**EVALUATION OF PRODUCTIVITY AND QUALITY OF DIFFERENT VARIETIES OF UKRAINIAN GROUP OF NICOTIANA RUSTICA**

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**ОЦІНКА ВРОЖАЙНОСТІ ТА ЯКОСТІ РІЗНИХ УКРАЇНСЬКИХ СОРТІВ УКРАЇНСЬКОЇ ГРУПИ NICOTIANA RUSTICA**

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**ABSTRACT**

*The availability of varieties and collections of N. rustica L. became the basis for planning experiments to study their adaptive potential. The purpose of the research is to evaluate the productivity and quality of leaves of the Ukrainian group of varieties of shaggy N. rustica L.. The main material during the formation of the collection was the amateur material of local varieties preserved by farmers and individual individuals, which clearly represent different ecotypes with a large set of economic and valuable features, well adapted to cultivation in certain conditions of their cultivation. Biometric assessment of five Ukrainian cultivars was carried out. The study of the dynamics of the passage of the main phenological phases of shag growth made it possible to establish varietal features. Varieties with early vegetation and pod formation were selected as valuable starting material for breeding. Varieties of Nicotiana rustica of the Ukrainian group are characterized by rather fast vegetation and a short flowering period. This property allows varieties of this group to form a sufficient amount of vegetative mass with high nicotine content for cultivation.* Four varieties can be divided into a line according to the decrease in nicotine content:Vysokorosla Zelena > Koriotes dark >, Kharkyvska > Ukraynka.

**ТЕЗИ**

*Наявність сортів і колекції N. rustica L. стала основою для планування дослідів з вивчення їх адаптивного потенціалу. Мета дослідження – оцінка продуктивності та якості сортів української групи сортів махорки N. rustica L.. Основним матеріалом під час формування колекції слугував збережений фермерами, окремими приватними особами аматорський матеріал місцевих сортів, які виразно представляють різні екотипи з великою сукупністю господарсько-цінних ознак, добре адаптованих до вирощування в певних умовах їх культивування. Біометрична оцінка п’яти українських сортотипів проведена. Вивчення динаміки проходження основних фенологічних фаз росту махорки дозволило встановити сортові особливості. Сорти з ранньою вегетацією та формуванням стручків відібрано як цінний вихідний матеріал для селекції. Сорти Nicotiana rustica української групи відрізняються досить швидкою вегетацією і коротким періодом цвітіння. Ця властивість дозволяє сортам цієї групи формувати достатню для вирощування кількість вегетативної маси з високим вмістом нікотину. За зниженням вмісту нікотину наступні чотири сорти можна розділити в лінійку: Високоросла Зелена > Коріотес темний >, Харківська > Українка.*

**INTRODUCTION**

The plant Nicotiana rustica L. (also known as "wild tobacco", "Aztec tobacco" or "tobacco") and *Nicotiana tabacum L.* (common tobacco) are only two of the 76 species of *Nicotiana (Solanaceae)*. Varieties of the genus *Nicotiana* - shag and tobacco belong to the same nightshade family. Meanwhile, they differ significantly in appearance and internal qualities. *N. rustica L.* is an underestimated culture that contains many biologically active substances that have a strong effect on the human body. *N. rustica L.* was once a type of smoking product, but later it lost its consumers. It is important to determine the chemical composition of *N. rustica L.* to introduce the best samples into the breeding process. Note that tobacco is still used in some countries to treat scabies in animals (Hirschmann & De Arias, 1990) or as an antidote for snakebites (Martínez & Luján, 2011). According to the scientific approaches of ethnopharmacology, the leaves of the shag are used in the treatment of ulcer abscesses, fistulas, ulcers, ingrained polyps and many other ailments (Tsouh Fokou et al., 2015). Aqueous infusion of horsehair is a well-known means of biological protection against pests in organic farming.

