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JUSTIFICATION OF METHODS FOR CREATING NEW STARTING MATERIAL FOR BREEDING HIGH-YIELDING TOBACCO VARIETIES (NICOTIANA TABACUM L.) ADAPTED TO THE AGROCLIMATIC CONDITIONS OF THE FOREST-STEPPE OF UKRAINE

Until recently, tobacco farming was one of the most profitable agricultural sectors with a profitability level of 28-40%. However, over the years of our country's independence, there has been a steady downward trend in the production of raw tobacco. The main reason for the decline in tobacco production is the reduction of cultivation areas in Zakarpattia and Transnistria and the loss of the unique cultivation zone in Crimea [1, c. 24–27]. According to official statistics, tobacco production in Ukraine currently meets the needs of the industry by only 5%. The operation of tobacco factories is completely dependent on imports of raw materials from abroad.

Accordingly, the strategic task of the industry is to increase the volume of tobacco produced domestically, which is possible only through the introduction of new competitive varieties of domestic breeding with improved quantitative and qualitative productivity indicators [2, c. 25–27].
The progress of modern tobacco breeding is primarily due to the genetic potential and diversity of the source material. Long-term study of collection samples makes it possible to identify the sources of the most important morphological and economically valuable traits with high genotype adaptability to the agroclimatic conditions of the central Forest-Steppe of Ukraine [3, c. 70–76].
One of the important directions of the development of the tobacco industry is not only the increase in the volume of tobacco cultivation, but also the improvement of its quality. This is due, first of all, to the fact that a significant part of the tobacco products of Ukrainian factories is made from imported raw materials. Accordingly, the support of the own producer is possible only due to the introduction into production of new competitive varieties of domestic breeding with improved quantitative and qualitative indicators of productivity. Our country can be one of the leading European countries that produces high-quality tobacco raw materials. Growing tobacco in Ukraine has become traditional thanks to the geographical location, favorable climatic conditions, the presence of large areas of fertile land, and qualified labor resources.
According to the results of the research, the tobacco trait collection was classified according to a set of morphological, biological and economically valuable traits and the source material for breeding highly productive tobacco varieties adapted to the agroclimatic conditions of the central part of the Forest-Steppe of Ukraine was formed.
Key words: *tobacco, collection nursery, variety sample, gene pool, variety type, agroecotype, economically valuable traits, morphological and biological traits.*

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ОБҐРУНТУВАННЯ МЕТОДІВ СТВОРЕННЯ НОВОЇ ВИХІДНОЇ СИРОВИНИ ДЛЯ ВИВЕДЕННЯ ВИСОКОПРОДУКТИВНИХ СОРТІВ ТЮТЮНУ (NICOTIANA TABACUM L.), АДАПТОВАНИХ ДО АГРОКЛІМАТИЧНИХ УМОВ ЛІСОСТЕПУ УКРАЇНИ

