}P_{90}K_{90}$	6.97	7.00	7.07	7.35	7.38	7.34	7.18
Average factor B	5.69	5.71	5.89	6.06	6.12	6.11	5.93

**0 (control); 3.0 l/ha (1.0 + 1.0 + 1.0); 4.5 l/ha (1.5 + 1.5 + 1.5); 6.0 l/ha (2.0 + 2.0 + 2.0); 7,5 l/ha (2.5 + 2.5 + 2.5); 9,0 l/ha (3.0 + 3.0 + 3.0)*

Despite the statistical analysis of experimental data with the above results of analysis of variance and the establishment of differences significance between the average grain yields of spring barley, it is advisable to further compare the group average data. This makes it possible to argue about the effectiveness of the microfertilizers use in the technology of growing malting barley on the basis of foliar nutrition, as an important factor (Table 6).

Table 6. The effect of the factor of microfertilizer «Wuxal» on the grain yield of spring barley according to the Duncan test, t/ha

Total rate of three-time applications of microfertilizer, l/ha	Yield, t/ha	Homogeneous groups		
		1	2	3
0	5.69	***		
3.0	5.71	***		
4.5	5.89		***	
6.0	6.06			***
7.5	6.12			***
9.0	6.11			***

According to the results obtained using the test of planned comparisons of LSD, three homogeneous groups were identified, which proves the effectiveness of the factor when comparing the average values of yield between variants. Accordingly, the group analysis shows that the total rate of application of microfertilizer 3.0 l/ha (during tillering – 1.0 l/ha, stem elongation – 1.0 l/ha and at the beginning of flowering – 1.0 l/ha) is not effective. The total rate of microfertilizer «Wuxal» 4.5 l/ha (during tillering – 1.5 l/ha, stem elongation – 1.5 l/ha and at the beginning of flowering – 1.5 l/ha) increases the yield and allocated to a separate statistical group. Also effective is the total use rate of 6.0 l/ha (during tillering – 2.0 l/ha, stem elongation – 2.0 l/ha and at the beginning of flowering – 2.0 l/ha), at which the level yield is 6.06 t/ha and is significantly higher compared to the second homogeneous group. Increasing the rate of use of microfertilizers during foliar fertilization to 7.5 l/ha (during tillering – 2.5 l/ha, stem elongation – 2.5 l/ha and at the beginning of flowering – 2.5 l/ha) and 9.0 l/ha (during tillering – 3.0 l/ ha, stem elongation – 3.0 l/ha and at the beginning of flowering – 3.0 l/ha) did not significantly increase the level of barley grain yield. The obtained data of these variants are concentrated in one statistical group.

According to the analysis of variance on the basis of Duncan's test, the dependence of spring barley grain yield on mineral fertilizer was also established. In the control variant N0P0K0 the indicator was the lowest and amounted to 4.41 t/ha (Table 7).

Table 7. The effect of the mineral fertilizer factor on the grain yield of spring barley according to the Duncan test, t/ha

Fertilizer rate, kg/ha a.s.	Yield, t/ha	Homogeneous groups		
		1	2	3
$N_0P_0K_0$	4.41	***		
$N_{30}P_{45}K_{45}$	6.19		***	
$N_{60}P_{90}K_{90}$	7.18			***

Against the background of nutrition N30P45K45, a significantly higher level of yield was set compared to the control of 1.78 t/ha. The application rate of mineral fertilizers N60P90K90 led to a further significant increase in grain yield – 7.18 t/ha. This pattern was annual.

Conclusions

The effectiveness of mineral fertilizers and the application of foliar fertilization of spring barley plants with microfertilizers «Wuxal P Max» and «Wuxal Grain» is proved.

The level of grain yield for experimental variants N0P0K0 – 4.41 t/ha, N30P45K45 – 6.19 t/ha and N60P90K90 – 7.18 t/ha.

The efficiency of microfertilizers as a result of foliar nutrition of spring barley plants on the influence on the level of grain yield depended on the background of mineral nutrition. The optimal rate of microfertilizers use on the background of N30P45K45 is 4.5 l/ha with a single application of 1.5 l/ha during the phases: tillering – «Wuxal P Max», stem elongation and flowering – «Wuxal Grain», on the background of N60P90K90 – 6.0 l/ha with a single application of 2.0 l/ha during the above phases of development.

Bibliography

1. Voitsekhovskyi I.O. (2013). Efektyvnist vykorystannia dobryv ta rehuliatoriv rostu u vyroshchuvanni yachmeniu yaroho v Pivdennomu Stepu Ukrainy. [Efficiency of fertilizers and growth regulators in the cultivation of spring barley in the Southern Steppe of Ukraine]. Bulletin of Agricultural Science. No. 4. Pp. 78–79.
2. Yeshchenko V.O., Kopytko P.G., Kostogryz P.V., Opryshko V.P. (2014). Osnovy naukovykh doslidzhen v ahronomii: Pidruchnyk. [Fundamentals of Scientific Research in Agronomy: Textbook]. Vinnytsia: PE «TD «Edelweiss & K»». 332 p.
3. Zaryshniak A.S., Ivanina V.V., Kolibabchuk T.V. (2013). Optymizatsiia udobrennia zernovykh kultur u zernovo-buriakovii sivozmini. [Optimization of grain crops fertilization in grain-beet crop rotation]. Bulletin of Agricultural Science. No. 4. Pp. 78–79.
4. Svydyniuk I.M., Liubchych S.G. (2009). Formuvannia urozhainosti ta yakosti zerna pshenytsi ozymoi zalezhno vid dobryv. [Formation of yield and grain quality of winter wheat depending on fertilizers]. Collection of scientific works of NSC «Institute of Agriculture UAAS». Ed. 3. Pp. 56–63.
5. Tsvey Ya.P., Petrova O.T., Voroniuk N.M. (2009). Produktyvnist pshenytsi ozymoi zalezhno vid systemy udobrennia v Lisostepu. [Productivity of winter wheat depending on the fertilizer system in the Forest-Steppe]. Collection of scientific

works of NSC «Institute of Agriculture UAAS». Ed. 4. Pp. 96–99.
6. Len O.I. (2010). Pyvovarni vlastyvosti zerna yachmeniu yaroho zalezhno vid umov vyroshchuvannia v Livoberezhnomu Lisostepu. [Brewing properties of spring barley grain depending on growing conditions in the Left Bank Forest-Steppe]. Collection of scientific works of NSC «Institute of Agriculture UAAS». Ed. 4. Pp. 107–112.
7. Zhemela G.P., Shakaliy S.M. (2012). Vplyv mineralnoho zhyvlennia na elementy produktyvnosti ta yakist zerna pshenytsi ozymoi. [Influence of mineral nutrition on the elements of productivity and grain quality of winter wheat]. Bulletin of the Poltava State Agrarian Academy. No. 4. Pp. 14–16.
8. Poltoretskyi S., Tretiakova S., Mostoviak I., Yatsenko A., Tereshchenko Y., Poltoretska N., Berezovskyi A. (2020). Growth and productivity of winter wheat (Tritium aestivum L.) depending on the sowing parameters. Ukrainian Journal of Ecology. 10(2). P. 81–87. DOI: https://doi.org/10.15421/2020_68.
9. Gorash O., Klymyshena R., Khomina V., Vilchynska L. (2020). Ecological and biological conformity of conditions of the brewing barley cultivation zone. Ukrainian Journal of Ecology. 10(1). P. 246–253. DOI: https://doi.org/10.15421/2020_39.
10. Gorash, O.S. (2017). Upravlinnia produtsiinym protsesom pyvovarnoho yachmeniu: monohrafiia; 2 vydannia z dopovnenniamy. [Management of brewing barley production process: monograph; 2 editions with additions]. Kamyanets-Podilskyi: PE Medobory-2006, 464 p.
11. Dospekhov B.A. (1985). Metodika polevogo opyta. [Methods of field experience]. Moscow: Agropromizdat. 351 p.
12. Ermantraut E.R., Prysiazhniuk O.I., Shevchenko I.L. (2007). Statystychnyi analiz ahronomichnykh doslidnykh danykh v paketi Statistica 6.0. [Statistical analysis of agronomic research data in the package Statistica 6.0]. Kyiv: Ukrainian Academy of Agrarian Sciences. 55 p.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 61-71
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Tetiana Kozina
State Agrarian and Engineering University in Podilia

AGROECOLOGICAL FEATURES OF SEED PRODUCTIVITY INCREASE OF WHITE MUSTARD IN THE CONDITIONS OF PODILLIA

Summary

The purpose of the study is to establish the patterns of seed productivity formation of white mustard depending on the biological characteristics of the variety and the period of sowing seeds.

Based on the results of the study during 2016-2018, the influence of sowing dates of white mustard varieties Carolina, Pidpecheretska, Podolianka on seed yield was highlighted.

It was found that with the optimal early spring (first term) sowing period and soil thermal regime of 3-4°C at the depth of white mustard seed wrapping, higher seed yield was obtained compared to sowing of the second and third sowing dates.

The highest yield of white mustard seeds was provided by the Podolianka variety - 2.76 t/ha.

Planned measures to further increase the production of oilseeds and improve their quality are of great importance for solving the priority tasks of strengthening the economic sector.

Based on the study, it was found that in order to increase the seed productivity of white mustard seeds the variety Podolianka it is advisable to sow in early spring (first term) at the level of thermal regime of the soil 3-4°C at the depth of seed wrapping, which provides a seed yield of 2.76 tons/ha and oil yield 626 kg/ha.

The prospect of further research is the optimization of agro-technological measures

for growing modern high-yielding varieties of white mustard.

Key words: white mustard, variety, sowing period, field germination, plant survival, seed yield, oil yield.

Introduction

Agricultural enterprises of Ukraine face the task of further increasing the production of oilseeds and improving product quality. A special place in solving this problem belongs to mustard, the oil of which, due to its unique biological and chemical properties, is increasingly used in the food and medical industries. In addition, mustard is used for food, for green manure, it is also a valuable honey plant [1].

Significant contribution to the development of technology for growing white mustard was made by such well-known domestic scientists as: Abramyk M.I., Vyshnivsky P.S., Oksimets O.L., Kaminsky V.F., Lys N.M., Mazur V.O., Shuvar I.A. and other.

In terms of mustard crops, our country is one of the ten world leaders in growing this crop. In Ukraine, mustard ranks fourth place in terms of production among oilseeds and second only to rapeseed, soybeans and sunflowers. Seeds account for 2% of its world production, which is quite high.

Under favorable conditions for growing rapeseed, white mustard is significantly inferior in yield to the former. However, due to the introduction of new promising varieties, improvement of the seed production system, improvement of agro-technological measures of cultivation, there is a real opportunity to significantly increase the yield of seeds, to improve its quality.

According to the State Statistics Service of Ukraine, in 2016 the area of mustard sowing was 44.5 thousand hectares. The main areas are located in the regions, thousand hectares: Kherson - 11.1; Zaporizhzhia - 4.9; Khmelnytsky - 1.5; Cherkasy - 1.0; Vinnytsia -1.1; Kyiv - 1.7; Poltava -1.4; Luhansk - 3.1; Donetsk - 5.7; Chernihiv - 2.6; Kharkiv - 1.2 and others. The obtained analytical data on sown and harvested areas, production volumes, crop yields show that mustard crops are located on 75% of the territory of Ukraine [4, 5].

In recent years in Ukraine, the use of mineral and organic fertilizers in the recommended doses is too energy-intensive measure, so it is increasing attention to a cheap and effective way to fertilize the soil - growing crops on green manure [2, 6].

The ecological effect of the use of straw destruction in combination with green fertilizers is manifested in the ability to disinfect the soil from pathogenic microflora. After all, due to the plowing of organic matter in the soil, the activity of a large group of saprophytic microorganisms, which are antagonists of many pathogens, increases. This is especially true in modern economic conditions, when the system of scientifically sound alternation of crops in crop rotation is violated, and part of the winter grain crops are sown after stubble predecessors [8].

Agroecological advantages of mustard cultivation in Ukraine, its economic and valuable and medical and biological properties, high profitability of production (over 110%) contribute to the further development of mustard market, its processing, increase crop profitability and demand for seeds. To collect consistently high yields with high economic efficiency, it is necessary to follow carefully the technology of growing the crop, in particular the period of sowing and seeding rates, the use of mineral fertilizers [7].

I.A. Shuvar notes that white mustard responds well to early sowing, which has the following advantages:

a) low positive temperatures and soil layer contribute to the formation of a strong root system and leaf rosette, which increases the competitiveness of the crop to weeds;

b) mustard - a long-day plant, so in the case of late sowing, it quickly goes through all phases of growth and development, which negatively affects yields;

c) early sowing helps to reduce the harmfulness of cruciferous fleas.

Mustard is sown as early as possible under conditions of soil maturation. Its seedlings can withstand frosts, and early crops are better able to withstand not only drought, but also damage by fleas, which are a serious danger to seedlings and young plants. In addition, early sowing of mustard better suppress weeds [9, 10].

Therefore, the agricultural enterprises of Ukraine have a task to increase the production of high-quality white mustard seeds, which will increase the area under white mustard.

Purpose, subject and methods of research

The purpose of the study is to establish the patterns of seed productivity formation of white mustard depending on the biological characteristics of the variety and the period of sowing.

The yield of white mustard depends on soil and climatic conditions, agronomic measures of cultivation, in particular, on the predecessor of the variety, type of fertilizer, sowing date, etc. Most researchers believe that the optimal sowing time is one of the important values in the formation of the mustard seed crop.

In order to solve this problem during 2016-2018, field and laboratory studies were performed in the research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia on typical black soil.

The soil of the experimental field is typical leached black soil, low-humus, medium loamy on forest-like loams with agrochemical properties of the soil. Physical and agrochemical characteristics of 0-30 cm of the soil layer of the experimental plot to the bookmark of the experiment: solid phase density - 2.58 g/m3, moisture density - 1.17-1.25 g/m3, total porosity - 51.6-54.7%, nitrogen content according to Cornfield - 111-121 mg/kg, phosphorus and potassium according to Chirikov - 90-91 and 172-179 mg/kg, the amount of absorbed bases - 20.9-22.1 mg/eq. per 100 g of soil, hydrolytic acidity - 0.76-0.87 mg/eq. per 100 g of soil, the degree of saturation of the bases - 94.7-99.0%. The humus content in the arable horizon of the soil is 3.86-4.11%, which corresponds to a low level of security. With depth, the amount of humus decreases and in the horizon Phk is 2.47%. Water and physical properties of the soil are good: maximum hygroscopicity of the soil - 5.2%; the lowest moisture content - 23.4%; total field moisture content - 41.2%.

Agrotechnical measures for growing white mustard in the field experiment were performed according to the generally accepted methods for this area [3]. The predecessor of white mustard is winter wheat.

Research results

Based on our study, it was found that the growth and development of white mustard plants during the growing season depended on the biological properties of varieties, weather conditions and sowing dates.

Growth and development reflect the whole set of interaction processes of the organism with environmental factors. Applying certain technological measures, we change the living conditions of plants, so the study of the impact of different combinations of agricultural techniques is of great theoretical and practical importance.

The period of sowing influenced the growth and development of white mustard, in particular the length of the growing season, field germination, linear growth, leaf surface formation, weight of 1000 seeds of the crop and others (Table 1).

Analysis of the study results showed that the varieties of white mustard Pidpecheretska and Podolianka had on average slightly higher seed germination - 75.0 and 75.7%, respectively, and plant survival during the growing season: 84.3 and 85.6%, respectively, compared to the Carolina variety, in which these figures were 68.8 and 82.0%, respectively. Delayed sowing reduced seed germination. Thus, if during the sowing of early spring (first) term in white mustard variety Carolina germinated 77.6% of the seeds, the medium term - 72.5%, late - 66.6%, or 5.1 and 11.0% less, respectively. For the variety Pidpecheretska the decrease in seed germination at later sowing dates was 7.0 and 12.7%, respectively, and for the variety Podolianka - 7.5 and 13.9%. This is due to the deterioration of the water regime of the soil at late sowing dates.

Table 1. Influence of sowing period on field germination and survival of agrocenosis plants of white mustard (average for 2016–2018)

Variety (Factor A)	Period of sowing (Factor B)	Number of plants in the phase of culture seedlings, pcs/m^2	Field germination ,%	Number of plants for the period of harvest, pcs/m^2	Survival,%
Carolina	first	155,3	77,6	125,3	80,6
	second	145,0	72,5	116,6	80,1
	third	133,3	66,6	100,6	75,4
Pidpecheretska	first	163,0	81,5	139,3	85,1
	second	149,0	74,5	122,6	82,1
	third	137,6	68,8	103	74,8

Podolianka	first	166,0	83,0	141,6	85,4
	second	151,0	75,5	128	84,6
	third	137,3	69,1	105,3	76,7

Source: research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia

The period of sowing also affected the survival of white mustard plants during the growing season. At the same time, this indicator was the highest (80.4-85.4%) in the variants where white mustard was sown in the early spring period, the lowest (74.8–76.7%) - in the late period.

On average, during the three years of the study, the highest survival of plants (85.4%) and the highest density of stems (141.6 pcs/m2) were in the variants of growing white mustard Podolianka in the early spring sowing period.

We found that the weight of 1000 seeds of Pidpecheretska (4.8–6.2 g) and Podolianka (5.4–6.2 g) varieties was significantly higher than that of Carolina variety (4.3–5.0 g). At the same time, the highest weight of 1000 seeds of white mustard varieties was provided for sowing the crop in early spring. Thus, for the Carolina variety it averaged 5.0 g or 0.2 g more than during the second sowing period and 0.7 g more than during the third Pidpecheretska variety - 6.2 g or 0.9 g more respectively than in the second sowing period and 1.4 g more than in the third. For the variety Podolianka - for the first sowing period, these figures were respectively - 6.2 g, or 0.3 g more than for the second and 0.8 g more than for the third sowing period of mustard (Table 2).

Table 2. The effect of sowing dates of white mustard on the weight of 1000 seeds,g

Variety	Period of sowing	Year			Average for 2016-2018
		2016	2017	2018	
Carolina	first	4,9	4,9	5,2	5,0
	second	4,7	4,9	4,7	4,8
	third	4,2	4,2	4,4	4,3
Pidpecheretska	first	5,8	6,5	6,4	6,2

	second	4,8	5,5	5,7	5,3
	third	5,1	4,2	5,2	4,8
Podolianka	first	6,2	6,1	6,2	6,2
	second	5,7	6,0	6,1	5,9
	third	5,4	5,4	5,4	5,4

Source: research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia

The results of the study showed that during 2016-2018 the highest yield of experimental varieties was obtained during the first sowing period, when the level of thermal regime of the soil at the depth of seed wrapping reached 3-4°C.

During the first sowing period of the varieties Carolina, Pidpecheretska, Podolianka, the yield was on average 0.39-0.88 t/ha higher than in the second and third sowing periods. Thus, during the first sowing period of the Pidpecheretska variety the average yield for the years of study was 2.37 t/ha, which is 0.39 t/ha more than during the second and 0.68 t/ha - during the third sowing period. The highest yield (2.76 t/ha) of white mustard Podolianka was obtained in the first sowing period, which is 0.51 t/ha, or 22.7% more than in the second sowing period and 0.88 t/ha or 46.8% more than in the third sowing period (Table 3).

Table 3. The effect of sowing dates on the yield of white mustard, t/ha

Variety	**Period of sowing**	**Year**			**Average for 2016-2018**
		2016	**2017**	**2018**	
Carolina	first	1,82	1,63	1,94	1,80
	second	1,40	1,26	1,57	1,41
	third	1,25	1,10	1,40	1,25
Pidpecheretska	first	2,04	2,46	2,62	2,37
	second	1,78	1,82	2,34	1,98

	third	1,52	1,50	2,05	1,69
Podolianka	first	2,62	2,69	2,98	2,76
	second	2,14	2,22	2,40	2,25
	third	1,76	1,74	2,15	1,88
LSD_{05A}		0,09	0,08	0,10	
LSD_{05B}		0,11	0,09	0,12	
LSD_{05AB}		0,19	0,16	0,20	

Source: research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia

The most favorable conditions for growing white mustard were in 2016. Thus, in early spring (first term) sowing the yield of white Carolina mustard was 1.82 t/ha, which is 0.57 t/ha more than in the third period of sowing (late spring) and 0.19 t/ha more than 2017.

Podolianka white mustard in 2016 provided 2.62 t/ha of seeds during the first sowing period, which is 0.86 t/ha more than during the third sowing period and 0.84 t/ha more than during the second sowing period.

Our research in 2016–2018 established that the oil content of white mustard seeds of the Carolina, Pidpecheretska, and Podolianka varieties was significantly influenced by sowing dates. In this case, the highest content of crude oil in the seeds of white mustard Podolianka and its total yield was in the variants for the early spring (first) sowing period (Table 4).

Thus, the average yield of Podolianka variety was 2.76 t/ha, oil content - 31.0%, and its yield from 1 ha - 626 kg, which compared to the third sowing period is higher by 5.1 and 56.5%, respectively, compared with varieties Pidpecheretska and Carolina

Table 4. Influence of sowing period of white mustard on the content and total oil yield (average for 2016-2018).