The high level of alkaloids and its suitability for the industrial production of nicotine and nicotine-containing products is one of the reasons for the cultivation of shag (Jassbi et al., 2017; Kurucu et al., 1998). Two obtained aromatic products (concrete and resinoid) were tested for antimicrobial activity against a set of test microorganisms (Popova et al., 2020). It is known that they inhibited the growth of such Gram-positive bacteria as *Staphylococcus aureus and Bacillus subtilis* (Bakht et al., 2013). The rest of the tested bacteria, yeasts and molds were not sensitive to these two aromatic products from the leaves of *N. rustica.*

A significant amount of such chemical compounds as alkaloids, proteins, tobacco protein of two fractions, solanesol, and lipids remains in the field, because up to 80‒85 thousand stems with 3‒4 small upper leaves and seeds remain on 1 ha of the field after the breaking of tobacco leaves (Smailov & Samieva, 2008). Cellulose, pentosans and lignin make up to 80% of the total mass of air-dry raw materials (Samieva, 2013). These compounds are of interest for the hydrolysis, microbiological, pulp and paper industry.

Indian scientists recommend the use of "coarse extracts" from shaggy biomass as components of fertilizers for agricultural production, since a longer retention of phosphorus components in the soil has been recorded in such a preparation due to the effect of chelation of organic acids with iron and aluminum ions (Chakraborty et al., 1983 ). Shag oil is used in the production of paints, varnishes and soap.

The species *N. rustica L.* and *N. Tabacum L*. belong to the genus *Nicotiana* of the family *Solonaceae*. This family includes 85 genera and more than 2000 species distributed in America, Africa, Australia, Europe and Asia. The main genus of the family - Solanum has up to 1,500 species, larger than other genera - Petunia, Cestrum and Nicotiana. Some cultivars of *Nicotiana* have been identified with several advantages, including high phenotypic diversity, susceptibility to controlled hybridization and ploidy manipulation, and high fecundity and responsiveness to *in vitro* tissue culture (Lewis, 2011). Consequently, *N. tabacum* and *N. benthamiana Domin* have emerged as model organisms in generating new knowledge related to hybridization, cytogenetics, and polyploid evolution and determination of salt stress tolerance (Goodin et al., 2008; Zhang et al., 2011; Bally et al., 2018; Schiavinato et al., 2019; Xu et al., 2022). Nicotiana species have undergone genetic differentiation involving aneuploidy, gene mutations, chromosomal changes, and hybrid recombination in parallel with amphiploidy (Mehmood et al., 2020). Today there are species that represent the last evolutionary stage of the genus, and at this stage the youngest 24 paired species occupy the highest phylogenetic position. *N. rustica L.* and *N. tabacum L.* belong to these species.

The evolution of the genus Nicotiana took place on the South American continent for tens of millions of years, during which glaciations, the change of dry and wet periods, mass epiphytotia of diseases and pests were recorded, therefore modern species of *Nicotiana*, including *N. rustica L.* and *N. tabacum L*., have potentially adaptive genotypes to many adverse conditions (Ortiz, 1963). Numerous evidences confirm that *N. rustica L*. and *N. tabacum L.* were cultivated on the continent for a long time, and its range included the modern territories of Mexico, Central America and a large part of the South American continent (Bährle-Rapp, 2007). A certain technology for growing and processing nicotine-containing plants existed as early as the age of Columbus (Knapp et al., 2004). It has been established that the nicotine content depends on *Nicotiana* cultivars of different varieties grown under the same conditions (Tayoub et al., 2015). There are known data that the amount of nicotine in the leaves of *N. rustica L*. cultivars can reach 3.4 and even 8.3%. The nicotine content can vary by three or more times. Much more nicotine accumulates in dry years. It is known that the nicotine content can be reduced by excessive irrigation by 3-5 times (Henry et al., 2019). The positive effect of gibberellic acid on the growth of tobacco plants and the accumulation of nicotine was no less significant (Carew, 1961). A reduction in nicotine content was observed as gibberellic acid treatment increased growth rate and total chlorophyll content.

The polyploid nature of the species, its heterozygous state, as factors of shape formation, contributed to a large intraspecific variation in different natural growth conditions. New necessary forms were created under the influence of natural hybridization and active human activity (Binorkar & Jani, 2012). A large variety of varieties and forms of *N. rustica L.* was formed in different ecological and geographical zones during long-term culture.