Тютюн є важливою технічною культурою агропромислового комплексу України. До недавнього часу тютюнництво було однією з найприбутковіших галузей сільського господарства з рівнем рентабельності 28–40 %. Однак, за роки незалежності нашої держави, спостерігається стала тенденція до зниження обсягів виробництва сировини тютюну. Головною причиною зниження тютюнового виробництва є скорочення площ вирощування на Закарпатті, Придністров'ї та втрата унікальної зони культивування в Криму [1, с. 24–27]. За офіційною статистикою, виробництво тютюну в Україні нині забезпечує потреби галузі тільки на 5 %. Робота тютюнових фабрик повністю залежить від імпорту сировини із-за кордону.
Відповідно, стратегічним завданням галузі є збільшення обсягів тютюну власного виробництва, що можливо лише за рахунок впровадження нових конкурентоздатних сортів вітчизняної селекції з поліпшеними кількісними та якісними показниками продуктивності [2, с. 25–27].
Прогрес сучасної селекції тютюну обумовлений, насамперед, генетичним потенціалом та різноманіттям вихідного матеріалу. Багаторічне вивчення колекційних зразків дає змогу ідентифікувати джерела найбільш важливих морфологічних та господарсько-цінних ознак з високою адаптивністю генотипу до агрокліматичних умов центрального Лісостепу України [3, с. 70–78].
Одним із важливих напрямків розвитку галузі тютюнництва є не тільки збільшення обсягів вирощування тютюну, а й поліпшення його якості. Це обумовлено, насамперед тим, що значна частина тютюнової продукції українських фабрик виготовляється з імпортної сировини. Відповідно, підтримка власного виробника можлива лише за рахунок впровадження у виробництво нових конкурентоздатних сортів вітчизняної селекції з поліпшеними кількісними та якісними показниками продуктивності. Наша держава може бути однією з провідних європейських держав, яка виробляє високоякісну тютюнову сировину. Вирощування тютюну в Україні стало традиційним завдяки географічному положенню, сприятливим кліматичним умовам, наявності значних площ родючих земель, кваліфікованих трудових ресурсів.
За результатами досліджень проведено класифікацію ознакової колекції тютюну за комплексом морфо-біологічних і господарсько-цінних ознак та сформовано вихідний матеріал для селекції високопродуктивних сортів тютюну, адаптованих до агрокліматичних умов центральної частини Лісостепу України.
Ключові слова: *тютюн, колекційний розсадник, сортозразок, генофонд, сортотип, агроекотип, господарсько-цінні ознаки, морфо-біологічні ознаки.*

Problem statement. Tobacco is an important technical crop in the agricultural sector of Ukraine. The main reason for the decline in tobacco production is the reduction of cultivation areas in Zakarpattia and Transnistria and the loss of a unique cultivation zone in Crimea [4, p. 5–6]. According to official statistics, tobacco production in Ukraine currently meets the needs of the industry by only 5%. The operation of tobacco factories is completely dependent on imports of raw materials from abroad. Given the climate change, today a significant part of the territory of Ukraine is a classic zone for growing different varieties of tobacco [5, p. 50–55]. At present, tobacco is cultivated in the southern and western regions of Ukraine on sown areas of 3-4 thousand hectares (less than 0.01% of the total sown area of agricultural crops). Accordingly, an increase in the share of domestically produced tobacco is possible only through the introduction of new competitive varieties of domestic selection [6, p. 120–124]. Therefore, the introduction, study of tobacco plant organogenesis and further selection in the agroclimatic conditions of the central part of the Forest-Steppe of Ukraine are relevant at present

Analysis of recent research and publications. The progress of modern tobacco breeding is primarily due to the genetic potential and diversity of the source material. Long-term study of collection samples makes it possible to identify sources of the most important morphological and economically valuable traits with high adaptability of the genotype to the agroclimatic conditions of the central Forest-Steppe of Ukraine [7, p. 28–32]. According to the results of the research, the tobacco trait collection was classified according to a set of morphological, biological and economically valuable traits and the source material for breeding highly productive tobacco varieties adapted to the agroclimatic conditions of the central part of the Forest-Steppe of Ukraine was formed.

Tobacco farming is an extremely important branch of agricultural production in Ukraine. Large agricultural enterprises have completely stopped growing tobacco, resulting in the loss of jobs for tens of thousands of Ukrainian farmers [9, p. 11–46].

Task statement. The starting material for the research was 19 tobacco varieties of different geographical origin. The plants were grown according to the generally accepted technology, taking into account the peculiarities of the agroclimatic conditions of the Forest-Steppe of Ukraine. The area of the accounting plot was 21.0 m^2, replicated three times. Evaluation for morphological and biological traits was carried out according to the "Methodology for the examination of plant varieties for distinctiveness, uniformity and stability (VOS)" [5, p. 54–58, 8, p. 134–139, 10, 292 p.].