Variety	Period of sowing	Average yield, t/ha	Oil content, %	Oil yield, kg/ha
Carolina	first	1,80	29,1	434
	second	1,41	28,3	326
	third	1,25	27,3	285
Pidpecheretska	first	2,37	29,9	544
	second	1,98	29,4	454
	third	1,69	28,6	362
Podolianka	first	2,76	31,0	626
	second	2,25	29,8	491
	third	1,88	29,5	400

Source: research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia

In the case of early spring sowing, the average yield of Pidpecheretska and Carolina varieties was 2.37 and 1.80 t / ha, respectively, with the highest oil content - 29.9 and 29.1% and oil yield per 1 ha - 544 and 434 kg.

The dependence of the total oil yield on the average yield of white mustard seeds describes the following equation of approximation y = 2,0336 + 224,4794 * x and explains 98% of the variation of the variable r = 0,98 (Fig. 1).

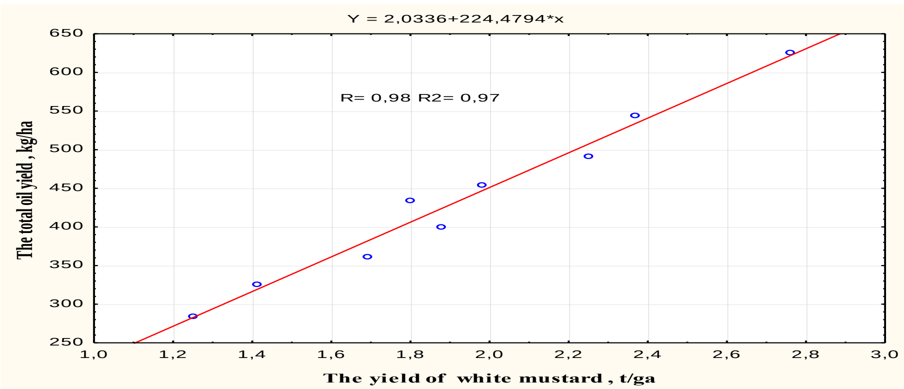

Fig. 1. The relationship between the yield of white mustard and the total oil yield in the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia (average for 2016-2018)

Source: research field of the Training and Production Center "Podillia" of State Agrarian and Engineering University in Podilia

Thus, the increase in total oil yield is largely due to increased yields of white mustard seeds.

Conclusion

In order to increase the seed productivity of white mustard among the experimental varieties (Carolina, Pidpecheretska and Podolianka) the highest productivity is provided by the variety Podolianka. It is necessary to sow the culture of this variety in the early spring (first term) period at the level of thermal regime of the soil at the depth of seed wrapping 3-4 ° C, which provides 2.76 t/ha of seeds and yield of 626 kg/ha of oil.

Bibliography

1. *Abramyk M.I., Guzinovych S.Y., Zozulia O.L., Shevchuk Ya.I.* (2011). Hirchytsia. [Mustard]. Ivano-Frankivsk: Symphony-forte. 32 p.
2. *Vyshnivsky P.S., Gubenko L.V., Remez G.G., Lepekha V.G.* (2010). Vplyv udobrennia na formuvannia produktyvnosti hirchytsi biloi. [Influence of fertilizer on the productivity formation of white mustard]. *Collection of scientific works of the National Research Center "Institute of Agriculture UAAS"*. Issue 1-2. Pp. 122-126.
3. *Yeshchenko V.O., Kopytko P.G., Kostogryz P.V., Opryshko V.P.* (2014). Osnovy naukovykh doslidzhen v ahronomii: Pidruchnyk. [Fundamentals of Scientific Research in Agronomy: Textbook]. Vinnytsia: PE «TD «Edelweiss & K»». 332 p.
4. *Kozina T.V.* (2015) Polova skhozhist nasinnia i vyzhyvannia roslyn sortiv hirchytsi biloi zalezhno vid norm vysivu v umovakh Lisostepu zakhidnoho. [Field germination of seeds and plants survival of white mustard varieties depending on sowing rates in the Western Forest-Steppe]. *Collection of scientific works of Podilsk State Agrarian and Technical University.* Kamyanets-Podilsky. Issue. 23. P. 191–198.
5. *Kozina T., Ovcharuk O., Trach I., Levytska V., Ovcharuk O., Hutsol T., Mudryk K., Jewiarz M., Wróbel M., Dziedzic K.* (2018). Spread Mustard and Prospects for Biofuels. Renewable Energy Sources. Engineering, Technology, Innovation: ICORES 2017. Pp.791-799. DOI 10.1007 / 978-3-319-72371-6_77.
6. *Oksimets O.L.* (2001). Vplyv dobryv i strokiv sivby na urozhai zelenoi masy ta

nasinnievu produktyvnist hirchytsi biloi. [Influence of fertilizers and sowing dates on green mass yield and seed productivity of white mustard]. *Collection of scientific works Institute of Agriculture UAAS.* Kyiv: Phytosocial Center. Issue 1-2. Pp. 134–136.

7. *Saiko V.O., Kaminsky V.F., Vyshnivsky P.S.* (2005). Rekomendatsii z vyroshchuvannia ripaku yaroho ta hirchytsi biloi. [Recommendations for growing spring rape and white mustard]. Kyiv: Koloobig. 34 p.
8. *Ivanyshyn V.V., Shuvar I.A., Bakhmat M.I., Sendetsky V.M. etc.* (2020). Soloma, pisliazhnyvni reshtky i syderaty – ahrotekhnolohichni elementy biolohizatsii suchasnoho zemlerobstva: monohrafiia; za zah. red. I.A. Shuvara, V.M. Sendetskoho. [Straw, post-harvest residues and greens - agrotechnological elements of biologization of modern agriculture: monograph; For the general. ed. I.A. Shuvara, V.M. Sendetsky]. Ivano-Frankivsk: Symphony forte. 292 p.
9. *Shuvar I.A., Boyko I.E., Lys N.M., Vereshchinsky R.A.* (2009). Hirchytsia bila ta yii efektyvne vykorystannia v biolohizatsii zemlerobstva. [White mustard and its effective use in the biologization of agriculture]. Lviv: LNAU. Pp. 3-12.
10. 10. *Shuvar I.A.* (2008). Ekolohichni osnovy znyzhennia zaburianenosti ahrofiotsenoziv: navchalnyi posibnyk. [Ecological bases of weediness reduction of agrophiocenoses: textbook]. Lviv: Novyi Svit-2000. 496 p.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 72-82
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Tetiana Kushniruk
State Agrarian and Engineering University in Podilia

LAND CADASTRAL ACCOUNTING OF LAND RESOURCES OF UKRAINE WITH THE USE OF GIS TECHNOLOGIES

Summary

The main problems of maintaining the State Land Cadastre in Ukraine at the present stage of development of land relations and ways to solve them are identified. The current state of the State Land Cadastre using GIS technologies is analyzed. In addition, a review of modern software and the level of application of GIS technologies in Ukraine was conducted..

Key words: State Land Cadastre, GIS-technologies, land cadastral accounting, land resources, automated system.

Introduction

Land resources are the national wealth of Ukraine, the efficient and rational use of which depends on the welfare of its citizens, the state of the environment and sustainable social development [4]. Land, as an object of land cadastre, is the basis for all human activities. In the course of reforming land relations, the question of economic use and reproduction of natural resources arises. Today, the state land cadastre plays an important role, as it contains land cadastral data on the classification of land by land and land users, quantitative and qualitative characteristics, monetary valuation and registration of land. Land cadastre, as a system of information and documents is a set of land cadastral documentation, materials and information on the legal regime of land, its distribution among landowners, land users, on the quantitative characteristics and economic value of land. The development of land relations in Ukraine began with the introduction of private ownership of land, as well as registration and guarantee of property rights [3, p. 153]. Less attention is paid to solving the main goal of land reform – the organization of rational use and protection of land.

According to the legislation, the data of the state land cadastre are intended for use in the process of regulating land relations, rational use and protection of land, determining the amount of land fees and land values as part of natural resources, control over land use and protection, economic and environmental justification of business plans and projects of land management. Therefore, the land cadastre should be maintained in such a way that the need for timeliness, accuracy and reliability of information on the current situation will be fully met. On the basis of cadastral data of all levels of government it will be possible to track existing trends in the use of the land fund of Ukraine. Automation of the state land cadastre will provide real opportunities for monitoring compliance with land legislation, will contribute to the emergence of a reliable and effective scientifically sound base of forecasting and planning [3].

Analyzing the information content of land cadastre data on the legal, economic, natural and economic condition of land, we note that the existing system is quite cumbersome, it is accompanied by a large amount of graphic and textual material on paper, requires significant time to copy from primary materials, making in electronic database and therefore does not provide cost-effective information for its operational use. In addition, the tabular material is not always sufficiently related to the cartographic representation of the territory and therefore the information about the land does not correspond to the actual situation.

Thus, a very important task of land management, economic and legal science is to develop ways to solve major problems that will accelerate the introduction of the state land cadastre as a state geographic information system.

Many well-known scientists in the field of land management dealt with the urgency of this issue, one of the brightest contributions was made by: Gnatkovych D.I., Gulko R.Y., Likhogrud M.G., Kovalishin O.F., Magazynshchykov T.P., Mykula O.Ya., Stupen M.G., Sokhnich A.Ya., Tretiak A.M. and many others. It is extremely interesting and relevant to conduct research on the system of state land cadastre and the introduction of new technologies for its maintenance. However, not all problems of maintaining the state land cadastre are solved and reflected in the scientific literature. The study used current regulations, draft regulations, official information of the State Geocadastre of Ukraine and the experience of departments and divisions of land resources of Khmelnytsky region.

The purpose of the article

The purpose of the study is a theoretical justification for land cadastral accounting with the use of GIS technologies for the organization of rational use and protection of land in modern conditions.

Subject of the study

The subject of the study is the maintenance of land cadastral accounting with the use of GIS technologies in Ukraine.

Research methods

The methodological basis of the study is the dialectical method of cognition, regulations of the state on the regulation of land relations, the transition to a market economy, the work of prominent domestic scientists on the problem. The following methods were used in the research: economic-mathematical, balance, statistical, computational, abstract-logical, graphic and others.

Results of the research

For almost 20 years, Ukraine remained almost the only country in the post-Soviet space that could not ensure the adoption of such an important act as a law that would regulate the main directions of construction and operation of the country's land cadastral system. By July 2011, the Verkhovna Rada of Ukraine had rejected and sent for revision about a dozen bills. Therefore, the Law of Ukraine No. 3613-UI “On the State Land Cadastre” adopted on July 7, 2011 became a defining milestone in the reform of land relations and pointed to the real prospects for creating a land market in Ukraine. It should be noted that given that the provisions of the new law are truly reformist in the land state accounting system, and therefore need time to be able to implement them, - parliamentarians postponed the entry into force of the law until 01.01.2013 [4].

Thus, the definition of the essence of the land cadastre will now change dramatically. In the Land Code of Ukraine until now, the State Land Cadastre was considered as “the only state system of land cadastral works, which established a procedure for recognizing or terminating the right of ownership and use of land and contained a set of information and documents on the location and legal status of these plots, their assessment, classification of lands, quantitative and qualitative characteristics, distribution among land owners and land users "[1, Article 193]. The new law recognizes the land cadastre as “the only state geographic information system of information on lands located within the state border of Ukraine, their purpose, restrictions on their use, as well as data on quantitative and qualitative characteristics of lands, their assessment, distribution of lands between owners and users [6]. The same document clarifies the interpretation of the term "geographic information system", which means an "information (automated) system that provides collection, processing, analysis, modeling and delivery of geospatial data.

The purpose of the state land cadastre is to provide the necessary information to public authorities and local governments, interested enterprises, institutions and organizations, as well as citizens to regulate land relations, rational use and protection of land, determine the amount of land fees and land values in natural resources, control over the use and protection of land, economic and environmental justification of business plans and land management projects.

When performing the duties of maintaining the state land cadastre, there are problems at the legislative, technical and organizational level, in particular: completeness of information on all land plots is not provided; the unified system of spatial coordinates and the system of identification of land plots are not applied; a unified system of land cadastral information and its reliability has not been introduced; the transitional registration system (TRS) does not work well; in some districts the interaction between the bodies of the State Land Committee and local self-government bodies has not been established.

In modern conditions, these problems can be solved only by creating an automated system of state land cadastre (SLC). However, the only program approved by the resolution of the Cabinet of Ministers of Ukraine in December 2, 1997 № 1355 "On the program of creating an automated system of state land cadastre", which provided a departure from traditional "paper technology" to automate information processes related to state land cadastre, due to insufficient budget funding did not fully ensure the implementation of its functions [2].

It should be noted that maintaining the state land cadastre is not only the registration of ownership or land use, but also a number of other areas, including: accounting for the quantity and quality of land, cadastral zoning, cadastral surveying, restoration of land boundaries and others.

The state land cadastre is in the stage period of its formation. We are talking about the introduction of a fundamentally new system of SLC, which provides an automated system for its maintenance, as well as storage, analysis and retrieval of data among a large array of information, because in Ukraine there are a large number of land plots, each of which is described by several dozen parameters.

The widespread implementation of GIS technologies in the automated systems of the State Land and Multipurpose Cadastres adequately meets today demands in the implementation of projects for the management of spatially linked information in various areas of management.

Currently, in the development of projects in the environment of geographic information systems tools are widely used that include both full-featured instrumental GIS (foreign, domestic) and programs and tools adapted by developers to solve a range of geographic information problems, including spatial management.

Systemic integration of GIS products is probably needed to implement large GIS projects. And this involves not only the supply of original products, but also the construction on their basis of working modern, production solutions for automation of organizations that create, store, process spatial information and manage it [1].

It is known that automated land cadastre systems use a fairly wide range of software and hardware tools, and especially GIS and SAPR products or packages close to their functionality, which use GIS technologies. In Ukraine there are the most widespread foreign packages among them: MGE, Geo Media, Arc View (ESRI, USA), ARC / INFO, Map info, Win Gis (Pro Gis w.h.v., Austria) and others. It is important to note that the tools for the implementation of complex projects, solving a wide range of geographic information problems for cadastral purposes in the environment of commercial GIS packages are constantly expanding and improving for both WINDOWS and UNIX platforms.

Developments of GIS projects in recent years have a clear trend of using different GIS products on personal computer platforms with a focus on connecting them to local and global information networks.

Telecommunication capabilities significantly increase the power and flexibility of developed GIS projects, combining the capabilities of hardware and software of different systems and accumulating information support by combining databases that operate on different computing platforms.

Computing platforms on which modern software GIS technologies operate are divided into large computers (Main Frame), mini-microcomputers (MC-HDR, VAX, Apollo), workstations (WS - Hewlet - Paskerd, Sun SPARC - Station) and a large family of personal computers (PC - Inter and Macintosh).

The latter are widely used in the processing of large and very large objects of textual and spatial information, including in GIS projects. This is due to the fact that the hardware market for instrumental support of information systems based on GIS technologies is expanding.

For the automated system of maintaining the state land cadastre to work and function at the proper level, the work must be performed in several areas, equal in importance, namely:

1. Software. Development of an automated system for maintaining the State Land Cadastre (AS SLC) and implementation of an information protection system;

2. Technical support. Purchase and installation of server and peripheral equipment in the center, regions and districts, establishment of communication channels and their protection;

3. Receipt, input and accumulation of data, including continuous aerial photography of the territory of Ukraine, on the basis of which the cartographic basis of the cadastre is created;

4. Personnel issues. It is necessary to train the staff who will work with this system;

5. Financial security.

The information necessary for the formation of the database of the automated system of conducting SLC is in the divisions of the State Geocadastre in the districts, so it is they who must fill it. The composition and structure of the database should meet the needs of cadastral data of various management structures and land use, planning the development of the economic mechanism of the region [3, p.95].

The Law "On the State Land Cadastre" entrusts the bodies of the State Geocadastre with tasks to ensure the creation of a single information system of the State Land Cadastre, entering information on the boundaries of administrative-territorial units, transferring records on state registration of land plots, restrictions (encumbrances) on their use, State Register of Lands. In practice, this means developed and implemented in a trial mode automated SLC system - a system with a minimum set of functionality, including. These works are carried out within the framework of the World Bank project "Issuance of state acts on land ownership in rural areas and development of the cadastre system".

The state land cadastre plays a special role in reforming land relations as an information base for effective land management, solving problems of sustainable development of regions, maintaining a system of registration, land management, support of tax and innovation policy, formation and development of land market, substantiation of land fees, determination of legal relations concerning land and other real estate. The state land cadastre at all stages of society development is the main means of implementing the land policy of the state.

There is a steady tendency in the world to combine a variety of information in inventories and use such inventories to solve a wide range of problems. Such cadastres are called multifunctional [3, p. 3], ie their information is used for the purposes of land accounting, their use, taxation, assessment, consolidation, restoration, spatial planning, environmental monitoring, etc. Accordingly, the cadastre is enriched with new indicators of objects and allows to solve a wider range of tasks. In addition, the gradual accumulation of various data within a single system, the unit of account of which is land (as the territorial basis of any activity), significantly improves the administration of these data and reduces the cost of functioning and maintenance of the system. The multifunctional cadastral and registration system creates new opportunities to increase the meaning and value of land-related data through their processing, as well as provides opportunities for their widespread use in both domestic and international markets [6, p. 12].

Carrying out a large-scale land reform in Ukraine has naturally raised the question of forming a full-fledged infrastructure for regulating land relations in our country. The functioning of a civilized land market (including agricultural land) is impossible without an appropriate institutional framework that would determine the institutional principles of land ownership and sale. The most important tasks of such a base are:

- registration of land ownership rights;
- registration of pledges and other obligations related to land ownership;
- maintaining the land cadastre;
- planning the use of land resources within the relevant legislation;
- conflict resolution;
- land mortgage [2, p. 26].

An important element of a market economy is the market for agricultural land. Its organizational and legal infrastructure is well researched, tested and installed in developed countries. Ukraine has a unique opportunity that the pioneers of the land market did not have - the opportunity to study, evaluate and choose the best experience and best practice [3].

Ukraine has chosen the path of creating a multifunctional cadastre and state register of real estate rights in the European model, combined into a single system.

The Ukrainian experience of the transition period shows that any reform that depends on the human factor is subject to additional risks. Accordingly, the creation of a land market system as a set of well-balanced institutions and an adequate and stable legal regime is an extremely important task. Such a system is the basis of a successful market for agricultural land, which, in turn, is the cornerstone of the national economy.

The real estate market and land resources have a high economic value. The realization of this value is carried out by attracting land to market circulation, primarily in the form of collateral for loans and borrowings. The involvement of land in circulation requires the formalization of land ownership, ie the provision of existing in society relations of ownership, use and disposal of land in a form that allows the sale, lease and pledge of land with the least risk.

Issues of correction of already assigned cadastral numbers of land plots, in respect of which duplication has been revealed, remain unresolved in the normative base; cadastral numbering when changing the boundaries of administrative-territorial entities, when forming land plots of linear objects, when allocating parts of land plots for concluding civil law agreements (easement agreement, lease), etc.

A significant problem in the formation of cadastral zones and quarters is the unregulated system of administrative-territorial organization of Ukraine and, above all, the uncertainty of the boundaries of administrative-territorial entities. The only special normative act in this area so far is the Regulation on the procedure for resolving issues of administrative-territorial organization of the Ukrainian SSR, approved by the Decree of the Presidium of the Verkhovna Rada of the Ukrainian SSR of 12.03.1981 р. № 1654-X.

From January 1, 2017, all data of the State Land Cadastre, except for classified information and personal data of landowners and land users, are subject to publication online on the official website of the State Geocadastre. Therefore, by the beginning of 2022 it is necessary to complete the first stage of filling the cadastre - the transfer of all available information and digitized paper archives.

In order for the cadastre to work, it is necessary to create not only a single database, but also a cartographic basis for obtaining up-to-date planning and cartographic information.

Conclusions

Thus, the priority ways to solve the problems of land cadastral accounting in Ukraine should be considered:

1. Introduction of a fundamentally new system of the State Land Cadastre, which provides for an automated system of its maintenance;
2. Ensuring the maintenance of the Land Book and the Book of records on state registration of state acts on land ownership and the right of permanent use of land, land lease agreements, as well as administration of the automated system of state land cadastre by the state represented by territorial bodies of specially authorized executive body on land resources;
3. Bringing in line with the legislation, as well as internal coordination of departmental regulations on the maintenance of state land cadastre and topographic, geodetic and cartographic works;
4. Training of state cadastral registrars and specialists who will service the automated system. These are mainly employees of territorial bodies of the State Geocadastre and the Center of the State Land Cadastre;
5. Sufficient budget funding.

The ways described above must be implemented before the entry into force of the delayed implementation of the Law of Ukraine "On State Land Cadastre" (until 01.01.2022).

Of course, the fact of adopting a "cadastral" law is the beginning of a new period of land reform in Ukraine: automation of land cadastral information, minimization of errors in land documentation, recognition of official and public status of cadastral information, improvement of management decisions based on effective and up-to-date land information, protection of legal land ownership rights, creation of principles of public control over land use, simplification of the state registration procedure - this is not the whole list of benefits we expect from the implementation of this document. However, analyzing the Law of Ukraine "On the State Land Cadastre" it should be noted that along with the undeniable advantages of its adoption and implementation, there are some concerns and shortcomings. Thus, in particular, that ensuring the creation of a quality state geographic information system requires sufficient time for this, because only in December 2019 (six months after signing) it became clear - if you do not postpone the entry into force of the law for a year, the law will remain another normative non-enforceable legal document. Some provisions of the law have a "framework" nature, ie - contain references to not yet developed standards, regulations, procedures, and so on. The gradual introduction of information and cartographic support of the cadastre in electronic form will ensure its transition to a qualitatively new level, which will increase the efficiency of land management.