The main objective of this case study was to evaluate the productivity and quality of varieties of the Ukrainian group of cultivarsof shag *N. rustica L.*

**MATERIALS AND METHODS**

The main material for research was a collection of domestic local varieties - representatives of various ecotypes with a large set of economic and valuable traits with high adaptability to cultivation in certain weather and soil conditions. Varieties of the genus Nicotiana - shag and tobacco, belong to the same family of nightshades, but they differ significantly in appearance and internal qualities. It is necessary to make significant efforts of a technical nature, because these plants belong to the seedling type of reproduction to restore the collection of *N. rustica L.* and maintain the existing tobacco collection, (Rahim et al., 2019).

Weather conditions at the time of the study hardly differed from the long-term average. Plants were grown by the seedling method. The repetition of the research is twofold. The plots are single-row, which occupied up to 20 m2. The measurements were made on 20 typical plants of the same variety. The number of leaves was counted at the end of the growing season. The size is indicated according to the leaves of the middle tier.

The methods of evaluating shag hair for distinctiveness, homogeneity and stability were used to evaluate varieties. Determination of alkaloids was carried out by the spectrophotometric method according to the international standard ISO 2881-77.

**RESULTS**

The duration of the growing season, yield, type of raw material and requirements for agrotechnical growing conditions and morphological characteristics were used as the basis for the breeding of cultivars of the Ukrainian group of *N. rustica L.* The results of biometric evaluation of six cultivars grown in Zakarpattia province is presented in Table 1.

**Table 1**

**Productivity of varieties of the Ukrainian group in conditions Zakarpattia**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety** | **Vegetation period** | **Height** | **Leaves number** | **Lengthx**  **wide** | **Dry weight of one plant** |
| **[day]** | **[cm]** | **[unit]** | **[cmxcm]** | **[g]** |
| Khmelyvka | 87 | 98 | 7 | 24.3х25.7 | 75.4 |
| Khmelyvka 125/6 | 90 | 92 | 8 | 23.4х24.1 | 75.4 |
| Ukraynka | 93 | 50 | 8 | 20х23 | 95.6 |
| Kharkyvska | 77 | 35 | 12 | 22х23 | 64.1 |
| Vysokorosla Zelena | | | | | |
| Vysokorosla Zelena | 40 | 85 | 15 | 24х24 | 83.0 |
| Kurchava | | | | | |
| Koriotes dark | 47 | 63 | 13 | 21.5х21.0 | 62.0 |
| Kurchava | 45 | 63 | 15 | 21.1х20.5 | 61.5 |
| Slag №5 | 41 | 68 | 12 | 21.2х21.3 | 62.0 |
| Bakun | | | | | |
| Bakun chorny | 54 | 78 | 15 | 30.3х27.7 | 137.0 |
| Bakun № 46 | 47 | 76 | 16 | 27.3х27.5 | 95.0 |
| Bakun Bessarabsky | 30 | 76 | 15 | 25.0х24.8 | 74.6 |
| Bakun Mena | 41 | 81 | 15 | 26.3х24.7 | 68.9 |
| Zhovta | | | | | |
| Zhovta -106 | 42 | 70 | 8 | 17.0х16.2 | 38.0 |
| Zhovta -109 | 80 | 70 | 10 | 16.8х16.5 | 48.3 |
| Zhovta | 39 | 80 | 12 | 24.2х24.2 | 60.7 |
| Sultan Albansky | 40 | 50 | 14 | 24.6х23.8 | 63.9 |
| Vergun zeleny | 42 | 68 | 8 | 19.0х18.5 | 45.3 |

Phenological observations of five cultivar types of the Ukrainian group were carried out for three years by replanting on the same plot. All varieties had a fairly fast vegetation period and a short flowering period. Flowering began on average 30 days after planting in the field. It was established that the duration of the summer-autumn development of N. rustica L. in the studied varieties was 135 days on average. The groups with early ripening and somewhat late flowering of plants were distinguished. The peculiaritity of late flowering enables the formation of productive organs.

Nicotine content depends on many factors. The plate of a tobacco leaf is characterized by uneven distribution of nicotine. Nicotine content increases from the middle to the edges and from the base to the top within one leaf. The middle vein has the lowest percentage of nicotine. The nicotine content increases from the lower layers of the leaf to the upper ones. A higher nicotine content is observed from leaves of intense green color compared to light colored ones. All varieties of the above-mentioned variety types have a fairly fast vegetation period and a short flowering period. Varieties of the Khmelivka group are characterized by the highest content of alkaloids in dried leaves. The dependence of the nicotine content on the intensity of the color of the ripe leaf of the shag is corrected with the results of the determination of nicotine and the elemental analysis of the leaves of high-yielding varieties of *N. rustica L.* (Table 2).