Table 1

Biometric parameters of plants of tobacco collection varieties, 2023–2024

Variety	The height of the lants, cm	The number of of leaves, pcs.	Leaf size, cm		The duration of the of the growing season period, days
			length	width	
Variety type Large-leaved					
Ternopilsky 7	180	25	42	24	108
Ternopilsky 14	171	22	44	27	108
Ternopil Perspective	140	21	43	23	112
Ruby sharp-leaf	166	19	49	29	108
Jubilee new ostroblast	179	24	42	23	109
Giant hollyhock	155	20	43	25	111
Yellow acanthus 3	173	24	41	23	122
Large-leaved 52	167	21	47	24	118
Brave 200	152	21	44	25	111
Ukrainian new	186	23	42	27	
Variety type Virginia					
Virginia 202	169	20	43	25	113
Virginia 27	175	21	45	24	125
Variety type Berley					
Berley 38	96	19	40	25	110
Berley 46	119	21	45	25	107
Burleigh White	146	21	49	24	105
Spectrum	166	17	44	25	112
Variety type Trapezoid					
Trapezoid	161	21	38	24	108
Variety American					
Tempo 321	173	24	41	28	128
Variety type Sobolchsky					
Sobolchsky 33	161	23	36	20	115
$LSD_{0,05}$	7,99	1,07			

The tobacco seedlings were grown in a breeding and greenhouse complex (B&GC). The seeding rate of dry seeds was 0.5–0.8 g per 1m^2. Sowing was carried out with seeds pre-germinated in thermostats. The formation of the optimal plant density (30 plants per 1 dm^2) was carried out manually. Tobacco seedlings reached the standard size in 45–60 days of vegetation, no damage to plants by diseases and pests was observed.

Due to cold weather in the first and second decades of May, tobacco seedlings were planted in the field in the third decade of May. The survival rate of seedlings in the open field was 98–100%. No replanting was carried out. The tobacco plantations were cared for with two inter-row loosening of the soil, manual weeding, hilling, topping and pinching of plants. Phenological observations of plants were carried out throughout the growing season. The periods of the main phases of development were noted: flowering, seed ripening, and vegetation termination. During the growing season, the plants were described, quantitative and qualitative traits were recorded, and their biological characteristics and resistance to diseases and pests were studied. The homogeneity of plants in terms of height, habit, leafiness and other traits was assessed in comparison with the standards. Leaves were collected and recorded in the phase of their technical maturity by tiers. Seeds were harvested when 60-70% of the bolls on the inflorescence of the bulk of the plants were brown. The yield of the samples was compared with the average yield of the typical standard. The best accessions, by individual traits or their complex, were recommended for breeding as source material.

Summary of the main research material. The main purpose of our research was to study the peculiarities of morphological and biological traits and properties of plants of tobacco collection samples in the agroclimatic conditions of the central forest-steppe of Ukraine, to establish the breeding value of the available gene pool of the crop, to identify sources of economically valuable traits and to form a representative collection of tobacco varieties. In 2023–2024, 19 tobacco accessions were involved in the study of tobacco plant adaptability and a trait collection was formed, which contains samples grouped by the level of phenotypic manifestation of both individual traits and their combinations, grown in the agroclimatic conditions of the Forest-Steppe of Ukraine. An important indicator in the selection of pairs for crossing, especially in heterotic breeding, is the high manifestation of quantitative traits (plant height, number of technical leaves, length and width of leaves), which well consolidate heterosis in tobacco. Therefore, in order to select the best tobacco varieties, we conducted a detailed evaluation of the initial forms to determine the stability of the traits and their adaptability (Table 1).