In general, the automation of the SLC management system will ensure the formation of a data set of all components of the state land cadastre, starting from information on the legal regime of land and ending with indicators of assessment and payment for land..

Bibliography

1. Zemelnyi kodeks Ukrainy: stanom na 20.03. 2018. [Land Code of Ukraine: as of March 20]. URL: http://zakon 3.Rada.gov.ua/laws/show/2768-14.
2. 2. Bazova osnova zemelnoho kadastru. Elektronnyi resurs:(http://kadastrua.ru/). [Basic basis of land cadastre]. Electronic resource: (http://kadastrua.ru/).

3. 3.Volodiy M.O. 2000. «Osnovy zemelnoho kadastru» Navchalnyi posibnyk. ["Fundamentals of land cadastre" A Textbook]. Kyiv. 360 p.
4. 4. Martin A.G. 2008. Suchasna klasyfikatsiia zemelnykh dilianok za tsilovym pryznachenniam. Zemleustrii i kadastr. [Modern classification of land plots by purpose. Land management and cadastre]. Kyiv. 150 p.
5. 5.Pankiv Z.P. 2008. Zemelni resursy: Navchalnyi posibnyk. Vydavnychyi tsentr LNU imeni Ivana Franka. [Land Resources: A Textbook. Ivan Franko Lviv National University Publishing Center]. 272 p.
6. 6. Tretiak A.M. 2002. Derzhavnyi zemelnyi kadastr: problemy ta perspektyvy. Zemlevporiadkuvannia. [State Land Cadastre: problems and prospects. Land management]. № 3. P. 26.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 83-93
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Veronika Khomina
State Agrarian and Engineering University in Podilia

YIELDS OF MILK THISTLE DEPENDING ON AGRONOMIC MEASURES

Summary

The purpose of research is to establish the dependence of the yield of milk thistle seeds on the placement of plants per unit area.

Sowing was carried out in early spring by continuous row (15 cm) and wide-row (30, 45 and 60 cm) methods with a distance between plants in a row of 15, 20, 25, 30 cm. The area of the accounting area is 25 m2. Repetition is four times. Agricultural techniques on experiments are common for the area. The research was performed with the Boykivchanka variety.

Results. The influence of row spacing and distances between plants in a row on the growth, development and formation of milk thistle plants productivity in the conditions of the Western Forest-Steppe of Ukraine has been established.

Conclusions. Studies have shown that more influential on the structure of plants was factor A – the width of the rows. The difference between the variants of continuous row and wide-row sowing methods was the most significant, the number of seeds per plant with a row spacing of 15 cm was lower by 104.1–423.3 pieces, and the weight of seeds was 2.0–8.5 grams per plant. The difference in the number of seeds from the plant between the variants with a distance between plants in the row 15-20 and 25-30 cm was 35.3-23.6 pieces in the continuous row method of sowing, and the weight of seeds from the plant – 0.7-0.5 g. In the case of wide-row sowing methods from a distance of 15–10 and 25–30 cm between plants, the difference between the variants in terms of the number of seeds was 282.7–361.5 pieces, and in terms of seed weight 0.7–7.3 grams. The best biometric indicators were characterized by variants of wide-row sowing methods at a distance

between plants in the row of 25 and 30 cm..

Key words: thistle, yields, biometric indicators.

Introduction

Milk thistle (Silybum marianum L.) is one of the most popular medicinal plants today. Pharmacologists have experimentally proven that in the treatment of diseases in the raw materials from milk thistle silymarin works most effectively. It contains silibinin, silidianin, silicristin and other flavolignans [1]. According to the biochemical classification, they are included in a number of flavonoids known as "vitamin P". These biologically active substances help to strengthen the walls of blood vessels, participate in redox processes, have anti-inflammatory, antiulcer, antioxidant and other beneficial properties. Their effect is enhanced by the presence of vitamin C (ascorbic acid) in the body [2]. Thistle has long been considered a powerful remedy for various liver diseases: cirrhosis, jaundice, liver damage, alcohol, drugs, toxins, radiation. Today it is used for cholecystitis, inflammation of the bile ducts and gallstones, diseases of the spleen, thyroid gland, as well as salt deposition, varicose veins, edema, dropsy, obesity, radiculitis, joint pain, hemorrhoids and allergic diseases. This multi-purpose use of milk thistle prompted us to study the technology of its cultivation in the Western Forest-Steppe.

There are various statements about the methods of sowing and sowing rates of milk thistle. Of course, this depends on many factors: soil and climatic conditions, sown area, fertilizer system, etc.

In terms of a continuous method of sowing, scientists T.P. Kohan, N.P. Kupenko (2010) consider that a fairly dense herbage is formed. It is formed 3-5 inflorescences of the top tier on each plant on the average (from shoots of the I and II orders). This ensures more or less simultaneous seed maturation and makes it possible to prevent significant seed losses due to rashes from baskets [3, 4].

However, recently many people have become interested in the healing properties of this plant and began to grow it in backyards and gardens for their own use, allocating small areas for it. Under such conditions, manual labor predominates. By the way, almost all the organs of milk thistle (except the roots and seeds) are covered with thorns, which creates certain problems during the care of plants and harvesting. Therefore, free access to each plant is required. They should be grown in sparse crops. Accordingly, the plants are quite intensively branched, flowering and seed maturation continue until the end of the growing season. Milk thistle has been grown on the territory of the Doslidnyk horticultural society of the Poltava Institute of Agricultural Production in the area of the Yakivtsi housing estate (Poltava) since 2003. Over time, we came to the following conclusion: it is best to grow no more than 4-6 plants per 1 m2 with a row spacing of 1 m. On one running meter, it is advisable to leave 6-7 plants in the center row at a distance of 14-16 cm from each other 2.5-3 plants (after 35-40 cm) [5].

Studies conducted in the Western Forest-Steppe have established the advantage of a wide-row method of sowing milk thistle, in which the seed yield increases due to the formation of more shoots and baskets, respectively [6, 7].

Purpose, subject and research methods

The purpose of research is to establish the feasibility of growing milk thistle in the Western Forest-Steppe of Ukraine, to determine the influence of row spacing and distance between plants in a row on the growth, development, productivity and yield of milk thistle seeds.

The research was performed in the production conditions of Obolon Agro LLC, Khmelnytsky region, Chemerivtsi district.

Sowing was carried out in early spring (second decade of April) by continuous row (15 cm) and wide-row (30, 45 and 60 cm) methods (factor A), with a distance between plants in a row of 15, 20, 25, 30 cm (factor B). The area of the accounting area is 25 m2. Repetition is four times. Agricultural techniques on experiments are common for the area. The studies were performed with the Boykivchanka variety.

Among the special methods we used: laboratory, vegetation-field, field. Each of them can be used in conjunction with other special and general scientific methods. Among the special methods also used the methods of mathematical statistics. Biometric parameters were determined by test beams, which were selected from two running meters in two non-contiguous repetitions in different parts of the site. Plants were selected before harvest, and the sheaf was analyzed according to the following indicators: plant height, number of leaves, number of baskets, basket diameter, number of seeds in the basket, weight of seeds from the plant. Systematic observations and accounting for the growth and development of experimental plants were carried out according to generally accepted methods [8-10].

Results of the research

Biometric analysis of test sheaves of milk thistle showed that over the years the least tall plants 92.7–99.4 cm were formed by a continuous row method of sowing at a plant density of 7–10 pieces per running meter (Table 1).

Table 1. Biometric indicators of milk thistle plants depending on the location of plants per unit area (average for 2014-2018).

Row spacing, cm (A)	Distance between plants in a row, cm (B)	Indicators					
		Plant height, cm	Number of leaves per plant	Number of baskets per plant, pcs	Number of seeds in the basket, pcs	Number of seeds from the plant, pcs	Weight of seeds from the plant, g
15	15	92.7	10.3	2.5	52.1	130.2	2.6
	20	99.4	11.5	2.8	53.2	148.9	2.9
	25	112.8	12.8	2.9	57.1	165.5	3.3
	30	116.4	12.9	3.0	57.5	172.5	3.4
30	15	100.1	15.3	4.2	55.8	234.3	4.6
	20	103.2	15.7	4.6	58.2	267.7	5.3
	25	129.5	18.3	8.3	62.3	517.0	10.3
	30	131.7	19.0	8.6	62.5	537.5	10.7
45	15	102.5	15.4	5.1	57.0	290.7	5.8
	20	106.8	15.7	5.3	57.3	303.6	6.0
	25	132.1	19.1	8.8	62.5	550.0	11.0

	30	133.9	19.5	8.9	63.0	560.7	11.2
60	15	107.1	16.2	5.0	59.0	295.0	5.9
	20	108.5	16.3	5.4	58.5	315.9	6.3
	25	133.7	19.9	8.9	64.4	573.1	11.4
	30	135.9	19.8	9.0	66.2	595.8	11.9

With wide-row sowing with a row spacing of 30–60 cm and a decrease in the density of plants per running meter from 9–10 to 3–4 pieces, there was a tendency to increase the height of plants from 100.1 to 135.9 cm, respectively.

Larger plants formed more leaves. Thus, in the variants with a row spacing of 15 cm and the number of plants per running meter 7-10 pieces, the figure was 10.3-11.5 pieces, and with the number of plants per running meter 3-6 pieces - the number of leaves was 12.8-12, 9 pieces. Similarly, in wide-row crops, at a lower density, there was a larger number of leaves, namely in the range of 18.3–19.9 pieces, and at a higher density, less leaves were formed than 15.3–16.3 pieces.

Since the main medicinal raw material of milk thistle is the seeds, the productivity of plants largely depends on the number of baskets and the number of seeds formed in them. As a rule, at the thickest crops, ie at a width of 15 cm between rows and the number of plants per running meter 9–10 and 7–8 pieces, 2.5 and 2.8 baskets were formed on the plants, respectively, were tied in one basket, 52.1–53.2 pieces of seeds.

With a continuous method of sowing at 15 cm and the number of plants 3–6 pieces per running meter baskets were slightly more, namely - 2.9–3.0 pieces per plant. On wide-row crops with a number of plants of 7–10 pieces per one meter, the baskets per plant were in the range of 4.2–5.4, and at a density of 3–6 plants - 8.3–9.0 pieces.

The largest number of seeds was observed on wide-row crops with the number of plants per running meter 3-6 pieces, namely in the range of 62.3-66.2 pieces. Therefore, it can be assumed that with a larger area of plant nutrition, more seed-filled baskets are formed.

The decisive indicator of the structure of plants, which affects individual productivity, is the number of seeds per plant and the weight of this seeds in grams. These indicators should be considered indicators of crop structure. Thus, the largest number of seeds of 595.8 pieces was observed with the smallest number of plants per unit area, ie with a row spacing of 60 cm and the number of plants per running meter 3-4 pieces. In the same case, respectively, and the largest weight of seeds, namely 11.9 grams per plant. The smallest seeds from the plant were obtained at continuous sowing, the indicator was in the range of 130.2–172.5 pieces (depending on the influence of factor B).

Regarding the number of seeds per plant on wide-row crops, the following tendency was observed: with the number of plants per running meter 7-10 pieces, the figure was much smaller compared to the number of plants 3-6 pieces per running meter, respectively 234.3-315.9 and 517, 0–595.8 pieces.

A similar tendency was observed with the indicator of seed weight per plant, ie when sowing with a row spacing of 15 cm with a smaller number of plants per running meter, the indicator increased and was in the range of 2.6–3.4 grams. With wide-row sowing at 30, 45 and 60 cm, the difference between the variants for the influence of factor A was insignificant, and for factor B on the variants with the number of plants per running meter 3-6 pieces, the figure exceeded the variants with higher crop density, ie 7-10 pieces, almost twice, respectively: 10.3–11.9 versus 3.4–6.3 grams per plant.

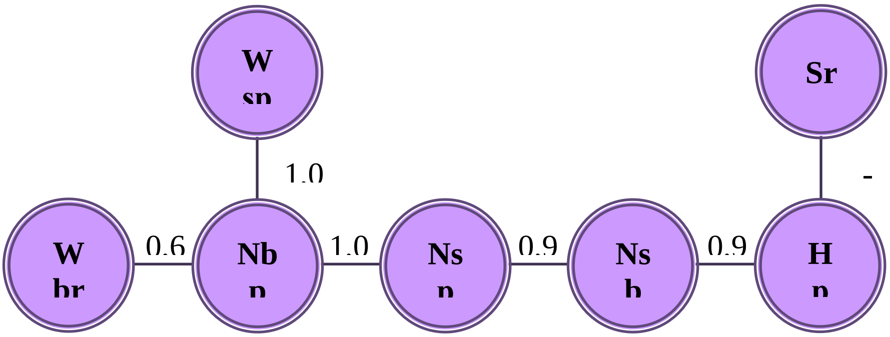

Fig. 1. Correlation pleiad of the communication system of milk thistle

Contents of variants: Wbr - width between rows, Wsp - weight of seeds from a plant, Nbp - number of baskets per plant, Nsp - number of seeds from the plant, Nsb - number of seeds in the basket, Hp - height of a plant, Sr - sowing rate (number of plants on meter running).

Figure 1 correlates the relationships between the biometrics of milk thistle plants and the studied factors. The average correlations in the range of r = 0.61–0.62 were observed between the width between rows and biometric indicators: the number of baskets per plant, the number of seeds in the basket, the number of seeds per plant, the weight of seeds per plant. Between the number of plants per running meter (seeding rate) and indicators: the number of baskets per plant, the number of seeds in the basket, the number of seeds per plant and the weight of seeds per plant also noted the average correlation (correlation coefficient r = 0.59-0,69), and between the seeding rate and plant height - high (correlation coefficient r = 0.84). Structural indicators had a strong dependence, which was expressed in the form of strong correlations, the correlation coefficient was in the range of r = 0.94-1.00.

The main criterion for evaluating all agronomic measures is the yield, which combines two main elements: plant productivity and the number of plants per unit area. It is the second element that has become a decisive factor in our research.

The largest number of plants per 1 ha was in the continuous row method of sowing, it ranged from 219997 pcs - at a distance of 30 cm in a row to 439995 pcs - at a distance of 15 cm, but the number of seeds per plant at this location was in the range of 252.8-330,8 pcs. from a plant that weighs about 10-13 g (table 2).

Studies have shown that the best was a wide-row method of sowing with a row spacing of 30 cm and a distance between plants in a row of 20 cm, the yield in this case was 11.6 c/ha, which exceeded the control by 3.6 c/ha.

Table 2. Yields of milk thistle depending on the location of plants per unit area (average for 2014-2018), c/ha

Row spacing, cm	Distance between plants in a row, cm	In fact	± before control
15	15	6.41	-1.58
	20	5.62	-2.37
	25	5.29	-2.70
	30	4.91	-3,08
30	15	11.0	+3.01
	20	11.6	+3.61

	25	8.39	+0.4
	30	6.60	-1.39
45	15	8.13	+0.14
	20 (control)	7.99	-
	25	6.26	-1.73
	30	5.43	-2.56
60	15	7.05	-0.94
	20	7.00	-0.99
	25	5.20	-2.79
	30	4.60	-3.39
LSD_{05}	A – 0.54; B – 0.54; AB – 1.09		

It should be noted that the control variant was also one of the best, of all the variants, only four variants exceeded the control by yield.

The obtained data show that the biometric parameters of plants are almost similar both at a row spacing of 30 cm and at 45 and 60 cm, so due to the number of plants per unit area at a row spacing of 30 cm, higher seed yield was obtained.

The advantage of sowing with a row spacing of 30 cm is that the rows of plants close and the rosette leaves completely cover the soil surface, the so-called "carpet" is formed, which dampens weeds in the initial periods of their development. Milk thistle plants when sown with a row spacing of 30 cm and a distance between plants in a row of 20 cm become an excellent means of combating unwanted vegetation. With a row spacing of 45 and 60 cm, the leaf surface area does not allow to completely cover the row spacing, so the gaps are littered with weeds that compete with crops, taking away moisture, nutrients and becoming a reservoir for pests and diseases.

The system of protective measures primarily involves compliance with agronomic measures aimed at prevention. These include: choosing a predecessor, timely weed control. Such a preventive measure as the removal of plant remains from plantations deserves attention.

Regarding pests, it should be noted that during the years of research we had to control flower pests only once. The control was carried out by spraying vegetative crops with the agent Aktellik 500 EC, k.e. (500 g/l pyrimiphosmethyl), which belongs to the III class of toxicity (low toxicity) and it is the only one included in the list of approved in Ukraine insecticide for use on medicinal plants.

Conclusions

From the above we should summarize the following: factor A- the width of the rows was more influential on the structure of plants. The difference between the variants of continuous row and wide-row sowing methods was the most significant, the number of seeds per plant with a row spacing of 15 cm was lower by 104.1–423.3 pieces, and the weight of seeds was 2.0–8.5 grams per plant. The difference in the number of seeds from the plant between the variants with a distance between plants in the row 15-20 and 25-30 cm was 35.3-23.6 pieces in the continuous row method of sowing, and the weight of seeds from the plant - 0.7-0.5 g. In the case of wide-row sowing methods from a distance of 15–10 and 25–30 cm between plants, the difference between the variants in terms of seeds number was 282.7–361.5 pieces, and in terms of seed weight 0.7–7.3 grams. The best biometric indicators were characterized by variants of wide-row sowing methods at a distance between plants in the row of 25 and 30 cm.

The expediency of growing milk thistle in the conditions of the Western Forest-Steppe of Ukraine, which is able to form the yield of medicinal raw materials (seeds) in the range of 4.6-11.6 c/ha of appropriate quality, is proved.

Studies have shown that sowing of the crop is desirable with a row spacing of 30 cm and a distance between plants in a row of 20 cm, the yield in this case was 11.6 c/ha.

Bibliography

1. *Kislichenko V.S., Pospelov S.V., Samorodov V.N.* and others (2010). Milk thistle - from introduction to use [Rastoropsha pyatnistaya – ot introduktsii k ispolzovaniyu]: monograph. Poltava.

2. *Bakhmat M.I.., Kvaschuk O.V., Khomina V.Y., Komarnitsky M.V.* (2011). Medicinal plant growing [Likarske roslynnytstvo] / Textbook. Kamyanets-Podilsky: PE "Medobory-2006", 256 p.
3. *Glukhova L.V.* (2008). Ecologically safe technology of milk thistle cultivation in the Forest-steppe of the Middle Volga region. [Ekologicheski bezopasnaya tekhnologiya vozdelyvaniya rastoropshi pyatnistoy v Lesostepi Srednego Povolzhia] Dissertation abstract Cand. agricultural Sciences: 06.01.09 - crop production / Penza State Agricultural Academy - Penza.
4. *Kokhan T.P., Kupenko N.P.* (2010). Growth and development of Silybum marianum L. at introduction. [Rost i razvitiye Silybum marianum L. Pri introduktsii] Industrial botany. issue 10.
5. *Vorontsov V.T., Opara M.M.* (2010). Experience in growing milk thistle in small areas and use for health purposes. [Dosvid vyroshchuvannia roztoropshi pliamystoi na nevelykykh diliankakh ta vykorystannia z metoiu ozdorovlennia] Bulletin of the Poltava State Agrarian Academy. №2.
6. *Khomina V.Y., Tarasyuk V.A.* (2015). Formation of crops of milk thistle depending on vegetation factors and agronomic factors. [Formuvannia posiviv roztoropshi pliamystoi zalezhno vid faktoriv vehetatsii ta ahrotekhnichnykh chynnykiv] Research and production journal "Machinery and technologies of agro-industrial complex". Bila Tserkva,. №2 (65). P.35–37.
7. *Khomina V.Y.., Tarasyuk V.A.* (2015). Yields of milk thistle depending on technological measures in the conditions of the Western Forest-Steppe. [Urozhainist roztoropshi pliamystoi zalezhno vid tekhnolohichnykh zakhodiv v umovakh Lisostepu Zakhidnoho] Collection of scientific works of NSC "Institute of Agriculture of NAAS" P.123-131.
8. *Yeshchenko V.O.., Kopytko P.G.., Kostogryz P.V., Opryshko V.P.* (2014). Fundamentals of scientific research in agronomy [Osnovy naukovykh doslidzhen v ahronomii]: Textbook. Vinnytsia: PE "TD" Edelweiss and K ". 332 p.
9. *Dospekhov B.A.* (1985). Methods of field experience (with the basics of statistical processing of research results) [Metodika polevogo opyta (s osnovami statisticheskoy obrabotki rezultatov issledovaniy)]. Moscow. Agropromizdat. 351 p.
10. *Ermantraut E.R., Prysyazhnyuk O.I., Shevchenko I.L.* (2007). Statistical analysis of

agronomic research data in the package Statistica 6.0. [Statystychnyi analiz ahronomichnykh doslidnykh danykh v paketi Statistica 6.0.] Kyiv: Ukrainian Academy of Agrarian Sciences. 55 p.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 94-99
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Nina Korevo
Zhytomyr Ivan Franko State University

FORMATION OF STUDENTS' PROFESSIONAL COMPETENCIES AND SOFT-SKILLS DURING THE STUDY OF PHYTOPATHOLOGY

Summary

A competent specialist must perceive and implement a complex system of acquired knowledge and have the professional thought skills. An important place for the formation of professional competence of the third-year students in the study of phytopathology is given to solving situational problems.