. **Table 2**

**Results of varieties of *N. rustica L.quality assessment***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety** | **Nikotine** | **Color** | **N** | **C** | **H** |
| **[%]** |  | **[%]** | **[%]** | **[%]** |
| Kharkyvska | 1.615 | Intense green | 3.1 | 38.3 | 5.5 |
| Khmelyvka 125/6 | 0.613 | Dark green | 2.4 | 35.4 | 5.5 |
| Khmelyvka | 0.952 | Moderately green | 2.9 | 37.5 | 5.8 |
| Ukraynka | 1.312 | Moderately green | 3.8 | 37.6 | 5.7 |
| Vysokorosla Zelena | 2.89 | Olive | 3.5 | 38.2 | 6.0 |
| Kurchaia | 0.311 | Dark blue | 2.9 | 37.5 | 5.9 |
| Koriotes dark | 2.371 | Green | 3.0 | 38.8 | 6.0 |
| Slag №5 | 0.864 | Green | 2.5 | 36.4 | 5.5 |
| Bakun chorny | 0.847 | Yellow-green | 3.4 | 36.9 | 5.7 |
| Bakun № 46 | 0.257 | Green | 2.1 | 30.7 | 4.8 |
| Bakun Bessarabskyй | 0.263 | Green | 1.9 | 28.3 | 4.2 |
| Bakun Mena | 0.652 | Light green | 3.0 | 34.3 | 5.3 |
| Zhovta-106 | 0,312 | Light green, yellowish | 2.9 | 35.5 | 5.7 |
| Zhovta -109 | 0.513 | Light green | 1.4 | 25.4 | 4.5 |
| Zhovta | 0.652 | Yellow-green | 1.9 | 28.5 | 4.9 |
| Sultan Albansky | 0.545 | Yellow-green | 1.4 | 24.9 | 4.3 |
| Vergun zeleny | 0.340 | Dark green | 3.0 | 35.8 | 5.9 |

Four varieties can be divided into a line according to the decrease in nicotine content:Vysokorosla Zelena > Koriotes dark >, Kharkyvska > Ukraynka.

The highest carbon content (>38%) was observed in Koriotes dark, Kharkyvska and Vysokorosla Zelena. The highest nitrogen content (>3%) was determined in Ukraynka, Vysokorosla Zelena, Kharkyvska and Bakun chorny.

**CONCLUSIONS**

*N. rustica L.* as a technical product is an underestimated crop, due to the rich number of valuable compounds in interest to the pharmaceutical, hydrolysis, microbiological and pulp and paper industries. The task is, to determine the chemical composition of *N. rustica L.* for the introduction of the best samples in the breeding process. The main material for the research was, a collection of domestic local varieties ‒ representatives of different ecotypes with a large set of economically valuable traits, with high adaptability to cultivation in certain conditions of their cultivation. As a result of observations it was established, that the duration of summer ‒ autumn development of *N. rustica L.* in the studied varieties averaged 135 days, and depending on the variety 100‒149 days. Chemical plants research of the genus Nicotiana involves the accurate study of the composition on different types of tobacco raw materials and the development methods for objective assessment of product quality. These studies allow to determine the degree of improvement on certain technological tobacco processing means, to develop methods of changing the tobacco raw materials composition in the right direction, and makes it possible to obtain valuable substances (nicotinic acid) in the maximum amount for a particular plant. The nicotine content in the varieties of the Ukrainian group was studied and were selected the samples with the highest nicotine content and the best varietal qualities of vegetative mass productivity and vegetation duration. The nicotine content depends on many factors. Nicotine content depends on the color of the leaf blade of *N. rustica L.* A higher nicotine content was recorded in the leaves of intense green color compared to light-colored. Almost all samples have a high nicotine content, but only two cultivars should be distin-guished ‒ Koriotes dark, in which the nicotine content exceeded 2%, and Khmelivka cultivar, reacted very positively to the growing conditions.

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