As a result of the research, four groups of cultivars were identified by plant height: short (<125 cm), medium (126–150 cm), and tall (151–185 cm):

– undersized (2 varieties) – Berley 38, Berley 46;

– medium-sized (2 varieties) – Burley White, Ternopil Perspective;

– tall (15 cultivars) – Ternopil 7, Ternopil 14, Rubin, Yubileinyi Novyi, Giant, Yellow 3, Krupnolistyi 52, Bravyi 200, Ukrainskyi Novyi, Virginia 202, Virginia 27, Spectrum, Trapezoid, Temp 321, Sobolchskyi 33.

The main quantitative trait in tobacco breeding is the number of technical leaves per plant (See Table. 1). Therefore, all samples were divided by the classifier into two groups with medium (13–18 pcs.) and large (19–25 pcs.) number of leaves:

– medium number of leaves (1 variety sample) Spectrum;

– a large number of leaves (18 varieties) – Ternopil 7, Ternopil 14, Ternopil Perspective, Rubin, Yubileinyi new, Giant, Yellow 3, Krupnolisty 52, Bravy 200, Ukrainian new, Virginia 202, Virginia 27, Burley 38, Burley 46, Burley White, Temp 321, Sobolchsky 33.

No less important traits are the length and width of the leaves of the studied varieties (See Table. 1). In 2023-2024, the length of the leaf was almost the same for all the cultivars, from 36 cm for Sobolchsky to 33 to 49 cm for Gostrolyst Rubin, the average length of the leaf in the experiment was 43.1 cm. In terms of leaf width, there was no significant difference between the varieties. The average width of the leaf was 24.7 cm, the smallest in Sobolchsky 33 – 20 cm, the largest in the variety Ukrainian new – 27 cm (See Table. 1).

Table 2

Yield of raw materials (dry leaves) of tobacco varieties, 2023–2024

Varieties	Productivity tons per 1 ha
Ternopilsky 7	3,31
Ternopilsky 14	3,21
Ternopil Perspective	3,21
Berley 38	4,03
Berley 46	4,86
Burleigh White	4,46
Tempo 321	4,14
Ruby sharp-leaf	4,05
Jubilee new ostroblast	4,90
Giant hollyhock	3,55
Yellow acanthus 3	3,98
Large-leaved 52	4,08
Spectrum	3,70
Sobolchsky 33	3,31
Brave 200	3,60
Trapezoid	3,84
Virginia 202	4,34
Virginia 27	4,71
Ukrainian new	4,56
Average for the experiment	3,99
$LSD_{0,05}$	0,20

Table 3

Description of tobacco varieties by morphological characteristics of generative organs, 2023–2024

Variety	Inflorescences			The flower, Color
	form	density	number of of boxes, pcs.	
Ternopilsky 7	spherical	loose	141	pink
Ternopilsky 14	spherical	loose	104	pink
Ternopil Perspective	spherical	dense	104	holy pink
Berley 38	spherical	dense	103	pink
Berley 46	spherical	dense	134	pink
Burleigh White	spherical	loose	129	holy pink
Tempo 321	spherical	loose	105	pink
Ruby sharp-leaf	spherical	loose	137	red
Jubilee new ostroblast	extensive	loose	126	holy pink
Giant hollyhock	thyroid	loose	115	holy pink
Yellow acanthus 3	spherical	loose	118	holy pink
Large-leaved 52	extensive	loose	101	holy pink
Spectrum	spherical	loose	120	holy pink
Sobolchsky 33	spherical	loose	114	pink
Brave 200	spherical	loose	101	holy pink
Trapezoid	spherical	loose	122	pink
Virginia 202	extensive	very loose	108	white
Virginia 27	spherical	loose	124	holy pink
Ukrainian new	spherical	loose	109	holy pink
Average value			116,6	
$LSD_{0,05}$			5,8	