The peculiarity of modern education is that it must comply the demands of society, contribute to the comprehensive development of the individual for his or her successful future. The constant growth of the amount of information that needs to be understood and used in practice contributes to the development of the individual abilities, thinking, satisfaction of cognitive needs and requirements. Ideas, theories, technologies are constantly changing and becoming obsolete. Thus, the amount of knowledge that students receive needs constant updating and readiness for future changes throughout life. The modern education system requires a shift of emphasis from the content of education to the result.

Key words: competence, professionalism, phytopathology, pathogen, physiological condition.

Introduction

Nature has endowed us with plenty of herbs and plants that are a source of health and longevity. It's hard to imagine the modern world without bright floral landscapes and colorful flowers, modern parks, forests and recreation areas. The plants that surround humanity impress with their brightness and colours, the fruits consumed by mankind are a source of vitamins and micro- and macronutrients, provide support for nutrients in the body. In order for plants to be healthy and retain all the nutrients, it is necessary to ensure their normal physiological condition, but this is not easy to achieve due to the large number of diseases and pests that affect plant organisms [2].

Pesults of the researcch

Thus, to ensure the growth of healthy plants and harmony in nature, the third-year higher education applicants of Zhytomyr Ivan Franko State University study the scientific discipline «Phytopathology». 90 hours (3 ECTS credits) are allocated for its study. The main purpose of its study is to provide bachelors with the necessary amount of theoretical knowledge, practical skills and abilities concerning pathogenic processes in plants, their causes and the development of disease control measures by affecting the plant, pathogen and environmental conditions. Students gain theoretical and practical knowledge about pathogenic processes in agricultural, forest crops, flower and ornamental plants, using the relationship «pathogen plant – environment». An important point of studying the scientific discipline «Phytopathology» is the combination of different forms of educational work: lectures, laboratory classes, individual work and educational practice.

The study of disease development in specific conditions allows to obtain profound knowledge of biology of the plant pathogens and environmental factors that promote or prevent the development of pathogens.

The object of study of the modern discipline «Phytopathology» is a diseased plant, which is characterized by the pathological process and is related with the pathogen and the environment, and a healthy plant. This object is especially important for the implementation of preventive measures, as the main task of phytopathology.

Students should be guided by the peculiarities of the detection of various diseases when they master the methods of accounting for the prevalence and intensity of disease. The diseased plant has certain morphological, biochemical and physiological characteristics, which are different from the healthy plant, depending on the activity of the pathological process and other factors. The development of symptoms caused by the pathogen depends on its systematic position, development cycle, physiological and biochemical condition of the plant.

A competent specialist must be able to perceive and implement a complex system of acquired knowledge and have the skills of professional thinking. Modern society views the specialist not only as a person with knowledge, skills and abilities in the professional sphere, but also as a person able to act effectively in complex, unusual situations, make decisions independently, develop creatively and self-improve, be tolerant of others, be able to communicate with people. These and other professionally important and personal qualities determine the professional competence of a specialist. The future competent specialist must be able to perceive and implement a complex system of acquired knowledge, as well as have the skills of professional thinking. The ability to solve competently and set the main types of professional tasks must also be formed in the course of study at a higher education institution [4].

Professional competence is the ability to use the acquired knowledge, skills and ability to solve the problem, active search for new experience and determination of its independent value, the availability of skills and abilities of independence in planning, organizing, control of personal activities. Competence is understood as mastering along with knowledge, skills and abilities. This is also the ability to behave as effectively as possible in professional situations, which can not always be predicted theoretically. Competence is a systemic concept that has its own structure, equal functions, unique characteristics and properties [6].

Competence is an integrated system of skills, abilities and values which are necessary for the professional and social activities and personal development of graduates and which they are obliged to master and demonstrate after completing part or all of the curriculum.

The higher education applicants have to master the necessary theoretical information, be able to apply it in practice, bring their knowledge and skills to automatism.

Professional competencies of future biology specialists are divided into the following groups:

1. Ability to implement an individual educational research program.
2. Ability to innovative scientific creativity.

3. Ability to obtain competitive scientific and practical results.
4. Ability to communicate in state and foreign languages both orally and in writing.
5. Development and implementation of state science-intensive targeted programs for plant protection and quarantine.
6. The use of psychological and communication technologies.
7. Carrying out of joint scientific researches, experimental and innovative development in scientific establishments and introduction of scientific results in different farm properties.
8. Conducting high-quality scientific research, processing, analysis and integration of acquired scientific knowledge.
9. Implementation of the ideas of scientific and pedagogical and innovative activities.
10. Application of scientifically based skills and scientific experience for personal highly professional development and self-improvement.
11. Ability to self-organize and develop scientific potential.
12. International scientific and innovative investment activities.
13. The use of theoretical knowledge and practical experience for career growth, management and teaching.
14. Implementation of safe research and production activities in accordance with the legislative and regulatory framework.
15. Monitoring for environmental protection.

A very important point is the combination of different forms of educational work.

The formation of professional and soft-skils competencies during practical classes and internships is especially effective. The higher education applicants master the skills and methods of identifying different types of plant diseases by external signs, independently determine the types of diseases, identify their pathogens, predict the emergence and spread of diseases, motivate measures to limit their development [4].

During the training practice, the higher education applicants must perform a number of tasks independently:
1. Conduct field surveys and identify signs of disease in different crops.
2. Master the methods of accounting for the prevalence and intensity of diseases of different cultures.
3. Organize measures to protect crops from disease directly in the production environment.
4. Prepare the herbarium of affected plants of at least 100 samples of 2-3 plants affected

by the same disease.

Herbarium collection is the most important stage in the study of phytopathology. Herbarium is carried out according to the «Guidelines for the collection and installation of botanical herbarium». The student mastering the methods of accounting for diseases of agricultural plants should know that the most important elements of accounting are the prevalence (number of affected plants) and intensity (degree of development) [3].

Plant damage is the number of diseased plants (organs), expressed as a percentage. The intensity or degree of development of the disease is a qualitative indicator of the disease. It is determined by the area of the affected surface of plant organs covered with spots, pustules, necrosis, etc.

Students mastering the methods of accounting for the prevalence and intensity of disease should be guided by the peculiarities of the detection of various diseases.

There are diseases whose pathogens affect only certain plants or their organs. These are different types of smut, potato cancer, cruciferous disease caused by the fungus Plasmodiophora brassicae. To study these diseases, their prevalence in the field is recorded. Two persons take part in carrying out the accounting. One conducts a review and evaluation, the other records dictated data. Assessment of all plant varieties for disease is carried out as soon as possible [5].

Another group of diseases is characterized by the formation of spots, plaques, pustules on various organs. These are peronosporosis, rust, spots, late blight. The degree of plant damage is determined by the area of the affected surface or organs covered with spots, plaques, pustules. Specially designed scales are used to do this. The area of the damage is accounted visually on individual vegetative organs (stems, leaves, fruits).

The results are recorded in special cards of damage (forms), developed for different types of crops and perennials. On the basis of the conducted inspections measures of protection of plants against diseases are planned.

Conclusions

Therefore, the formation of professional competencies is the knowledge that students acquire during their studies and the ability to apply them in practice. However, a good specialist must also have soft skills for career growth, be creative, stress-resistant, sociable, quickly adapt to new conditions, be able to think logically, solve difficult life situations. During the study of phytopathology the higher education applicants develop all these qualities. Prospects in the formation of professional competencies of the higher education applicants is that they focus on continuous self-development and promotion to the top of professional, spiritual and moral development of the individual. Students learn proficiently to use the acquired knowledge, skills and abilities, to think critically and independently, to look for ways to solve problems.

References

1. Andrushchenko, V.P. (2010). The main characteristics of European higher education and the possibility of its implementation in the education system of Ukraine. *Vyshcha osvita Ukrayiny*, 4, 5–16 [in Ukrainian].
2. Dybkova, L.M. (2010). Learning success in the context of the competency approach. *Informatsiyni tehnologiyi i zasoby navchannya,* 1 (15). Retrieved from: http://www.ime.edu-ua.net/em.html [in Ukrainian]
3. Holovan, M.S. (2008). Competency and competence: experience of theory, theory of experience. *Vyshcha osvita Ukrayiny*, 3, 23–30 [in Ukrainian].
4. *Phytopathology: curriculum for students of the first (bachelor's) level of higher education at the Faculty of Natural Sciences of Zhytomyr Ivan Franko State University*. (2020). Zhytomyr, Kyiv [in Ukrainian].
5. Savchenko, O.P. (2010). Competence approach in modern higher education. *Pedahohichna nauka: istoriya, teoriya, praktyka, tendentsiyi rozvytku,* e-journal, 3 [in Ukrainian].
6. Yesina, O.H. *Criteria for assessing the quality of training of modern specialists.* Ukraine, Odessa, Odessa National Economic University, 84–90. Retrieved from: olesas@ukr.net [in Ukrainian]

ZESZYTY NAUKOWE WSA w Łomży 84, s. 100-109
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Olha Koruniak
State Agrarian and Engineering University in Podillia

APPLICATION OF COACHING AS INNOVATIVE TEACHING TECHNOLOGY IN PREPARING FUTURE AGRARIANS

Summary

The article discusses coaching as an innovative educational practice and technology in the process of developing research competence in future farmers. A thorough analysis of scientific literature has been carried out to determine the essence of the concept of "coaching", which scientists consider as an art, a style of government, a means of supporting personality development, educational technology, the technology of scientific and methodological support, and the like. The basic principles on which the coaching technology is based are given. The efficiency of coaching used in the process of training future farmers is substantiated.

The educational potential of coaching as a promising educational technology in the process of training higher education is determined.
Key words: coaching, coaching technologies, educational coaching, research competence, future agrarians.

Introduction

Modern society dictates to the system of higher professional education a request for the formation of a successful and competitive specialist in the conditions of the financial and economic crisis, including specialists in the agro-industrial complex who can work in market conditions of management and ensure not only economically efficient production in agriculture, but in the general restoration of rural areas, infrastructure, which will contribute to the development of the Ukrainian countryside. In this regard, there is a need to define conceptual approaches to the professional development of students-agronomists and the search for effective learning technologies that will contribute to the formation of professional competencies in future professionals.

It is well known that the quality of modernization of modern higher education largely depends on the nature of innovation processes and is determined by the characteristics of such innovation, the innovative potential of the environment, and the teaching staff. The teacher is obliged to find, master, and adapt new knowledge in order to teach it to his students. In turn, students should take this knowledge actively, otherwise, they will not develop skills of self-education, which today are not the only sustainable personal competitive advantage. The educational activity of a modern teacher should be nothing more than coaching.

With the help of this technology, such conditions are created for the development and formation of a person's personality, which will be able to realize its capabilities, independently make decisions in various life situations.

Coaching means mentoring, inspiring, training. The task of a coach-coach is to help a person develop and be ready for change.

The purpose of the article

The purpose of the study is to reveal the concept of coaching, to outline the need for a methodological basis for a modern teacher, to show the feasibility of using such technology in the educational process of agricultural universities.

The subject of the study

The subject of the research is theoretical and applied aspects of training and development of students of agrarians based on coaching.

Research methods

The theoretical and methodological basis of the study is the dialectical method of scientific knowledge and general scientific principles and provisions of educational and professional training of agricultural students. A number of general scientific and special research methods were used in the work: system analysis - to reveal the essence of the basic categories, analysis, and synthesis - to reveal the existing coaching system; methods of network planning and methods of operations research in the development of a system of key competencies of a teacher-coach.

Results of the research

It is well known that very few domestic researchers deal with the problem of coaching nowadays. Coaching as a factor in revealing the potential of the individual in various fields of activity has been studied mainly by foreign scholars, in particular, such as M. Atkinson, W. Galvey, K. Griffiths, M. Downey, E. Parslow, J. Rogers, J. Whitmore, and others. Scientists have considered coaching technology as an effective factor in unlocking the potential of the individual in various fields.

In Ukraine, the key researcher in the field of coaching is V. Malichevskyi, who mainly studies the difficulties of introducing coaching in the management system of organizations. Research of coaching technology in vocational education was carried out by T. Borova, O. Borodienko, N. Horuk, S. Romanova.

Coaching is a process of partnership that stimulates the work of students, reveals their potential.

In practice, coaching is a dialogue in which the teacher (coach) helps the student to clarify, clarify and form their life, professional goals, and objectives, focus on their own development, search for internal and external resources, seek and find alternatives, make plans, to check them for reality, to take responsibility for their implementation.

The phenomenon of "coaching" in higher education is a fundamentally new direction in pedagogical science and practice, which is based on the formulation and the fastest possible achievement of the goal by mobilizing internal potential, mastering the leading strategies for obtaining results, developing and improving the necessary abilities and skills. A coach is a coach capable of making a champion out of a person, that is, it is about bringing up winners (winner-making).

Coaching creates the conditions for the formation of the subject of activity, capable of realizing their potential, independent decision-making in various situations of life choice.

There is no unambiguous interpretation of coaching, although each of the coaching schools has its own vision of the essence of this category. (Table1).

Table 1. Basic definitions of coaching [compiled by the author based on 1, 2, 3, 4, 5, 6]

Author	**Definition**
International Coaching Academy [1]	the type of counseling and method that helps to clearly define your goals and objectives to focus on achieving them and get the best results in the shortest possible time, with maximum efficiency and less effort.
W. Galvey [2]	the art of creating, through appropriate behavior, an environment that ensures a person's movement towards a specific goal, so that it brings pleasure
J. Whitmore [3]	a new style of human resource management, the technologies of which contribute to the mobilization of the internal capabilities of the potential of employees, the continuous improvement of their professionalism and qualifications, the growth of their level of competitiveness, ensuring the development of competence, encourages an innovative approach in the production process, the disclosure of human potential in order to maximize its efficiency. Coaching does not teach, it helps to learn
M. Downey [4]	The process of creating conditions for the coach for the comprehensive development of the student's personality; art to help increase the effectiveness of learning and development of another person
P. Wrycza [5]	the art of promoting other people's development
M. Nahara [6]	management technology not only for the current level of personnel competitiveness but also for its prospective competitiveness since it is aimed at mobilizing the internal resources of the enterprise, developing the necessary skills and abilities to work with dynamic information, contributing to the development of advanced strategies for obtaining results due to high

	labor motivation, creating an atmosphere of creativity and initiative, increasing responsibility for completing tasks.

There are several types of coaching.

Administrative coaching – a type of coaching used in organizations. Provides a variety of ways to assist employees in improving the efficiency of their professional and pedagogical activities; includes project coaching as well as situational and transitional coaching.

Life coaching – a type of coaching that involves helping employees achieve personal goals, which may be independent of professional or collective; contributes to the effective solution of various problems encountered in the transition from one stage of life to another.

Individual coaching – is a method of planning one's own life, managing its changes and development. The goal is to create oneself as a person with the necessary, desired qualities and characteristics in the social, personal, interpersonal, spiritual aspects.

Project coaching – is a type of coaching that involves the strategic management of the team for the most effective achievement of the result (acme result).

Situational coaching – is a type of coaching that focuses on improving the employee in a particular context, including his ability to improvise pedagogically, the ability to creatively solve professional situations, and so on.

Transitional coaching – is a type of coaching that involves helping employees in a stressful situation, the transition from one type of professional and pedagogical activity or role to another.

Pedagogical coaching assumes a systematic, vertical and horizontal integrity of the continuous educational process; integration of formal, non-formal, and informal education, educational, practical, and self-education; taking into account the content of the employee's professional needs at various stages of the life cycle and the like.

Pedagogical coaching is based on the idea that each individual is unique, has its own needs, goals, interests, motives, the satisfaction of which involves individual ways, forms, approaches to improving the professional and personal level.

In the context of this topic, coaching is a relationship between a teacher and students, when the teacher effectively organizes the process of students finding the best answers to their questions. The teacher should be more of a coach than a traditional teacher. The coach helps students to develop, consolidate new skills and achieve high results in their future profession. I think that the adaptation of higher education to new conditions in social, economic, political life can take place only based on a positive attitude to the student's personality, the disclosure of his opportunities.

Coaching in education is a topic that has been little studied, even outside our country, so the development of this area is extremely relevant, given the goal of education to form a new generation of citizens.

Coaching is a phenomenon of the educational process, built on motivated interaction, in which the teacher creates special conditions aimed at revealing the personal potential of the student to achieve important goals in a particular field of knowledge at the optimal time.

The main goals of coaching are:

– disclosure of the inner potential of the student's personality;

– personality development through delegation of responsibility;

– achieving a high level of responsibility and awareness of all participants in coaching.

To achieve these goals, coaches are guided by certain principles and use a number of methods. The principles of coaching include:

– the principle of awareness and responsibility;

– the principle of unity and interaction;

– the principle of flexibility;

– partnership principle;

– the principle of hierarchical development.

Scientist E. Tsybina defines the following methods of coaching in the context of education:

– the method of specific situations is based on the statement that the way to improve one's knowledge can be paved only through consideration, study, and discussion of specific problem situations;

– method of emotional stimulation of learning, in particular, the formation of cognitive interest by creating positive emotions to the proposed activity, increasing interest, and motivation in the learning process;

– the method of creating a situation of cognitive discussion is an effective method of activating learning, because in the discussion the truth is born, and the search for truth always causes increased interest in the topic;

– "Mosaic" is a method of division of responsibilities in a student group, when the division is carried out by the students themselves. This type of activity forces students to independently and without the help of a teacher-coach to distribute responsibilities in the group and be responsible for this division;

– the project method is a method that brings the activities of students to a new, educational and scientific level. At this level, each of the students carries out a large amount of independent work and learns self-control, which contributes to the self-education of students.

Coaching solves the problem of lack of motivation. The main feature and difference of coaching is that it is only to help a person learn, not to teach it. Without the student's interest in learning, coaching loses all meaning, because the student's personal motivation is the basis of coaching and the key to achieving goals.

It is important that the teacher-coach can professionally talk about the mechanisms, paradoxes, and the impact of motivation on the result. This stimulates the development and contributes to the achievement of potential opportunities for students. However, it should be emphasized that the coach should set up and motivate students not only to achieve the goal and get the result but also to gain experience during the learning process.

- Our use of coaching technologies in the process of teaching disciplines at the Faculty of Agrotechnology and Nature Management of the State Agrarian and Engineering University in Podillia allows us to highlight the following:

- Coach classes can be used both with the participation of the teacher and without him (to study the material allocated for independent work, in particular in the study of such large-scale disciplines as "Crop", "Agriculture", "Agrochemistry", "Breeding and Seed Production " etc.);

- presentation of information in the form of coaching scientific projects (wall newspapers, photo and video projects, etc.). The specificity of the disciplines of specialty 201 "Agronomy" is the study of a large number of agricultural plants, technological processes carried out in agriculture. Therefore, to improve the visualization and perception of information by students, it is advisable to diversify classes in teaching, including through the use of coaching methods. Simulated objects and processes have a greater impact on the student, as they help to improve the understanding and memorization of technological processes in the field of crop production, which are demonstrated in the form of power-point presentations, photo or video projects.

- coaching can be conducted not only for a group of students but also for the individual, distance learning (for example, for students who for some reason were absent from class).

Own experience in the use of coaching technologies in the study of agronomic disciplines allows us to identify a number of factors that affect the effectiveness of the educational process:

- increasing the amount of information that a student can learn, improving the perception of the material, memorizing it for a long time;
- increasing the level of student knowledge through a more logical presentation of the material;
- increasing the quality of the use of clarity in the classroom and reducing the time to reveal the topic.

When planning a coaching session, we determine together with the students the purpose and tasks, forms of final control of projects, and also make the so-called map - the plan where we specify the name of the project, type, thematic material for processing, final product, and skills which students develop and acquire. performing a project. Work on projects takes place in several stages, namely: preparatory, executive, presentation, and final. At these stages, students solve individual problems, such as: choosing a project topic, forming micro-groups, collecting information, working with reference books, questionnaires, etc., and, finally, presenting and evaluating projects. The final result of the implementation of projects is reports, scientific articles, photo and video presentations, and the like.

As a teacher-organizer of coaching activities in the teaching of agronomic disciplines, I set the following tasks due to the general principles of developmental and personality-oriented education:

- to provide conditions in the educational institution for the innovative mode of development of students;

- to create conditions for the development of creative personality, its self-realization and self-determination;
- to cooperate with teachers-colleagues in order to develop interdisciplinary projects.

But one of the main tasks of any learning is not only to teach something but, above all, to learn: to receive, find, seek the necessary knowledge. It is coaching that triggers mechanisms through the personal motivation of students to acquire knowledge independently

Conclusions

Thus, coaching as an innovative educational technology is one of the resource aspects in pedagogical activities and involves the transformation of the relationship between teacher-coach and students to a new level of interpersonal interaction based on the pedagogy of cooperation and flexibility in solving problems, mutual responsibility for results.

Practice shows that coaching technology acts as an effective tool for revealing the potential of a person in order to maximize its use in the process of forming research competence, in addition, this technology acts as a synthesis of coaching and self-coaching to accelerate the desired changes in the professional development of future agrarians in a higher education institution.

Of course, coaching is not a universal technology for solving all educational issues, but the use of this technology helps to reveal the research potential of future farmers, forms in them the necessary competencies and motivation for research.

The research carried out allows us to assert that the technology of coaching is productive pedagogical support or the creation of optimal conditions for the disclosure of the potential of an individual, is of great importance for the formation of a student manager of his educational and professional activities.

The coaching method prepares the student of agar university for the future activity motivated, purposeful, and operating, which is very important for his future professional activity, in particular in the perspective agrarian sphere.

References

1. Website of the International Coaching Academy [Online resource] / Access mode: http://www.coacha.ru/
2. *Galvey W. T*. Rabota kak vnutrenyaya igra. Focus, obucheniye, udovol'stviye i mobil'nost' na rabochem meste [Work is like an inner game. Focus, learning, fun and mobility in the workplace] / У. Т. Голви. – Moscow: Alpina biznes buks, 2005. – pp. 194.
3. *Whitmore J.* Kouching novyy stil' menedzhmenta i upravleniia personalom: prakticheskoye posobiye [Coaching a new style of management and personnel management: practical guide] / J. Whitmore. – Moscow : Izdatelstvo «Finansy i statistika», 2005. – 160 p.
4. *Downey M.* Efektivnyy couching: uroki koucha koucham [Effective Coaching: Lessons from a Coach by Coaches] / M. Downey / (transl. from Eng.). – Moscow: Dobraya kniga, 2008. – pp. 288.
5. *Wrycza P. Ardui J.* Kogda kachestvo deistviy vstrechaetsya s tsentrovkoy. Kompas dlya kouchey [When the quality of action meets alignment. Compass for coaches] / P. Wrycza, J.Ardui. – Moscow : International Academy for Transformational Coaching and Leadership, 2008. – pp. 18-102.
6. Nahara M. B. Rol kouchynhu u zabezpechenni konkurentospromozhnosti personal [The role of coaching in ensuring the competitiveness of staff] / M. B. Nahara// Bulletin of Donetsk National University. M. Tugan-Baranovsky: bulletin of scientific papers. – 2009. – No.4 (44). – pp. 96-101.
7. *Romanova S. M*. Kouchynh yak nova tekhnolohiia v profesiinii osviti [Coaching as a new technology in vocational education] / S. M. Romanova // Bulletin of the National Aviation University. Series: Pedagogy. Psychology. – 2010. – Issue 3. – pp. 83–86.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 110-122
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Danylo Plakhtii
State Agrarian and Engineering University in Podillia

IMPACT OF INOCULATION ON SOYBEAN SEED PRODUCTIVITY IN THE SOUTHERN PART OF THE WESTERN FOREST-STEPPE

Summary

The main results of research on the effect of seed inoculation on soybean productivity in the southern part of the western forest-steppe are highlighted in the present paper.

The field research was conducted during 2014-2016 at the research field of State Agrarian and Engineering University in Podillia. The soil structure of a study area is a typical black soil, deep, heavy-adrenal low-humus on loess loam.

During the years of experimental research, there were optimal weather conditions for the formation of a nodulation apparatus on the roots of the following soybean varieties: Anzhelika, Diona and Lehenda. We noticed the maximum number of root bulbs at Diona soybean variety in terms of micro stage BBCH 77 with HiStick application. The number of root bulbs at Diona soybean variety was 42.6 pcs/plant, it was 40.4 pcs/plant at Anzhelika soybean variety and it was 37.3 pcs/plant at Lehenda soybean variety. In the micro stage BBCH 77, the largest mass of tubers, which were formed on the roots of soy plants, was noted at the plants which were treated with HiStick inoculant. Those indicators ranged from 1.24 – 1.42 g/plant for Anzhelika, Diona and Lehenda varieties. It has been proved that the yield of soy grain depends on hydrothermal conditions of the year, the technology of cultivation and varietal crop characteristics. The results of the research revealed that Histick inoculant most influenced the seed productivity of Diona soy grain variety.

Key words: soybeans, varieties, inoculants, legumes-rhizobium symbiosis, yield.

Introduction

Soybeans are among the few cheapest complete protein vegetable-based foods, which can be used both in food and feed production, and are the basis for the edible fat pyramid [1].

For this reason, soybeans have become the leading crop in agricultural production due to the high quality of grain indicators. An important characteristic of soy is protein content, various vitamins, ash elements, enzymes and other equally valuable substances [2].

Soy protein is full-value according to amino acid composition, without cholesterol and reminds proteins of animal origin. No plant in the world can produce as much protein and fat as soybeans in 4-5 months. Providing the population with high-calorie foods such as soybean becomes a problem since the population growth on planet Earth significantly exceeds the increase in protein production.

Leguminous crops, including soybeans, play an extremely important role in the mobilization of biological nitrogen in the soil [3, 4]. They can partially provide themselves with nitrogen by fixing it with the help of tuber bacteria from the air. This positive genetic role of legumes is closely related to the vital activity of tuber bacteria, the plants are in a close symbiotic relationship with [5].

Biological fixation of atmospheric nitrogen is of great importance since biological nitrogen is environmentally harmless and practically inexhaustible [6, 7]. From the existing variety of microorganisms, the greatest interest in practical terms is caused by organisms that can fix atmospheric nitrogen. Biological nitrogen can serve as a significant addition to the nitrogen fund of the soil, contributing to its fertility and thereby ensuring a more economical consumption of nitrogen fertilizers [8].

Taking into account the economic and socio-political situation in the country, the use of mineral nitrogen fertilizers in crop production becomes problematic and unprofitable. The solution to this problem is possible due to alternative approaches in the cultivation of crops and legumes, in particular. Biological fixation of molecular nitrogen from the atmosphere is one of the main sources of nitrogen in agrocenoses. An important role in this process is played by tuber bacteria that can induce the formation of nitrogen-fixing tubers on the roots of legumes [9, 10].

In this regard, among the measures to improve the nitrogen supply of plants in agriculture, the emphasis is on theoretical and practical developments aimed at a significant increase in the level of biological transformation of atmospheric nitrogen into organic nitrogen-containing compounds by nitrogen fixers, primarily tuber bacteria. The latter in symbiosis with legumes can fix the molecular air nitrogen, provide the need for microbial symbionts and accumulate it in the arable layer of soil in the amount of 40 to 500 kg/ha per year, depending on the cultivated legume [11].

Analysis of recent researches and publications

It is well known that mandatory agronomical techniques in the technologies of legume cultivation should be the pre-sowing treatment of seeds with bio preparations based on breeding strains of specific tuber bacteria, which increases the nitrogen-fixing potential of leguminous-rhizobium symbiosis [12].

Stoliarov O.V. [13] argued that nitrogen fixation is the process of converting atmospheric nitrogen into the form that is best absorbed by the soy plant, and therefore is especially important for obtaining a high and sustainable harvest. It is necessary for this process that nitrogen-fixing bacteria during the required period of growth and development of plants are either already in sufficient quantities in the soil near the seeds, or applied to them so that tuber bacteria can be formed on the root. When seeds germinate, bacteria cover the root hairs and begin to multiply. Tubers, which are clusters of bacteria in the form of colonies, are located on the roots of plants. After scientists discovered the phenomenon of biological nitrogen fixation with the participation of tuber bacteria, the idea prevailed that these bacteria are the only ones that form tubers on the roots of all legumes. Much later it was proved that the interaction between the tuber bacteria and the host plant is quite harmonious and specific. Moreover, they are characterized by a narrow specialization [14, 15]. Rhizobia, depending on the specificity, are divided by scientists into seven groups, that is, they interact with plants of specific crops, but according to the classification, they are combined into one species – Rhizobium. Specific tuber bacteria called Rhizobium japonicum is used for soy [16].

Back in 1985, only one species of Bradyrhizobium and five types of Rhizobium were known, which actualizes the study of drugs based on them, with different variants of technological techniques. Shevnikov, for example, indicates that the yield of soy was higher when using bacterial drugs compared to the use of nitrogen fertilizers [17]. Agro technical techniques also affect the quality indicators of soy seeds, namely the protein content [18]. Different strains of nitrogen-fixing bacteria, depending on the growing conditions, have a positive effect on the formation of elements of the crop structure, as well as on the entire productivity of agrocenosis [19].

Kramariov S.M., Artemenko S.F., Andrienko A.L. proved that soybean is a crop that improves soil fertility. Due to the activity of the root system and fixation of tuber bacteria, soybeans weaken the compaction of the soil, as well as enrich it with nitrogen. This contributes to the increase in moisture penetration, its economic consumption and the receipt of high yields of subsequent crops in crop rotation [20].

Purpose, scope and research method

The purpose of the present study is to determine the effect of inoculants on the performance indicators of zoned varieties of soy in certain soil type and climatic conditions.

The field and laboratory tests were carried out during 2014-2016 on the research field of State Agrarian and Engineering University in Podillia.

The laboratory soil tests were carried out at the government agency Khmelnytskyi Regional State Technological Center for the Protection of Soil Fertility and Product Quality according to the following methods: pH method of water and salt suspensions and hydrolytic acidity according to the Kappen method; the sum of absorbed bases by Kappen-Gilkovitsa method; humus content according to Turin; alkaline hydrolysed nitrogen according to Cornfield; moving compounds of phosphorus and potassium according to the modified method of Chirikov [21].

The experiments used the inoculum Optimaiz *Bradyrhizobium japonicum* $5x10^9$ + Lipo-chitooligosaccharides $2x10^{-7}$%, Biomah Soia the *Bradyrhizobium japonicum* of LZ 21 strain with credit from 2, $5*10^9$ KUO, HiStick *Bradyrhizobium japonicum* 3.0×10^9 cells per gram + *Bacillus subtilis* 2.2×10^{10} cells per gram. Anzhelika, Diona and Lehenda soy varieties were used in the experiment.

Plants for the analysis were selected according to a three-leave phase: (BBCN micro stage 13), budding (BBCH micro stage 59), flowering (BBCH 66 micro stage) and full seed infusion (BBCH micro stage 77).

Accounting of nitrogen-fixing tubers of soy was carried out according to the methodology of Posypanov G. S. Simultaneously with the accounting of tubers, soy plants were weighed.

Results and discussion

Nitrogen sources for the nutrition of legumes are soil nitrogen, air nitrogen and mineral fertilizer nitrogen to a lesser extent. The theoretical and practical interest is focused primarily on the nitrogen of the air, fixed by the symbiotic system of plants in the form of biological nitrogen, which has indisputable advantages compared to technical nitrogen for its environmental friendliness and cheapness. The share of participation of each source in the crop varies according to the conditions of cultivation, the activity of symbiotic nitrogen fixation, and hence the objective need to increase the share of participation of biological nitrogen in the formation of the soy seed crop, as the final product of agrophytocoenoses [22].

According to the technological form modern inoculants are divided into dry and liquid (gel). Inoculants on carriers are dry (vermiculite, cellulite, peat, etc.). The most common inoculants are on peat: sterile and non-sterile. The inoculants on non-sterile peat are more affordable but less effective than inoculants on sterile peat. In addition, under inappropriate storage conditions (moisture, temperature), inoculants on non-sterile peat loose stability and the number of bacteria (titer) decreased in the inoculant. Liquid or gel-like preparations are most advisable when inoculated with large volumes of seeds and short sowing periods. In such inoculants, after drying the seeds, nitrogen-fixing bacteria in the soil did not lose activity due to the polysaccharide mucous membrane [23].

The experiments used promising inoculants of various types produced by most popular Ukrainian manufacturers.

The recording of the number and mass of tubers on plant roots was conducted during the growing season with Anzhelika, Diona, and Lehenda soy varieties. Thus, in the micro stage of BBCH 13, the largest number of tubers was observed with The HiStick inoculant variant (21.8-23.2 pcs/plant), which is a fairly large indicator for this development phase (Table 1). The smallest number of tubers on the roots of soy plants of all the varieties we examined was recorded in the sample where Biomah Soia inoculant was used (12.1-15.7 pcs/plant).

The intensive growth of tubers on the roots of soy plants was observed during the growing season and reached a maximum in the micro stage of BBCH 77.

In the micro stage of BBCH 59, the largest number of root bulbs (32.1 pcs/plant) was recorded with Diona soy variety where HiStick was used, which is 13.7 pcs/plant more than with control (without the use of inoculant) sample. These indicators were slightly lower with Anzhelika and Lehenda varieties - 31.6 and 25.7 pcs/plant, respectively.

During the reporting period, it has been established that the maximum number of root bulbs is noted with the Diona plant variety in the micro stage of BBCH 77 using the drug HiStick and amounted to 42.6 pcs/plant, in soy of the Anzhelika variety the indicators were 40.4 pcs/plant and in the Lehenda variety - 37.3 pcs/plant, which is 11.2 – 12.0 pcs/plant more than in checklist. These indicators were slightly lower in comparison to Optimaiz drug application. A smaller number of tubers were recorded on the roots of Lehenda soybean plants (32.4 pcs/plant) with Biomah Soia inoculant application.

Table 1: Dynamics of the number of tubers in soy plants depending on the variety and inoculant, pcs/plant (average 2014-2016)

Inoculant	Development phase (on a scale) BBCH											
	BBCH 13			BBCH 59			BBCH 66			BBCH 77		
	The variety											
	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda
Monitoring	9,2	11,5	10,5	16,5	18,4	16,3	24,1	23,8	22,2	29,2	28,3	25,3
Biomah Soia	12,1	15,7	12,9	21,9	22,3	20,8	32,8	34,5	24,7	34,7	38,3	21,2

Optimaiz	21,2	22,4	15,7	28,3	28,7	25,6	25,6	29,4	29,4	28,8	30,2	32,4
HiStick	21,8	23,2	22,9	31,6	32,1	25,7	38,7	35,0	32,8	40,4	42,6	37,3
Hip 0,05	*0,12*			*0,13*			*0,12*			*0,13*		

During the soybeans growing season, both the number and mass of tubers changed depending on the variety, weather conditions, the intensity of lighting, the content of nutrients in the soil, the inoculation of seeds with drugs that were studied. If lighting intensity is higher, the growth of tubers increases. It is explained by the increasing of both the photosynthesis intensity and the outflow of assimilates from the leaves to the root system and tubers. Providing tubers with assimilates is the main factor that affects the process of nitrogen fixation of legumes (Tab. 2).

During the years of research, we observed the positive effect of pre-sowing treatment of soybean seeds with bacterial preparations on the raw mass of tubers formed on the roots of Diona, Anzhelika and Lehenda soy varieties, so their mass ranged from 0.4 – 1.24 g/plant.

It has been established that a different number and weight of tubers is formed on the roots of examined soy varieties before the micro stadium of BBCH 13. Thus, in the areas where inoculant was used the Diona variety had the raw mass of tubers equal to 0.52 – 0.77 g/plant, in the Anzhelika variety it was equal to 0.4 – 0.72 g/plant and in the Lehenda variety had the raw mass of 0.43 – 0.76 g/plant, which is 0.1 – 0.27 g/plant more than the control sample.

It has been revealed that the use of HiStick inoculants, as a rule, contributed to the formation of tubers by local rhizobium populations, their mass during the growing periods of 2014-2016 increased compared to control by 7.5-18.0%. When using Optimaiz and BiomahSoia inoculum, the nodulation process on plant roots was less active compared to their effect on those plants whose seeds were treated with HiStick.

The positive dynamics of increasing the tubers mass was observed throughout the growing season and reached a maximum in the micro stages of BBCH 66-77. Thus, the largest mass of tubers was observed in the Diona variety using HiStick inoculant in the micro stage of BBCH 77 and was 1.42 g/plant. It should be noted that the largest mass of tubers that were formed on the soy plant roots in the sample was processed with HiStick drug, for Anzhelika variety made 1.34 g/plant and for the Lehenda sample produced 1.24 g/plant. The mass of tubers in samples with Optimaiz and BiomahSoia application was slightly smaller. In Anzhelika sample with the BiomahSoia application mass was from 0.4 to 1.15 g / plant, Lehenda 0.43 - 0.7 g / plant, Diona 0.52 - 1.27 g/plant. In the sample with the Optimaiz application, the indicators were as follows: Anzhelika 0.7 - 0.96 g/plant; Diona 0.75 – 1.03 g/plant, Lehenda 0.52 – 1.08 g/plant. During the recording, it was noted that the soy bulbs on the slices have an intense pink colour, which indicates the active passage of nitrogen fixation.

Table 2: Dynamics of raw mass of tubers depending on the variety and inoculant, g/plant

Inoculant	Development phase (on a scale) BBCH											
	BBCH 13			BBCH 59			BBCH 66			BBCH 77		
	The variety											
	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda	Anzhelika	Diona	Lehenda
Monitoring	0,30	0,38	0,35	0,55	0,61	0,54	0,80	0,79	0,74	0,97	0,94	0,84
BiomahSoia	0,40	0,52	0,43	0,73	0,74	0,69	1,09	1,15	0,82	1,15	1,27	0,70
Optimaiz	0,70	0,75	0,52	0,94	0,95	0,85	0,85	0,98	0,98	0,96	1,03	1,08
HiStick	0,72	0,77	0,76	1,05	1,07	0,85	1,29	1,16	1,09	1,34	1,42	1,24
Hip $_{0,05}$	*0,57*			*0,52*			*0,47*			*0,36*		

The technology of soy plant growing should include a set of consistent actions aimed at obtaining high yields, taking into account the biological characteristics of plants in the phases of growth and development. In our research, despite the wide possibilities of using agrochemicals in the cultivation of soy, we gave the priority to using microbial drugs.

It has been proved that soybeans are an inexhaustible source of soil enrichment with nitrogen compounds due to nitrogen fixation by tuber bacteria in symbioses with plants, and therefore have an important agro technical value. Their cultivation allows reducing the cost of crop production by including atmospheric nitrogen in the agricultural production process, improving the phytosanitary condition of crops and significantly increasing the productivity of arable land [24, 25].

The study has found that the level of grain yield of the examined soy sample significantly depended on the factors taken for study and years of research, which did not differ much in the amount and distribution of precipitation during the growing season of soy.

Data in Table 3 indicate that the yield of soy grain increased under the influence of seed treatment by nitrogen-fixing bacteria. A three-year research showed that the yield of Anzhelika soy grain was 1.36 t/ha, in the Lehenda sample it was 1.20 t/ha and in the Diona sample, the yield was 1.45 t/ha at the area with untreated seeds (control sample).

Significant efficacy was provided by the inoculation of soy seeds with nitrogen-fixing bacteria. The increase in yield from inoculation was 0.64 – 1.35 t/ha. Varieties almost equally reacted to this procedure. Thus, the inoculation of Anzhelika seeds provided a yield increase of 0.64 t/ha, Lehenda 0.72 t/ha and Diona 1.35 t/ha.

Table 3: Seed productivity of soybeans depending on varieties and inoculant, t/ha

Inoculant	The variety		
	Anzhelika	Diona	Lehenda
Monitoring	1,36	1,45	1,20
Biomah Soia	1,41	1,52	1,35
Optimaiz	1,65	2,20	1,43
HiStick	2,00	2,79	1,92

In samples where Biomah Soia and Optimaiz were used, the yield of Anzhelika, Diona and Lehenda varieties ranged from 1.35 to 2.20 t/ha. It should be noted that the HiStick inoculant influenced the seed productivity of soy grain over the years of research. These indicators in the Diona sample were maximized - 2.79 t/ha, somewhat smaller they were in Lehenda and Anzhelika samples and amounted from 1.92 to 2.0 t/ha, respectively.

Conclusion

Consequently, the considerable duration of active symbiosis, especially under adverse conditions and the identification of factors influencing the activation of this process determine the great importance in ensuring the intensity of the soybean production process. The results of the study showed that the treatment of soy seeds with the help of bacterial preparations increases the activity of symbiosis and nodulation apparatus by soy plants. When evaluating the studied elements of the technology, including preparations for the treatment of soy plant seeds, yield is the main indicator. The analysis of soy seed yield when using inoculant showed that it differed and the difference depended on the variety of soybean.

Bibliography

1. Kots S.Y., *Сучасний стан досліджень біологічної фіксації азоту, [The current state of research on biological nitrogen fixation], Физиология и биохимия культурных растений, [Crop physiology and biochemistry]*. 43(3), 2011.
2. Hadzalo Y.M., *Аграрний потенціал України,* [Agrarian potential of Ukraine], *Аграрна наука, [Agrarian Science],* Kyiv 2016.
3. Kindie Y., Bezabih A., Beshir W., Field Pea (Pisum sativum L.). Variety Development for Moisture Deficit Areas of Eastern Amhara. *Advances in Agriculture*. Amhara 2019.
4. Campo R. J., Hungria M., Compatibilidade de uso de inoculantes e fungicidas no tratamento de sementes de soja. Londrina: Embrapa Soja 2000.
5. Yakymenko M. V., Behun S. A., *Совместное применение штаммов ризобий и некоторых препаратов для предпосевной обработки семян сои, [Joint use of*

rhizobium strains and some drugs for pre-planting soybean seed], Земледелие, [Agriculture] 2016

6. Pavlyshche A. V,. Zhemoida A. V., Kirizii D. A., Rybachenko L. I., *Функціонування симбіотичного і фотосинтетичного апаратів сої за впливу протруйників фунгіцидної дії та екзогенного лектин, [Functioning of soy symbiotic and photosynthetic devices under the influence of fungicide and exogenous lectin*], *Физиология растений и генетика [Physiology of plants and genetics],* 51(6), 2019. DOI: https://doi.org/10.15407/ frg2019.06.517
7. Fedoruk I. V., *Вплив інокуляції насіння на врожай сої, [Influence of seed inoculation on the soy crop], Таврійський науковий вісник, [Tavria Scientific Bulletin,]* ‘Helvetica House” 108, Kherson 2019.
8. Novitskaya N. V., Dzhemesiuk A. V., *Урожайность сои в зависимости от элементов технологии на черноземах типичных Лесостепи Украины [Soybean yields depending on the elements of technology on the black soil of the typical forest-steppe of Ukraine], Вестник Алтайского государственного аграрного университета, [Herald of Altai State Agricultural University],* 5(127), 2015
9. Bakhmat M. I. Bakhmat O. M., *Формування сортової врожайності сої в умовах Лісостепу Західного. [Formation of varietal yield of soy in the western forest-steppe], Корми і кормо виробництво, [Feed and feed production: university bulletin],* 73, Vinnytsia 2012.
10. Monti M, Pellicanò A, Santonoceto C, Preiti G, Pristeri A., *Yield components and nitrogen use in cereal-pea intercrops in Mediterranean environment*. Field Crop Res., 196, 2016.
11. Reckling M, Hecker J. M, Bergkvist G. [et al.] A cropping system assessment framework – evaluating effects of introducing legumes into crop rotations. Eur J Agron, 76, 2016.
12. Bakhmat O. M., Моделювання адаптивної технології вирощування сої [Modeling of adaptive technology of soy cultivation], Monograph. Kamianets-Podilskyi: Publisher Zvoleiko D.G. 2012.
13. Stoliarov O.V., *Нут, соя и кормовые бобы в Центральном Черноземье (Вопросы теории и практики повышения азотфиксации, величины и качества урожая семян), [Chickpeas, soybeans and forage beans in the Central Black Earth (issues*

of theory and practice of increasing nitrogen fixation, size and quality of seed harvest)]: abstract. dis. ... Dr. Agricultural Sciences, Voronezh 2005.