Table 4

Seed yield of tobacco varieties, 2023–2024

Variety	Yield, t^{h-1}	Weight of 1000 seeds, mg
Ternopilsky 7	0,67	78
Ternopilsky 14	0,58	82
Ternopil Perspective	0,67	80
Berley 38	0,77	64
Berley 46	1,01	77
Burleigh White	0,67	70
Tempo 321	1,06	79
Jubilee new ostroblast	1,01	71
Giant hollyhock	0,96	90
Yellow acanthus 3	0,91	55
Large-leaved 52	1,01	74
Spectrum	0,86	68
Jubilee new ostroblast	0,72	70
Sobolchsky 33	0,86	60
Brave 200	0,96	57
Trapezoid	1,01	64
Virginia 202	0,86	70
Virginia 27	1,15	98
Ukrainian new	0,91	97
Average for the experiment	*0,88*	*73,9*
$LSD_{0,05}$	*0,04*	3,7

According to the results of the research on the productivity of tobacco varieties, it was not possible to distinguish tobacco collections by yield in 2023-2024 (Table 2). The average yield in the experiment was 3.99 t/ha. Always productive varieties of Ternopil selection showed relatively low yields, 3.21 – 3.31 t/ha, which can be explained by the lack of moisture in the soil. High yields, as for 2023-2024, with a moisture deficit, were shown by the varieties Gostrolyt Yubileinyi Novyi – 4.9 t/ha and Berley 46 – 4.86 t/ha, which were created in regions with relatively dry growing conditions.

As a result of observations of the growth and development of generative traits, it was found that there is a need to select biotypes that are hereditarily able to withstand negative environmental factors with high genetic potential for yield and quality without reducing seed productivity (Table 3). The density of branches and flowers in an inflorescence is a systemic feature of tobacco plants. Inflorescences are distinguished depending on the density of flowers on the branches of the first and second orders: loose, dense and not dense.

According to the density of the inflorescence, the research of 2023-2024 identified cultivars with a loose inflorescence – 9, dense – 3, and loose – 7. As a result of research on the number of seed pods per plant, it was found that tobacco varieties have an average of 116.6 pcs., depending on the variety, it ranges from 101–103 pcs. in varieties Brave 200, Berley 38 to 137–141 pcs. in varieties Gostrolist Rubin, Ternopil 7.

In 2023-2024, all tobacco varieties studied in the experiment had a very extended period of ripening of 50% of the bolls, which is the first and second decade of October. Weather conditions during seed formation significantly affect its development and sowing qualities. There are large differences in the quality of seeds formed in favorable and unfavorable weather conditions. It was also found that the sowing and yielding qualities of tobacco seeds are greatly influenced by the environmental and agronomic conditions of its cultivation. According to the seed productivity of plants, we can distinguish tobacco varieties that had low seed yields, 0.58 t/ha of Ternopil 14 and 0.67 t/ha of Ternopil 7, Ternopil Perspective and Burley White. The best results were shown by varieties Burley 46, Gostrolyst Rubin, Gostrolyst Zhovtyy 3, Trapezond – 1.01 t/ha and Virginia 27 – 1.15 t/ha (Table 4).

Analyzing the collected research materials in 2023–2024, it should be noted that the average weight of 1000 seeds in tobacco varieties was 73.9 mg, which corresponds to the description of the studied samples (Table 4). The low weight of 1000 seeds of 55, 57, and 64 mg was observed in the varieties Giant Gostrolist, Bravy 200, and Berley 38, respectively. The best results in terms of weight of 1000 seeds were shown by Virginia 27 – 98 mg, Ukrainian new – 97 mg, Gostrolist Yubileiny new – 90 mg.

Conclusions. According to the results of the research, a complex of morphological, biological and economically valuable traits was studied and the source material for breeding highly productive tobacco varieties adapted to the agroclimatic conditions of the Forest-Steppe of Ukraine was formed. For breeding work, sources with a complex of morphological, biological and economically valuable traits were identified for use in heterotic selection. To obtain hybrids with high inheritance of elements of raw material yield and seed productivity, it is necessary to involve varieties and collection samples with different patterns of variability in hybridization, where the mother form will be characterized by high raw material yields and the father form by high seed productivity.

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