14. Tretiakova S. O., Chynchyk O. S., Olifirovych S. Y., *Перспективи біологізації вирощування зернобобових культур в Україні [Prospects for biologization of growing leguminous crops in Ukraine], Збірник наук. пр. УНУС, [Collection of Scientific Papers UNUS]*, 94, Uman 2019.
15. Khotianovych A.V., *Методы культивирования азотфиксирующих бактерий, способы получения и применения препаратов на их основе, [Cultivation methods of nitrogen-fixing bacteria, ways of obtaining and using drugs based on them], методические рекомендации, [methodical recommendations]*, St. Peterburg 1991.
16. Willems A. *The taxonomy of rhizobium: an overview. Plant and Soil*, 287, 2006.
17. Shevnikov M. Ya., *Ефективність застосування біопрепаратів та мінеральних добрив при вирощуванні сої в умовах нестійкого зволоження Лісостепу України, [The effectiveness of the use of biopreparations and mineral fertilizers in the cultivation of soy in conditions of unsustuitable moisture of the forest-steppe of Ukraine], Вісник Полтавської державної аграрної академії, [Bulletin of Poltava State Agrarian Academy]*, 2, 2011.
18. Hillocks R. J., Maruthi M. N., Grass pea (Lathyrus sativus): Is there a case for further crop improvement. *Euphytica*, 186, 2012.
19. Chynchyk O. S., *Основні показники якості насіння сортів сої залежно від агротехнічних прийомів вирощування в умовах західного Лісостепу [The main quality indicators of soy seed varieties depending on agrotechnical methods of cultivation in the western forest-steppe], Бюлетень Інституту сільського господарства степової зони, [Bulletin of the Steppe Zone Agricultural Institute]*, 3, 2012.
20. Kramariov S. M., Artemenko S. F., Andriienko A.L., *Ефективність інокуляції сої в умовах північного Степу, [The effectiveness of soy inoculation in the northern steppe], Вісник Степу: наук. зб. за матеріалами VI Всеукр. наук.-практ. конф. молодих вчених і спеціалістів [„Агропромислове виробництво України – стан та перспективи розвитку"], (НААН, Кіровоградський інститут агропромислового виробництва, [Steppe Herald: materials of VI all-Ukrainian. Scient.-pract. young scientists and specialists conference ["Agro-industrial*

production of Ukraine – state and prospects of development"], (NAA, Kirovohrad Institute of Agro-Industrial Production], 7, Kirovohrad: KOD 2010.

21. ДСТУ 7863:2015. Національний стандарт України, [DSTU 7863:2015. National Standard of Ukraine], *Якість ґрунту. Визначення легкогідролізованого азоту методом Корнфільда, [Soil quality. Determination of lightlyhydrolized nitrogen by the Kornfield method], [Valid from 2016-07-01].* Kyiv, DP UkrNDNTs 2016.
22. Posypanov H. S., *Методы изучения биологической фиксации азота воздуха, [Methods for studying biological nitrogen capture of air],* Ahropromyzdat, Moskow 1991.
23. Chynchyk O. S., *Вплив обробки насіння біопрепаратами на тривалість вегетаційного періоду та урожайність сортів гороху, [Influence of seed treatment with biopreparations on the duration of the growing season and the yield of peas varieties], Корми і кормовиробництво, [Feed and feed production: university bulletin],* 81, Dilo, Vinnytsia, 2015.
24. Dyachenko E. A., Ryzhova N. N., Kochieva E. Z., Vishnyakova M. A. Molecular genetic diversity of the pea (Pisum sativum L.) from the Vavilov Research Institute collection by the AFLP analysis. *Russ. J. Genet*., 50(9), 2017.
25. FAO (Ed.) Yearbook Production 2014. *Food and Agricultural Organization of United Nations*. Rome. 2015.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 123-135
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Vitalii Stepanchenko
State Agrarian and Engineering University in Podillia

THE FORMATION OF HIGHLY PRODUCTIVE FORAGE PHYTOCENOSES

Summary

The article presents the results of the research on the influence of single-species grass crops, their grass mixtures, the use of mineral fertilizers, bacterial preparation based on tuber bacteria rhizobophyte and plant growth regulator Emistim C on the formation of perennial forage cenoses.

The research was conducted during 2015-2017 in the research field of State Agrarian and Engineering University in Podillia. The soil of the experimental field is black soil leached deep low-humus heavy loam.

From the studied species of perennial grasses and their grass mixtures in the conditions of the southern part of the Western Forest-steppe the maximum yield of dry mass without fertilizers was provided by grass mixture of alfalfa with boneless stalk – 8.14 t/ha, the maximum yield of crude protein provided single species of alfalfa – 1.47 t/ha.

The combined use of rhizobophyte and Emistim C on alfalfa-hay grassland provided an increase in dry mass yield from 7.95 t/ha to 8.89 t/ha without mineral fertilizers and up to 9.87 t/ha in the variant with annual application of P60K60.

In the study of various nutrition sources of alfalfa-loam grass, the highest yield of dry mass was provided by the annual application of N60P60K60 – 9.64 t/ha. Almost on the same level with the application of complete mineral fertilizer was the yield of dry mass on the variant using Ecograin – 9.47 t/ha.

Key words: grass mixtures, leguminous and leguminous-cereal grasslands, fertilizers, productivity, nutrition quality.

Introduction

Significant improvement in the solvency of large farms in the coming years is quite problematic. Only some of them, who were able to adapt to market conditions, are able to purchase new equipment, fertilizers, plant protection products and intensify on this basis the feed industry. The vast majority of agricultural formations in the renewed and accelerated development of fodder production should primarily focus on the maximum realization of the biological potential of fodder crops and low-cost technologies. From low-cost methods of biologization of fodder production it is necessary to practice expansion of crops areas of perennial grasses which improve agrochemical properties of soil and increase its fertility, seeds inoculation of field crops by nitrogen fixers of symbiotic and associative action, cultivation of leguminous grasses and low doses of mineral fertilizers when sowing fodder crops. All this will make it possible to produce cheap feed and plant raw materials and intensify the feed industry [1]. In addition, in recent years, much attention has been paid to the biologization of agricultural production [2].

Climatic conditions of the Forest-Steppe are favorable for growing all forage crops. Perennial grasses are the least expensive and provide sustainable yields and complete feed for livestock [3]. The strategic direction of field grass sowing in the Forest-Steppe is the expansion of legume crops, including alfalfa, meadow clover, etc. and their mixtures with cereals in the coming years to 55-60% of the total area of the forage group and up to 70-75% - in the future [4, 5, 6]. Particular attention should be paid to the cultivation of alfalfa [7]. In the structure of fodder crops, its share should be on average 30-35% or 55-60% of the area of perennial grasses.

The main principle of selection of species for grass mixtures is to take into account their environmental adaptation and response to a given mode of use [8]. It is also known that sown grasses are relatively quickly naturalized, forming stable biogeocenoses, in which, as a rule, all structural elements are closely associated with each other and involved in a continuous cycle of matter and energy [9].

In perennial grasses, when grown together with legumes, a noticeable increase in plant weight due to stronger tillering and better leafing of shoots.

Analysis of recent researches and publications

When growing perennial grasses, there is still no unequivocal opinion about the superiority of single-species crops or grass mixtures. As noted by I.P. Minin [10], a comparative assessment of mixed and pure grass crops was made, as a rule, in the following main areas: a) the influence of both on soil fertility; b) differences in eating herbs in pure and mixed crops and as feed; c) differences in the level and stability of grass yields in single-species and multi-species crops. Mixed crops with a high content of legumes have an advantage over pure cereals for hay. They reduce the use of more expensive feed. At the same time, when drying and storing hay mixtures of cereals and legumes, its quality decreases less than when drying only legumes. When harvesting silage, mixed crops also have an advantage, improving the ensiling of raw materials due to the higher content of carbohydrates in cereals [10].

In recent years, Ukraine has seen an increase in average annual temperature and a sharp increase in the unevenness of precipitation during the year [11]. As a result, the frequency of droughts and floods has more than doubled. Under these conditions, legumes and legume-cereal mixtures should be used more widely, especially alfalfa [12].

NSC "Institute of Agriculture NAAS" emphasizes that in the conditions of increasing aridity of the climate the priority direction of forage production should be the expansion of crops of perennial grasses (alfalfa and its mixtures with buckthorn or barberry, as well as sainfoin and clover, which does not have sweat) which, having a strong root system, do not react so sharply with productivity to air drought and lack of moisture in the top layer of soil. Also, forage crops should be sown only in mixtures, which will allow the most efficient use of bioclimatic factors of the zone [13].

However, there is still no unequivocal opinion, it is more appropriate to grow alfalfa in single-species crops, or in mixtures with other herbs.

Studies conducted in Latvia showed that on sod-carbonate soils the largest collection of dry matter was provided by a mixture of alfalfa (90%) and meadow thyme (10%) - 87.0 c/ha (109% compared to the yield of net alfalfa). On sod-loamy soil the most productive was a grass mixture of alfalfa (50%) and meadow clover (50%) - 90.3 c/ha (138% to pure alfalfa) [14].

At inclusion in a biological cycle of by-products of plant growing, green manures the important role belongs to biotechnologies. These include biologicals, growth stimulants, solutions of chelated compounds of micro- and macronutrients used for seed treatment or in the vegetation process of plants [15]. One of the most affordable means of increasing crop yields are domestic bacterial preparations developed by the Institute of Agricultural Microbiology of NAAS (microgumin and polymyxobacterin) [16].

Another significant factor in increasing the productivity of perennial grasses may be the use of growth stimulants [17, 18].

Purpose, scope and research method

The aim of the work was to identify the patterns of species structure formation and productive properties of perennial phytocenoses depending on the use of bacterial preparation and plant growth regulator.

Based on the purpose of the research, to solve the tasks in 2015 in the research field of State Agrarian and Engineering University in Podillia was laid the appropriate experiment.

The soil of the experimental field is black soil leached deep low-humus heavy loam. The experimental plot had the following agrochemical parameters (in the soil layer 0–30 cm): humus content - 4.34%; Hr - 0.77; pH - 6.8; the amount of absorbed bases - 22.6 mg-eq./100 g of soil; easily hydrolyzed nitrogen - 124 mg/kg of soil; mobile phosphorus - 86 mg/kg of soil; exchangeable potassium - 167 mg/kg of soil.

Sowing of grasses was carried out simultaneously on all variants in the first decade of April 2015 in combination with oats for green fodder with a seeding rate of 100 kg/ha. Conditional seeds of the following regionalized varieties of perennial grasses were used for sowing: Vinnychanka alfalfa, Ternopilska-4 meadow clover, Bromus inermis Mars, Lyudmyla festuca arundinacea. First, oats were sown, and then, across the sowing of oats - perennial grasses.

We also used a plant growth regulator Emistim C (TU U 88.264.021-95) with a rate of 15 ml of the agent per 1 ton of alfalfa seeds and liquid inoculum rhizobophyte produced by the Institute of Agricultural Microbiology NAAS.

Results and discussion

Legumes are a particularly important source of nitrogen replenishment in agriculture. Today, when Ukrainian agriculture operates in a negative balance of humus, as well as phosphorus, nitrogen and other nutrients, the widest use of biological products created by domestic microbiologists is a significant resource for increasing crop productivity [19]. Studies show that from an ecological, business and economic point of view, when growing fodder crops, it is advantageous to use as much as possible not mineral but biological nitrogen, which is fixed from the atmosphere by legumes [20]. All legumes are able to absorb nitrogen from the atmosphere, but the leading role belongs to perennial grasses. Nitrogen fixation is a biotechnology technique in agriculture where bacteria are used to absorb molecular nitrogen from the air to convert it to ammonia to partially replace the application of nitrogen fertilizers.

One of the ways to increase symbiotic nitrogen fixation is the use of microbial preparations based on active strains of nitrogen-fixing microorganisms.

The use of biological products for pre-sowing bacterization of seeds is accompanied by stabilization of biocoenotic relationships in the ecosystem, preservation and restoration of soil fertility, improving the ecological state of the environment, increasing crop yields and low energy costs [21].

Legumes: alfalfa, meadow clover, hornbeam accumulate biological nitrogen in the soil, which is equivalent to application 120-180 kg/ha of mineral nitrogen [22]. Nitrogen-fixing ability in alfalfa is much higher than in other legumes.

Optimal conditions for the fixation of atmospheric nitrogen are created by a neutral reaction of the soil, sufficiently provided with phosphorus, potassium, trace elements, a favorable moisture regime [23]. Our studies were conducted on soils with a pH of 6.8 (close to neutral, which promotes the activity of nodule bacteria), the content of mobile phosphorus - 86 mg/kg of soil, metabolic potassium - 167 mg/kg of soil. Thus, soil conditions are favorable for active rhizobial symbiosis. Another, no less important factor is the humidification conditions. In 2015, during the formation of the first slope, the humidification conditions were favorable - in April, 144 mm of precipitation, and in May - 79.8 mm of precipitation at a rate of 48 and 64 mm, respectively. Therefore, when processing alfalfa seeds sown with rhizobophyte, the dry matter yield increased from 4.49

t/ha in the control to 5.20 t/ha or 15.8%. Against the background of the introduction of $P_{60}K_{60}$, this increase was 19.8%. That is, the additional application of phosphorus and potassium, despite the relatively high content of these elements in the soil, had a positive effect on increasing the level of biological nitrogen fixation.

Today in Ukraine a number of highly effective plant growth regulators for all crops have been created. The effect of biostimulants on the growth of crop productivity is due to the fact that they intensify the vital activity of plant cells and accelerate biochemical processes in them, which leads to increased nutrition, respiration and photosynthesis, increases by 20-30% of fertilizer use. These agents increase the resistance of crops to adverse weather conditions and increase the number of beneficial microorganisms in the root system. Due to low application rates and low purchase prices, modern biostimulators are characterized by a high level of cost recovery by yield increases [24].

The best effect is obtained from grass mixtures of legumes and cereals, less - from grass mixtures from species of one family. Species and varieties must be available for their seed production. For short-term (3-5 years of use) grass mixtures should have a simplified composition and should consist of 1-2, rarely three types of cereals and one or two types of legumes, or even one of the most productive species should be sown in this habitat.

The use of plant growth regulator Emistim C had less effect on the increase in dry matter yield in the first slope in 2015, compared with the use of rhizobophyte. The increase before control was 0.12 t/ha or 2.7%. Thus the addition is not mathematically derived. A significant increase in the yield of dry mass from the use of Emistim C was obtained in the second slope of 2015 - 0.26 t/ha or 8.3%. In the second slope of 2015 there was only a tendency to increase the yield of alfalfa-stock grass mixture from the use of rhizobophyte. In the third slope of 2015, the increase in dry matter yield in the variant using the inoculum was significant and amounted to 0.35 t/ha or 18.7%. In total, for three slopes in 2015, a higher yield of dry mass was provided by the use of inoculant - 10.56 t/ha, and Emission C - 10.01 t/ha. 9.48 t/ha of dry mass were obtained at the control (Fig. 1). Highly effective was the combined use of rhizobophyte and Emistim C, in which the dry matter yield increased to 11.22 t/ha, or 18.4%. The use of only inoculant or Emistim C provided a yield increase of 11.4 and 5.6%, respectively. Against the background of $P_{60}K_{60}$ treatment of alfalfa seeds sown with inoculant in 2015 increased the dry matter yield by 1.75 t/ha or 16.2%. The combined use of rhizobophyte and Emistim C increased the yield by 1.99 t/ha of dry weight or 18.4%. That is, phosphorus-potassium fertilizers increase, first of all, the efficiency of rhizobophyte use.

In 2015, the efficiency of processing alfalfa seeds sown with rhizobophyte decreased sharply. A significant increase in dry matter yield in the variant with rhizobophyte was obtained only in the third slope. In our opinion, this is due to the arid conditions that prevailed in 2016. It is known that favorable humidification conditions are one of the main factors of effective symbiotic nitrogen fixation. Low - 0.32 t/ha or 4.3%, but a significant increase in dry matter yield was provided by the use of biostimulator Emistim C.

In 2017, there was a tendency to increase yields on variants using rhizobophyte and emistim C. More noticeable increase in yield was with the combined use of inoculant and Emistim C.

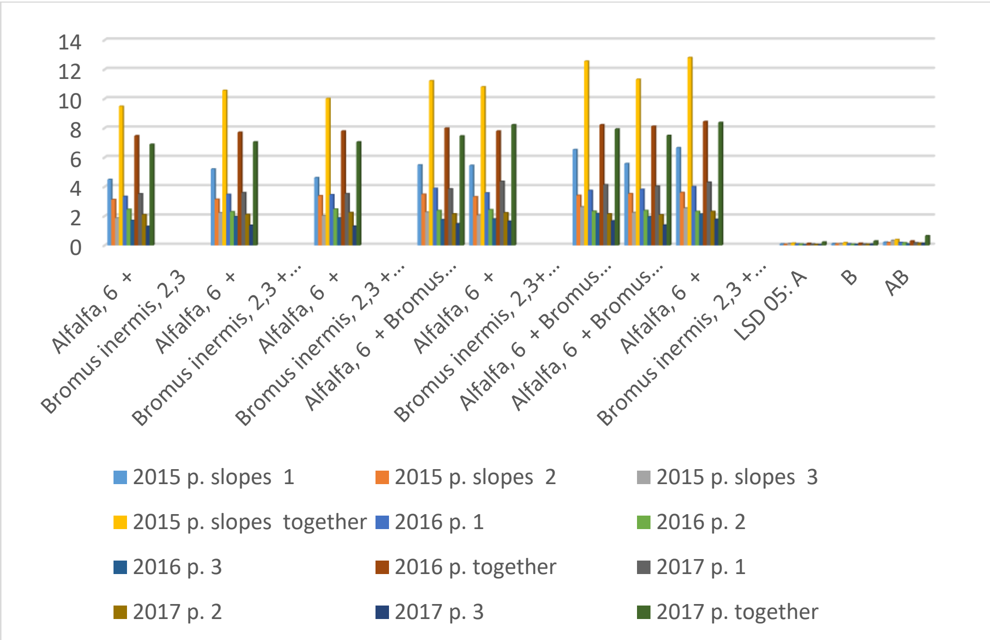

Fig. 1 Yield of dry weight depending on the use of rhizobophyte, Emistim C and fertilizer, t/ha

In general, with the combined use of inoculant and Emistim C the highest increase in dry weight was observed. In the first slope of 2015, the use of these agents increased the average daily increase in dry weight from 0.051 to 0.062 t/ha. There was a high increase in the average daily increase in dry weight in the first slope of 2016 - from 0.056 to 0.066 t/ha.

In the third year, the use of rhizobophyte and Emistim C had less effect on the growth of the average daily increase in dry weight (from 0.054 to 0.059 t/ha). Despite the more intensive formation of the crop of the second slope, the average daily increase in dry weight from the use of bacterial preparation based on tuber bacteria rhizobophyte and plant growth regulator Emistim C was lower compared to the average daily increase in the first slope (Table 1).

In general, in 2015–2017, the highest yield of dry weight was obtained with the combined use of inoculant and Emistim C.

This is due to the peculiarities of the plant growth regulator Emistim C, which is known to contain a balanced complex of phytohormones of auxin and cytokinin nature [24].

Table 1. Average daily increase in dry weight on slopes*, t/ha

Variants	2015			2016			2017		
	slopes								
	first	second	third	first	second	third	first	second	third
1	0,051 / 89	0,076 / 41	0,039 / 48	0,056 / 59	0,052 / 43	0,031 / 54	0,054 / 65	0,060 / 35	0,027 / 48
2	0,059 / 89	0,077 / 41	0,046 / 48	0,059 / 59	0,053 / 43	0,045 / 54	0,055 / 65	0,060 / 35	0,028 / 48
3	0,052 / 89	0,082 / 41	0,042 / 48	0,058 / 59	0,057 / 43	0,035 / 54	0,054 / 65	0,064 / 35	0,027 / 48
4	0,062 / 89	0,085 / 41	0,047 / 48	0,066 / 59	0,055 / 43	0,032 / 54	0,059 / 65	0,061 / 35	0,031 / 48
5	0,062 / 89	0,081 / 41	0,043 / 48	0,061 / 59	0,057 / 43	0,033 / 54	0,059 / 65	0,057 / 35	0,033 / 48
6	0,074 / 89	0,083 / 41	0,055 / 48	0,063 / 59	0,054 / 43	0,040 / 54	0,064 / 65	0,061 / 35	0,035 / 48
7	0,063 / 89	0,086 / 41	0,046 / 48	0,065 / 59	0,055 / 43	0,036 / 54	0,062 / 65	0,059 / 35	0,029 / 48
8	0,076 / 89	0,088 / 41	0,053 / 48	0,068 / 59	0,054 / 43	0,039 / 54	0,066 / 65	0,066 / 35	0,037 / 48

Note*. The numerator shows the average daily increase in dry weight, t/ha; in the denominator – the days of the growing season.

And the increased activity of nitrogen fixation processes in the root zone of plants can be achieved due to physiologically active substances that have auxinocytokinin activity [25].

Also significantly increases the efficiency of rhizobophyte application of phosphorus-potassium fertilizers. On the other hand, it can be argued that in the context of research, inoculants and Emistim C improve the utilization of phosphorus and potassium by perennial grasses from mineral fertilizers.

According to K.P. Kovtun [26], in the root zone of alfalfa-stem hairy grass the most active stimulation of rhizotorphin was observed in the third year of grass use. According to N.I. Klekot [27], the highest efficiency of treatment of alfalfa seeds with rhizotorphin was in the first year of use by the herb. In the second year, its effect decreased sharply, and in the third there was only a tendency to increase yields.

Conclusion

According to the years of the herb use, the effectiveness of the used biological products differed significantly. The largest increase in yield was obtained in the first year of grass use. The sharp decrease in the efficiency of rhizobophyte in the second year of grass use, in our opinion, it can be explained by unfavorable conditions of moisture (in the absence of moisture in the soil, the effectiveness of biological nitrogen fixation decreases). In the third year of the grass use, despite the favorable conditions of moisture, the efficiency of the inoculum was much lower compared to the first year of grass use. There is no unanimity in the literature on the effectiveness of inoculants over the years of the grass use.

Bibliography

1. *Petrychenko V.F.* (2003). Scientific foundations of sustainable development of feed production in Ukraine. [Naukovi osnovy staloho rozvytku kormovyrobnytstva v Ukraini]. Vinnytsia: Ed. 50. - Pp. 3–10.
2. *Petiukh G.P., Patyka V.P.* (2005). Modern agrotechnologies in Ukraine: problems and prospects. [Suchasni ahrotekhnolohii v Ukraini: problemy ta perspektyvy].

Agroecological Journal. №1. - Pp. 3–7.

3. *Matkevych V.T., Matkevych A.P., Smalius V. M.* (2003). The state and prospects of feed production in the northern steppe of Ukraine. [Stan i perspektyvy rozvytku kormovyrobnytstva v pivnichnomu Stepu Ukrainy]. Vinnytsia: Ed. 50. - P. 10–15.
4. *Petrychenko V.F., Kvitko G.P., Tsarenko M.K.* (2008). Scientific bases of intensification of field fodder production in Ukraine. [Naukovi osnovy intensyfikatsii polovoho kormovyrobnytstva v Ukraini].Vinnytsia: FOP. «Danilyuk V.G.» 240 p.
5. *Dzyubailo A., Lagush N.* (2003). Productivity of fodder crop rotation depending on the saturation of its perennial grasses. [Produktyvnist kormovoi sivozminy zalezhno vid nasychennia yii bahatorichnymy travamy]. Lviv: Lviv State Agrarian University. Pp. 481–485.
6. *Glushchenko D.P.* (2008). The effectiveness of optimization of intensive feed production. [Efektyvnist optymizatsii intensyvnoho kormovyrobnytstva]. Vinnytsia: Danyliuk V.G . Issue. 60. - P. 155–162.
7. *Kyrylesko O.L.* (2004). Productivity of perennial legume-cereal grasses of oblique-pasture use on the slopes of arable lands in the conditions of the south-western Forest-steppe of Ukraine. [Produktyvnist bahatorichnykh bobovo-zlakovykh travostoiv ukisno-pasovyshchnoho vykorystannia na skhylakh vyvedenykh z rilli v umovakh pivdenno-zakhidnoho Lisostepu Ukrainy]. Vinnytsia: Vip. 52. –Pp. 87–95.
8. *Mashchak Ya.I., Mizernyk I.D., Nagirniak T.B., Sloboda O.M.* (2005). Onion cultivation in theory and practice. [Lukivnytstvo v teorii i praktytsi]. Lviv: Spolom. 295 p.
9. *Ogienko N.I.* (2008). Influence of the composition of grass mixtures on the peculiarities of the formation of biomorphological structure of grass stands in the conditions of the north-eastern left-bank Forest-Steppe of Ukraine. [Vplyv skladu travosumishok na osoblyvosti formuvannia biomorfolohichnoi struktury travostoiv v umovakh pivnichno-skhidnoho livoberezhnoho Lisostepu Ukrainy]. Vinnytsia: Danyliuk V.G. Issue. 60. - Pp. 106–111.
10. *Minina I.P.* (1972). Meadow grass mixtures. [Lugovye travosmesi]. Moscow: Kolos. 288 p.
11. *Petrychenko V.F.* (2006). Actual tasks of development of modern fodder production

in Ukraine. [Aktualni zavdannia rozvytku suchasnoho kormovyrobnytstva v Ukraini]. Bulletin of agrarian science. №12. Pp. 55–58.

12. *Podobied L.I.* (2002). Perspective directions of improvement of feed production in Ukraine. [Perspektyvni napriamky udoskonalennia kormo– vyrobnytstva v Ukraini]. Kyiv: Agrarian science. Ed. 48. Pp. 3–7.
13. *Arkhipenko F.M.* (2008). Features of feed production in conditions of climate change. [Osoblyvosti kormovyrobnytstva v umovakh zminy klimatu]. Coll. Science Proceedings of the NSC "Institute of Agriculture UAAS". K .: VD "EKMO". Spec. output. Pp. 143–160.
14. *Drikis J.* (1978). Yield of alfalfa in pure crops and mixtures in the first year of use. [Urozhajnost ljucerny v chistom poseve i smesjah v pervyj god ispol'zovanija]. Proceedings of the Latvian Agricultural Academy. Issue. 151. Pp. 60–69.
15. *M.V. Zubets* (2004). Scientific bases of agro-industrial production in the zone of the Forest-steppe of Ukraine. [Naukovi osnovy ahropromyslovoho vyrobnytstva v zoni Lisostepu Ukrainy]. Kyiv: Logos. 776 p.
16. *Zhalina K.V., Makliuk O.I.* (2009). Combined action of the biological product Microgumin and organo-mineral fertilizer Organic on soils of different degrees of washing. [Sumisna diia biopreparatu Mikrohumin ta orhano-mineralnoho dobryva Orhanik na gruntakh riznoho stupenia zmytosti]. Agroecological Journal. №2. Pp. 68–73.
17. *Antipova L.K.* (1994). Influence of seeds soaking and processing of crops of DMSO on seed productivity of alfalfa. [Vplyv zamochuvannia nasinnia ta obrobky posiviv DMSO na nasinnievu produktyvnist liutserny]. Feed and feed production. Kyiv: Vip. 37. Pp. 76–78.
18. *Nazarov S.G., Makarenko P.S., Kovtun K.P.* (2003). Scientific bases of creation of cultural pastures and hayfields on different types of meadow lands of the Forest-Steppe. [Naukovi osnovy stvorennia kulturnykh pasovyshch i sinozhatei na riznykh typakh luchnykh uhid Lisostepu]. Bulletin of Agrarian Science. Pp. 23–26.
19. *Smirnov V.V., Patyka V.P., Pidgarsky V.S.* (2002). Microbial biotechnology in agriculture. [Mikrobni biotekhnolohii v silskomu hospodarstvi]. Agroecological Journal. №3. Pp. 3–9.
20. *Kovbasiuk P.V., Musienko N.M.* (2002). Stripe crops - an effective measure for the

formation of highly productive legume-cereal grasses and preservation of legumes in them. [Smuhovi posivy – efektyvnyi zakhid formuvannia vysokoproduktyvnykh bobovo-zlakovykh travostoiv ta zberezhennia v nykh bobovykh vydiv]. Feed and feed production. Kyiv: Agrarian science. Ed. 48. Pp. 67–71.

21. *Kovalenko T.M.* (2009). Influence of multifunctional complex of microorganisms in the cultivation of meadow clover on productivity and energy aspects. [Vplyv polifunktsionalnoho kompleksu mikroorhanizmiv pry vyroshchuvanni koniushyny luchnoi na produktyvnist ta enerhetychni aspekty]. Feed and feed production. Vinnytsia: Glavetska R.V. Ed. 64. - Pp. 143–147.
22. *Kyrylesko O.L.* (2002). Productivity and size of accumulation of biological nitrogen by legumes in the flooding of sloping lands derived from arable land. [Produktyvnist ta rozmiry nakopychennia biolohichnoho azotu bobovymy travamy pry zaluzhenni skhylovykh zemel vyvedenykh iz rilli]. Feed and feed production. Kyiv: Agrarian science. Ed. 48. Pp. 202–205.
23. Streeter J. G. Interaction of plant and bacterial metabolism in nitrogen fixing systems // Nitrogen Fixation: Fundamentals and Applications. Proc. of the 10th Inter. Congr. on Nitr. Fixation. (St. Petersburg, May 28 - June 3, 1995). - Dordrecht / Boston / London: Kluwer Acad. Publ., 1995. - P. 67–76.
24. *Ponomarenko S.P.* (2009). Plant growth regulators - a significant reserve of the harvest in 2009. [Rehuliatory rostu roslyn – vahomyi rezerv urozhaiu 2009 // Posibnyk ukrainskoho khliboroba: (naukovo-vyrobnychyi shchorichnyk 2009)]. Kyiv: Academpress. Pp. 102–104.
25. *Volkogon V.V.* (2005). Microbiology in modern agricultural production. [Mikrobiolohiia u suchasnomu ahrarnomu vyrobnytstvi]. Chernihiv: Issue. 1-2. - Pp. 6–29.
26. *Kovtun K.P.* (2002). Influence of preparations of nitrogen-fixing microorganisms on the activity of nitrogen fixation in the soil under legume-cereal grass mixtures. [Vplyv preparativ azotfiksuiuchykh mikroorhanizmiv na aktyvnist azotfiksatsii v grunti pid bobovo-zlakovymy travosumishkamy]. Kyiv: Agrarian science. Ed. 48. - P. 72–74.
27. *Klekot N.I.* (1998). Influence of rhizotorphin on the productivity of different varieties of alfalfa under irrigation. [Vplyv ryzotorfinu na produktyvnist riznykh sortiv

liutserny v umovakh zroshennia]. Feed and feed production. Kyiv: Ed. 45. - Pp. 187–188.

ZESZYTY NAUKOWE WSA w Łomży 84, s. 136-145
data przesłania 07.09.2021/ akceptacji artykułu 20.12.2021

Vitalii Burdyha
State Agrarian and Engineering University in Podillia

PERSPECTIVES USE OF THE COLLECTION OF THE WORLD GENEFUND OF THE GENUS FAGOPYRUM MILL IN AGRICULTURE PRODUCTION

Summary

Increasing the yield of buckwheat and enlarging its stability is impossible without the use of new varieties in the production that combine high productivity, early maturity, ripening friendliness, high grain quality, resistance to drought, low temperatures, condition, shedding of fruits, diseases, pests, etc. To solve this problem, as pointed out by M. I. Vavylov, it is necessary to use local material that has been subjected to long-term natural selection and is adapted to certain conditions, as well as a world range that combines the best world varieties and all the botanical diversity that is known for this crop.
Key words: buckwheat, gene pool, collection, yield, large-fruited, sample-standard.

Introduction

Buckwheat is one of the most valuable cereal crops grown on the territory of Ukraine. It is the source of Ukrainian traditional valuable food product – buckwheat cereal, raw material for the production of dietary products that are irreplaceable for health, and the largest component of the beekeeping fodder base. Despite the significant study of the botanical and biological characteristics of the buckwheat plant for quite a long time, when this crop has been breeding, it has not been possible to solve several problems related to both the yield level of commercial buckwheat crops and the stability of the implementation of the productive potential in changing environmental conditions.

Since 1992, when Ukraine adopted the National Program related to the mobilization, conservation, and study of genetic plant resources of Ukraine, two collections of buckwheat gene pool have been placed in the O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia (PDATU) and Ustymivska Experimental Station of the Plant Production Institute nd. a. V. Ya. Yuryev NAAS were combined into the National Buckwheat Collection, which has more than 2.5 thousand samples [3].

For Ukraine, for several centuries, buckwheat has been a traditional agricultural crop, and buckwheat is one of the most favorite Ukrainian dishes. Considering that the physiological norm of cereals consumption per person per year is 14-15 kg (the bulk of which in Ukraine are buckwheat and rice), it is important to increase the cultivation of buckwheat grain to 180 thousand tons [5] (economically feasible is to increase the area by 2-2.5 times) [6]. The solution to this problem is possible both due to the increase in area and due to increased yields of buckwheat grain, more complete use of plant products obtained from the field and in the process of processing into buckwheat.

Considering the significant value of buckwheat as food, fodder, melliferous, medicinal, insurance and industrial crop, as well as the almost waste-free technology of its cultivation, and despite the low and unstable yield, attention to this crop not only has not decreased recently, but in some years it increases significantly. In this regard, production workers are making demands not only to increase the level of grain yield but also to ensure its stability in constantly changing environmental conditions.

The main condition for fulfilling this requirement is the breeding of new varieties of intensive type with a potential yield of 25-30 kg/ha, with large, leveled, and thin-film grain with a high content of protein, lysine, and fat. New varieties must have a well-developed root system, be resistant to disease and pest damage, against lodging and shedding of fruit [2]. The basis for successful selection is the introduction into the research process of varieties that carry the desired characteristics. And the discoveries of scientists in recent years indicate the possibility of a significant increase in the productivity of the buckwheat plant, using the identified features such as determinant growth, homostyle, self-compatibility, and male sterility. The genetic variability of resistance to lodging and shedding, cold resistance and thermal resistance, the course of the process of distribution of assimilants, and other traits and properties require further study.

The aim, subject, and research methods

O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia has formed and is working with a collection of buckwheat with a total of about a thousand samples of various ecological and geographical origin. The study of material on morphological and economically valuable characteristics is constantly being carried out, and the sources of selection-significant traits are identified.

The research was conducted in the fields of scientific crop rotation in 2016-2020. The cultivation of cultivars was carried out according to the generally accepted technology for wide-row sowing and sowing rates of 1.5 million seeds per hectare and a plot area of 5.4 m2 with three repetitions. The study used "Methodological guidelines for the study of collection samples of corn, sorghum and cereal crops (millet, buckwheat, rice)" [4] and "Analysis of the structure of buckwheat plants" (Methodological recommendations) [1]. To fully characterize the climatic conditions of the research years, it is necessary to take into account the average daily temperatures and precipitation from April to August. Despite the sowing in the second decade of May, the decisive influence on the conditions of the post-sowing period is caused by the weather conditions of April - the moisture reserve created during this period and the dynamics of temperature rise. Based on the above, the weather conditions in the years of research were characterized by significant diversity in terms of the level of heat and the amount of precipitation, which made it possible to evaluate the collection material in terms of the stability of the manifestation of characters.

The purpose of the research is to identify selection and economically valuable material and, on its basis, to form a collection of buckwheat by yield and large-fruitedness. As a result of the work, samples were identified with different, but stable over the years, level of manifestation of characters as standard samples of yield, the productivity of one plant, 1000 grain weight, number of grains and inflorescences per plant, branching, plant height and attachment of the lower productive inflorescence.

Research results

When working with the buckwheat gene pool, in addition to the obligatory set of studies to determine the yield and adaptive characteristics of the collection material, a number of agrotechnical experiments were carried out, including: the study of the influence of growing conditions on the hereditary basis of seeds (experience comparing the yield of samples when sowing with seeds of a late and early term sowing last year), while the dependence of the yield of samples on the timing of sowing of both parental forms and offspring was revealed - the yield was higher when sowing offspring at the same time as the parental forms, it was found that the duration of the growing season depends only on conditions the year of reproduction and does not depend on the conditions of the year of growing seeds for sowing; studies of the influence of the place of growing seeds on sowing qualities and on the size of the yield, the influence of the place of growing on yield, large-fruited, flower color, and to a lesser extent, on the shape of stamens, branching and leafiness of plants was revealed, and the largest yield was formed by seeds from the originator; study of the variability of approbation and identification characteristics (according to 14 indicators); study of the influence of the degree of development of the root system on the yield indicators in diploid buckwheat, by the method of assessing the productivity of a plant with different degrees of development of the root system in seedlings; the study of the yield of straw and grain in different types of buckwheat (the ratio of grain yield to straw yield was established: for common buckwheat 1: 1.8.

In the course of the research, the time and ecological range of buckwheat vegetation in repeated crops in the forest-steppe zone of Ukraine was determined. The character of inheritance of the main selection-controlled traits in groups with a predominance of short-day, photo neutral, and long-day characteristics was determined. The original source material has been created for the selection of new buckwheat varieties focused on the technology of repeated seeding.

It should be noted the important role of buckwheat varieties of indeterminate (normal) morphotype. Naturally, the genetic diversity of plants of overlap populations is much wider than can be statistically predicted, guided by the laws of heredity. Particularly noteworthy is the new variety Volodar, bred by the O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia, which in 2020 was entered in the State Register of Plant Varieties suitable for distribution in Ukraine. Over the years of testing at the various plots of Ukraine, the variety provided an average yield of 2.5-2.8 t / ha. At the same time, an important factor determining the varietal peculiarity of the Volodar buckwheat variety is its stability in terms of productivity, as well as an increased level of drought resistance in the flowering and fruit formation phase, at high temperatures does not reduce the release of nectar by flowers, as a result of which pollination and fruit binding deteriorate and ensure uniform visits by bees to buckwheat flowers to obtain the most useful high-grade ecologically pure honey.

The question of the use of herbicides in buckwheat crops remains controversial. The use of herbicides is incompatible with the flowering biology of the crop. Buckwheat two-thirds of the ontogeny period stays in this phase and is characterized by cross-pollination, which is carried out mainly by bees. The biology of crop development and the direction of the use of buckwheat grain indicate the inexpediency of using the chemical method of protection against weeds in crops. An alternative to chemical protection is the agronomic method in the technology of growing buckwheat. So, indeterminate varieties have valuable economic characteristics, namely, early maturity, friendliness of ripening, a narrow ratio of grain and straw, resistance to lodging and shedding, and at the same time high technological qualities of grain. High yield potential and its stability in specific climatic conditions is a characteristic feature of such varieties. Early compared to conventional varieties, the rate of maturation allows the use of such varieties for post-harvest and post-harvest placement, which is now a relevant technological direction.

The problems of maintaining, preserving, studying, and rational use of the gene pool of buckwheat and their wild relatives is a state issue, strategically important and directly related to ensuring both national and global food, biological resource, and environmental security. The collection of the world buckwheat gene pool is created not only for guaranteed preservation of plant material for present and future generations but also serves as a source for the creation of new forms that differ in certain features or their complexity.

The collection of mutants includes a group of green flower samples, which are characterized by different types of flowering and shape of inflorescences, color intensity. Cytological studies of the peduncle of these samples showed that it differs from the peduncle of ordinary white-flowered buckwheat by the number of vascular bundles. If ordinary buckwheat has 2-3 of them, then green-flowered 4-6, which causes high resistance of plants to fruit fall.

The results of studies of morpho-biological features of the new green-flowered form of buckwheat allowed us to distinguish it into an independent botanical variety ssp.

Greenflawer Al. This variety is involved in the selection process. The first variety of this direction was the variety Zelenokvitkova (green-flowered) 90, which can withstand stagnation at the root for more than three weeks. The variety was included in the Register of Plant Varieties of Ukraine. Next were the varieties Zelenokvitkova 93 and Malikovska, which had high technological properties of the grain. By involving the green-flowered variety in hybridization, the Roxolana variety was bred, which with high technological properties has increased resistance to fruit fall. It is also included in the Register of Plant Varieties of Ukraine. The green-flowered form, transferred to the polyploid level, became the starting material for the tetraploid variety Nika, which is characterized by a high plasticity, large-fruitedness, and resistance to fruit fall.

Varieties of Podilska, Yana, Kara-Dag, which were created as a result of selection for grain size, were derived from large-fruited mutants of the collection. Varieties Podilska and Yana are provided for optimal and late crops. They are characterized by excellent technological properties, large fruits (weight of 1000 grains 30-32 g) with high uniformity (92%).

A new promising direction is breeding taking into account the peculiarities of waste-free technology for growing buckwheat. This is, first of all, breeding varieties to obtain food coloring. The implementation of this aspect was the work on the creation of a productive variety with a high content of anthocyanins in straw, buckwheat plants can synthesize. The content of anthocyanins in straw is a genetically inherited trait. In conventional varieties, this figure varies from 4.0 to 8.3 mg 10-3 / g. However, the collection includes mutant populations with a very high content of anthocyanins in straw (56.0-65.0 mg 10-3 / g). This mutant became the source material for the creation of a special purpose variety Rubra, recommended for food coloring. The variety has been entered in the State Register of Plant Varieties of Ukraine since 2004.

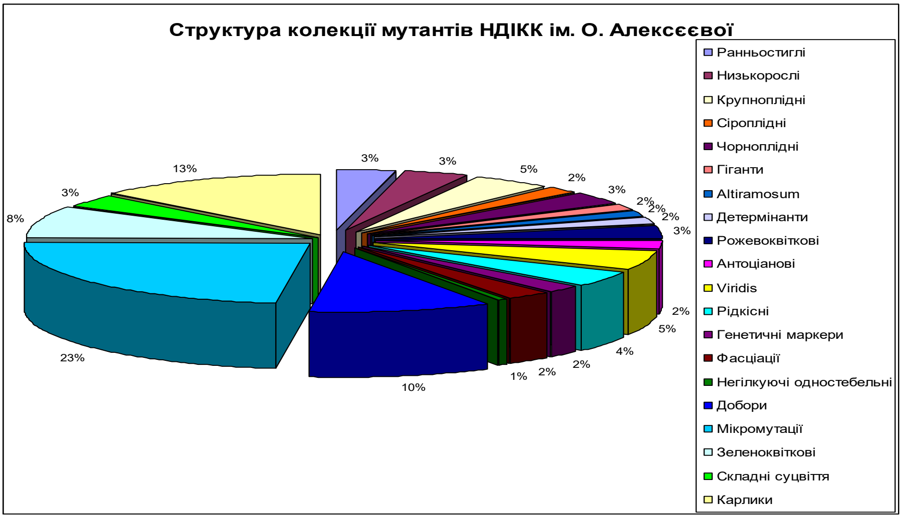

Fig. 1. Mutant collection structure
Source: O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia

In the above group, we can identify mutants that are characterized by economically valuable properties. For example, the group of green flowers is characterized by high resistance to grain shedding, and intensely colored anthocyanin forms - resistance to wilting and low temperatures.

Some mutants are characterized by high fruit uniformity (90-100%) and low filminess (16-18%).

The main groups of mutants in our collection and their characteristics are given in table. 1.

Table 1. Structure and characteristics of the collection of mutants.

No	Morphogroups of mutants	Number of samples, pcs	Vegetation period, days	Mass of 1000 grains, g
1	Micro mutations	133	85-90	27,5-29,7
2	Early ripening	11	75-80	26,5-28,0
3	Undersized	11	75-80	27,0-29,1
4	Large-fruited	15	80-85	30,3-33,6

5	Grey-fruited	6	85-90	27,1-28,3
6	Black-fruited	11	85-90	26,5-29,0
7	Giant	5	110-115	26,7-28,0
8	Altiramosum	5	114-119	27,1-29,4
9	Determinants	6	80-85	26,1-29,0
10	Pink-flowered	11	84-89	27,3-29,2
11	Anthocyanins	7	85-90	26,3-28,7
12	Viridis	17	86-90	26,8-28,2
13	Green-flowered	27	88-100	27,1-29,3
14	Complex inflorescences	11	85-93	26,9-28,1
15	Dwarfs	42	85-95	20,3-26,3
16	Rare	13	83-95	26,4-28,1
17	Genetic markers	7	85-87	23,5-26,7
18	Fasciation	8	85-90	26,3-28,1
19	Non-branching single-stemmed	2	70-75	23,1-25,8
20	Selections	33	85-90	26,5-28,0
	Total	381		

Source: O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia

At the O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia, the viability of the available seed material of collection samples is maintained at the appropriate methodological and technical level. Considering the cross-pollination of buckwheat plants, isolation methods are strictly applied when restoring the similarity and reproduction of the seeds of the samples - local isolation using tissue isolators and spatial isolation - isolated areas with placement over 300 m and sowing diploid material in isolation from a tetraploid form and vice versa. Storage of seeds for 10 or more years provides special modes of its preparation (cleaning and drying up to 6-7% humidity) and storage (in airtight containers (foil bags) in thermal chambers at temperatures up to +4ºC and humidity up to 30%).

The presence of significant species and varietal diversity and the relevant scientific and methodological and technical base allows to fully assess the available in the collection of the gene pool of buckwheat as individual economic and valuable indicators and biological characteristics, and their complexity. Each year, sets of 100-150 samples are formed to evaluate new and study previously included material in the collection. The study is conducted in accordance with the "Guidelines for the study of collection samples of corn, sorghum, and cereals (millet, buckwheat, rice)" [4], "Analysis of the structure of buckwheat plants" (Methodical recommendations). In addition, according to specific tasks, nurseries are established for the study of samples on the stability of abiotic and biotic factors, agrobiological, selection, and agrotechnical research of the material.

The work on the study of buckwheat gene pool in the western forest-steppe allowed to select from the collection a unique material with such important features as high yield and productivity, large-fruitedness, short stature, high maturity, and resistance to shedding when standing in the field or transportation, resistance to action abiotic (drought and high temperatures) and biotic (diseases and pests) factors, etc. Among the collection material, the following material was highlighted: in terms of productivity (6.5-11.6 g), high ripening friendliness (8-9 points), coarse-grained (30-33.2 g), increased leafiness - samples from Japan; single stem; green rolls; with intense anthocyanin coloration of the stem and leaves; undersized (up to 100 cm); with a lot of branches on the plant; with a large number of inflorescences; with a significant thickness of the stem (lower internodes), the fastest ripening (65-70 days) with the fasciations of the stem; with a determinant type of growth; with long lateral inflorescences; with two leaves in the attachment point of the upper inflorescence; with lateral inflorescences in the form of twigs; with a high attachment of the lower inflorescence (above 30 cm); with a small number of internodes on the main stem (6 pcs.).

Conclusion

As a result of research on the species diversity of the genus Fagopyrum Mill, a set of samples different in both ecological and geographical origin and years of creation makes it possible to form the basic principles and directions of searching for source forms among a significant variety of collection material. Based on the conducted studies, special and characteristic collections were formed, containing material of various origins and formed according to individual characteristics (productivity, early maturity, short stature, coarse grain, controlled number of branches per plant, increased number of inflorescences, and ripening friendliness) and their combination. Based on the collection of the O. Alekseieva Scientific Research Institute of Cereal Crops of State Agrarian and Engineering University in Podillia using different genetic content and timing of buckwheat material will not only improve the selection of this crop but also significantly change approaches to solving agronomic issues of its cultivation, consider possible factors influencing the yield and quality characteristics of buckwheat and its products.

References

1. Alekseieva O.S. Henetyka, seleksiia i nasinnytstvo hrechky [Genetics, selection and seed production of buckwheat] / O.S. Alekseieva, L.K. Taranenko, M.M. Malyna. – Kyiv : Vyshcha shkola, 2004. – 214 p.
2. Bochkareva L.P. Analiz struktury rasteniya grechihi [Analysis of the structure of the buckwheat plant] // Metodicheskie rekomendatsii [Methodical recommendations]; Eds.: Alekseeva E.S. & Goncharuk A.V. – Chernovtsy, 1994. – 45p.
3. Tryhub O.V., Burdyha V.M. Formuvannia kolektsii svitovoho henofondu hrechky v Ukraini ta napriamky ii vykorystannia. Posibnyk ukrainskoho khliboroba [Formation of the collection of the world gene pool of buckwheat in Ukraine and directions of its use. Ukrainian farmer's manual]. Kyiv, 2015. pp.118-123.
4. Krotov A.S. Grechiha [Buckwheat] // Metodicheskie rekomendatsii po izucheniyu kolektsyonnyh obraztsov kukuruzy, sorgo, i krupianyh kul’tur [Methodical recommendations for the study of collection samples of corn, sorghum, and cereal crops] / A.S. Krotov. – L.: Izdatelstvo VIR, 1968. – pp. 37-44.
5. Maslak O. 2012. Rynok hrechky: stabilizatsiia vyrobnytstva ta spozhyvannia [Buckwheat market: stabilization of production and consumption] // Ahrobiznes sohodni [Agribusiness today]. No.10 (233). [online] 2012 [cit 2015-08-25]. Available at: http://www.agro-business.com.ua/ekonomichnyi-gektar/1077-rynok-grechky-stabilizatsiia-vyrobnytstva-ta-spozhyvannia.html.
6. Taranenko L.K., Yatsyshyn O.L. 2014. Pryntsypy, metody i dosiahnennia selektsii hrechky [Principles, methods and achievements of buckwheat breeding] (Fagopyrum esculentum Moench). Vinnytsia: TOV "Nilan Ltd". pp. 10-147.

Regulamin nadsyłania i publikowania prac w Zeszytach Naukowych WSA

1. Zeszyty Naukowe Wyższej Szkoły Agrobiznesu, zwane dalej Zeszytami, są periodykiem naukowym wydawanym w nieregularnym cyklu wydawniczym.
2. Treść każdego Zeszytu odpowiada zakresowi tematycznemu jednego z odpowiednich wydziałów w Wyższej Szkole Agrobiznesu t. Wydziałowi Rolniczo-Ekonomicznemu, Wydziałowi Technicznemu, bądź Wydziałowi Medycznemu.
3. Redakcja Zeszytów mieści się w sekretariacie Wydawnictwa Wyższej Szkoły Agrobiznesu. Pracą redakcji kieruje redaktor naczelny.
4. W celu zapewnienia poziomu naukowego Zeszytów oraz zachowania właściwego cyklu wydawniczego redakcja współpracuje z krajowymi i zagranicznymi jednostkami naukowymi, stowarzyszeniami oraz innymi instytucjami.
5. Do oceny przyjmowane są dotychczas niepublikowane oryginalne prace redakcyjne, monograficzne, poglądowe, historyczne, teksty źródłowe, sprawozdania z posiedzeń naukowych, oceny książek, komunikaty naukowe, wspomnienia oraz wiadomości jubileuszowe. Opracowania przyjmowane są przez redakcję do końca czerwca każdego roku. Redakcja nie zwraca Autorom nadesłanych materiałów.
6. Do publikacji należy dołączyć oświadczenie o oryginalności pracy oraz o tym, że nie została zgłoszona do innej redakcji (wzór oświadczenia jest możliwy do pobrania na stronie internetowej WSA – załącznik nr 1 do Regulaminu). Oświadczenie powinno zawierać adres pierwszego autora pracy, numer telefonu oraz e-mail. W oświadczeniu powinna być zawarta zgoda (podpis) wszystkich współautorów pracy.
7. Prace są publikowane w języku polskim lub angielskim z uwzględnieniem opinii redaktora językowego.
8. W oświadczeniu dołączonym do tekstu należy opisać wkład poszczególnych autorów w powstanie pracy oraz podać źródło finansowania publikacji. *„Ghostwriting”* oraz „*guest authorship*” są przejawem nierzetelności naukowej, a wszelkie wykryte przypadki będą demaskowane i dokumentowane, włącznie z powiadomieniem odpowiednich podmiotów (instytucje zatrudniające autorów, towarzystwa naukowe, stowarzyszenia edytorów naukowych itp.).
9. Przekazane do redakcji opracowania są wstępnie oceniane i kwalifikowane do druku przez Naukową Radę Redakcyjną, zwaną dalej Radą. Skład Rady określany jest przez Senat WSA.
10. Publikacje wstępnie zakwalifikowane przez Radę są oceniane przez recenzentów, zgodnie z procedurą recenzowania opublikowaną na stronie internetowej WSA w zakładce Zeszyty naukowe WSA. Łącznie z opinią recenzent wypełnia deklarację konfliktu interesów, stanowiącą załącznik nr 2 do regulaminu. Redakcja powiadamia Autorów o wyniku oceny, zastrzegając sobie prawo do zachowania poufności recenzji.
11. Za proces wydawniczy Zeszytów jest odpowiedzialny sekretarz naukowy redakcji, który zatwierdza układ treści Zeszytów, określa wymagania wydawnicze dla publikowanych materiałów, współpracuje z recenzentami, przedstawia do zatwierdzenia całość materiałów przed drukiem Naukowej Radzie Redakcyjnej, współpracuje z Radą i innymi instytucjami w zakresie niezbędnym do zapewnienia poziomu naukowego Zeszytów oraz zachowania cyklu wydawniczego.
12. Redakcja zastrzega sobie możliwość odmowy przyjęcia artykułu bez podania przyczyn.
13. Nadesłane materiały, niespełniające wymagań wydawniczych określonych przez redakcję, są zwracane Autorowi/Autorom.

14. Wydawnictwo Wyższej Szkoły Agrobiznesu nie wypłaca wynagrodzenia za nadesłane publikacje zakwalifikowane do druku w Zeszytach.
15. Wersją pierwotną (referencyjną) czasopisma jest wydanie papierowe. „Zeszyty Naukowe WSA" są dostępne także na stronie internetowej Wyższej Szkoły Agrobiznesu – www.wsa.edu.pl, w zakładce Wydawnictwa.

Wymagania wydawnicze - Zeszyty Naukowe WSA

1. Artykuły powinny być przygotowane w formie wydruku komputerowego oraz w wersji elektronicznej, w języku polskim lub angielskim. W celu usprawnienia procesu wydawniczego prosimy o rygorystyczne przestrzeganie poniższych zasad:
   - przesłany artykuł powinien być opatrzony dokładną afiliacją Autora/Autorów,
   - objętość artykułu nie może przekraczać 15 stron formatu A4,
   - imię i nazwisko Autora/ów – czcionka 12 pkt,
   - nazwa instytucji/jednostki naukowej – czcionka 12 pkt,
   - tytuł artykułu w języku polskim i angielskim – czcionka 14 pkt (bold); podtytuły – czcionka 12 pkt (bold),
   - do publikacji należy dołączyć słowa kluczowe (3–5) oraz streszczenie nieprzekraczające 15 wierszy napisane w językach polskim i angielskim – czcionka 11 pkt,
   - tekst zasadniczy referatu pisany czcionką Times New Roman CE – 12 pkt,
   - odstęp między wierszami – 1,5,
   - jeżeli referat zawiera tabele (najlepiej wykonane w edytorze Word albo Excel) lub rysunki (preferowany format CorelDraw, Excel, Word), należy dołączyć pliki źródłowe,
   - tabele i rysunki powinny być zaopatrzone w kolejne numery, tytuły i źródło,
   - przy pisaniu wzorów należy korzystać wyłącznie z edytora równań dla MS WORD,
   - preferowane formaty zdjęć: TIFF, JPG (o rozdzielczości minimum 300 dpi),
   - w przypadku publikowania prac badawczych układ treści artykułu powinien odpowiadać schematowi: wprowadzenie (ewentualnie cel opracowania), opis wykorzystanych materiałów czy metod, opis badań własnych (omówienie wyników badań), wnioski (podsumowanie), wykaz piśmiennictwa.

2. Odsyłaczami do literatury zamieszczonymi w tekście publikacji są przypisy dolne, które muszą mieć numerację ciągłą w obrębie całego artykułu. Odsyłaczami przypisów dolnych są cyfry arabskie złożone w indeksie górnym, np. (2).

3. Zapis cytowanej pozycji bibliograficznej powinien zawierać: inicjał imienia i nazwisko autora, tytuł dzieła, miejsce i rok wydania, numer strony, której dotyczy przypis; w przypadku pracy zbiorowej: tytuł dzieła, inicjał imienia i nazwisko redaktora, miejsce i rok wydania; w przypadku pracy będącej częścią większej całości – także jej tytuł, inicjał imienia i nazwisko redaktora. Źródła internetowe oraz akty prawne należy podawać także jako przypis dolny.

4. W wykazie piśmiennictwa zamieszczonym w kolejności alfabetycznej na końcu publikacji należy podać kolejno: nazwisko autora/ów i pierwszą literę imienia, rok wydania, tytuł pracy (czcionka italic), wydawnictwo oraz miejsce wydania. Przykłady:
   - **wydawnictwa książkowe: Janowiec A. 2010.** *Ziemniaki skrobiowe – rola w województwie podlaskim*. Wydawnictwo WSA, Łomża.
   - **prace zbiorowe:** Górczewski R. (red.) 2007. *Przemieszczenie trawieńca*. Wydawnictwo PWN, Warszawa.
   - **czasopisma:** Staszewski M., Getek I. 2007. *Specyfika żywienia krów o wysokiej*

wydajności. Wydawnictwo WSA, Łomża, Zeszyty Naukowe WSA nr 37.

- **strony internetowe:** www.4lomza.pl. 1.12.2009 r.
- **akty prawne:** Ustawa z dnia 27 lipca 2002 r. o zmianie ustawy o szkolnictwie wyższym oraz ustawy o wyższych szkołach zawodowych. Dz.U. z 2002 r. Nr 150, poz. 1239.

UWAGA: teksty niespełniające powyższych wymagań zostaną zwrócone Autorowi

Procedura recenzowania prac naukowych nadsyłanych do publikacji w Zeszytach Naukowych Wyższej Szkoły Agrobiznesu

Procedura recenzowania artykułów w Zeszytach Naukowych WSA jest zgodna z zaleceniami Ministerstwa Nauki i Szkolnictwa Wyższego oraz dobrymi praktykami w procedurach recenzyjnych w nauce *.

Przekazanie publikacji do Redakcji Wydawnictwa WSA jest jednoznaczne z wyrażeniem przez Autora/Autorów zgody na wszczęcie procedury recenzji artykułu. Autor/Autorzy przesyłają utwór wraz z wypełnionym oświadczeniem, którego wzór znajduje się na stronie internetowej WSA. Nadesłane materiały są poddawane wstępnej ocenie formalnej przez Naukową Radę Redakcyjną WSA, zwaną dalej Radą, zwłaszcza pod kątem ich zgodności z wymaganiami wydawniczymi opracowanymi i publikowanymi przez Wyższą Szkołę Agrobiznesu, jak również obszarami tematycznymi ZN. Następnie artykuły są recenzowane przez dwóch niezależnych recenzentów, którzy nie są członkami Rady, posiadających co najmniej stopień naukowy doktora. Nadesłane artykuły nie są nigdy wysyłane do recenzentów z tej samej placówki, w której zatrudniony jest Autor/Autorzy. Prace recenzowane są anonimowo. Autorzy nie znają nazwisk recenzentów. Artykułowi nadawany jest numer redakcyjny, identyfikujący go na dalszych etapach procesu wydawniczego. W innych przypadkach recenzent podpisuje deklarację o niewystępowaniu konfliktu interesów – formularz jest publikowany na stronie Internetowej WSA. Autor każdorazowo jest informowany z zachowaniem zasady poufności recenzji o wyniku procedury recenzenckiej, zakończonej kategorycznym wnioskiem o dopuszczeniu bądź odrzuceniu publikacji do druku. W sytuacjach spornych powoływany jest kolejny recenzent.

Lista recenzentów współpracujących z wydawnictwem publikowana jest w każdym numerze czasopisma oraz na stronie Internetowej WSA.

* Dobre Praktyki w procedurach recenzyjnych w nauce. Zespół do Spraw Etyki w Nauce. Ministerstwo Nauki i Szkolnictwa Wyższego. Warszawa 2011

Załącznik nr 1
miejscowość, data..,............................

Oświadczenie Autora/Autorów

Zwracam się z uprzejmą prośbą o przyjęcie do Redakcji Wydawnictwa WSA i ogłoszenie drukiem publikacji/pracy pt.

....
....
....
....

autorstwa:

....
....
....
....
....
....

Równocześnie oświadczam(y), że publikacja nie została wydana w przeszłości drukiem i/lub w wersji elektronicznej w innym czasopiśmie, nie została zgłoszona do innego czasopisma, nie znajduje się w recenzji innej Redakcji, nie narusza patentów, praw autorskich i praw pokrewnych oraz innych zastrzeżonych praw osób trzecich, a także że wszyscy wymienieni Autorzy pracy przeczytali ją i zaakceptowali skierowanie jej do druku.

Przeciwdziałanie nierzetelności naukowej - „*ghostwriting*” oraz „***guest authorship***”;

· źródło finansowania publikacji:...
....
....

· podmioty, które przyczyniły się do powstania publikacji i ich udział:
....
....
....
....
....
....

· wkład Autora/Autorów w powstanie publikacji (szczegółowy opis z określeniem ich afiliacji):
....
....
....
....
....

....
....
....
Imię i nazwisko **podpis**
data 1...
..
....

2.. **..**
....

3.. **..**
....

4... **...**
....

Imię, nazwisko, adres, telefon, e-mail, osoby odpowiedzialnej za wysłanie niniejszego oświadczenia (głównego Autora pracy):
....
....
....
....
....
....

Załącznik nr 2.

DEKLARACJA KONFLIKTU INTERESÓW

Konflikt interesów* ma miejsce wtedy, gdy recenzent ma powiązania, relacje lub zależności przynajmniej z jednym z autorów pracy, takie jak na przykład zależności finansowe (poprzez zatrudnienie czy honoraria), bezpośrednie lub za pośrednictwem najbliższej rodziny.

Tytuł
pracy...

Data....

Konflikt nie występuje

Recenzent oświadcza, że nie ma powiązań ani innych finansowych zależności wobec Autora/Autorów:

....

Podpis recenzenta

*** Recenzent oświadcza, że występuje następujący konflikt interesów**

....

....

....

....

....

....

....

Podpis recenzenta:

..