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PROSPECTS FOR GROWING AND FEATURES OF AGROTECHNOLOGY OF ANNUAL WHITE SWEET CLOVER (*MELILOTUS ALBUS MEDIK.*) IN THE CONDITIONS OF THE SOUTHERN STEPPE OF UKRAINE

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Problem statement. In recent years, against the background of intensive structural reforms, the lack of pricing policy stability for livestock products, and, as a result, the disappearance of permanent sales markets, there has been a sharp decrease in the livestock population [1-3]. This situation has led to the fact that feed production has begun to lose its industrial scale and has affected the development and systematic nature of this industry [1, 3-5].

Along with the crop production intensification and increasing the yield of fodder crops, fodder producers must ensure the production of high-quality fodder, since it is on this that the productivity of farm animals depends [3-9]. The nutritional value of fodder plants is directly affected by their chemical composition, which depends on the biological characteristics of the crop, variety, vegetation phase, areas of use, soil and climatic, agrotechnical conditions and other factors [7, 10-12].

In conditions of protein deficiency, legumes are considered one of the main sources of feed protein [1, 13]. The introduction of legumes into grass mixtures, as well as independent sowing of grass crop, will contribute to the accumulation of crude protein in the dry mass, which in turn will allow to increase its content compared to cereal grasses [14-17]. In addition to increasing the content of digestible protein, feed units, and metabolizable energy in the feed unit, legumes will increase the content of calcium, magnesium, copper, and manganese, which will contribute to improving the digestibility of dry mass [17, 18]. Also, such measure will allow to increase the ratio of calcium to phosphorus, protein ratio and potassium to the sum of calcium and magnesium while simultaneously ensuring a decrease in the content of nitrogen-free extractive substances, and with long-term use it will also lead to a decrease in potassium [19-23].

Another important feature of legumes is their impact on soil fertility, which is of great importance in areas that have been subjected to anthropogenic impact [7, 9]. As evidenced by many years of research conducted by domestic and foreign scientists, legumes are considered true pioneers in the field of phytoremediation of soils that have been subjected to technogenic load [24-29].

The positive impact of legumes occurs not only due to improved drainage, but also due to the process of carbonic acid release by the root system, which directly contributes to the chemical process of salinization. That is, legumes contribute to the process of land reclamation, and in addition, they are a less expensive biological method [29-31]. It has been proven that they are the best precursors in crop rotation, as they are able to enrich the soil with nitrogen and contribute to improving its structure, which contributes to obtaining better yields of agricultural crops (both seeds and commercial grains) [25, 27, 29]. The most popular legume forage crops are lucerne, red clover and sainfoin. The introduction of forage legume crops into the crop rotation structure and their cultivation on lands that have undergone salinization will contribute to positive changes in the agrochemical composition of elements and the salinization of such soils, which will allow for a reduction in the use of mineral fertilizers [25].

One of such legume crops is annual white sweet clover (*Melilotus albus Medik.)*. The cultivation of this crop in the modern arid conditions of Southern Ukraine is relevant.

Analysis of recent research and publications. In modern production of agricultural plant products, a significant part of the costs is spent on the purchase and application of mineral fertilizers, which in turn leads to a significant increase in the cost of production [1, 31-33]. In addition, the use of mineral fertilizers, which are predominantly salts, leads to soil salinization, increasing the environmental load on the environment [1, 33]. The introduction of fodder legumes (annual white sweet clover, red clover, sainfoin, lucerne) into the crop rotation system will contribute to the accumulation of nitrogen available to plants in the soil. Thus, growing annual white sweet clover leads to the accumulation of up to 150 kg/ha of nitrogen in the soil. For comparison, to ensure the receipt of such an amount of nitrogen using ammonium nitrate, 0.4 t is required per 1 ha, the estimated cost of which is 3,000 UAH per 0.1 t. Therefore, the approximate savings will be 12,000 UAH per ha. And this is without taking into account the costs of equipment, fuel and lubricants, and labor costs for the fertilizer application operation [34, 35].

This crop is considered to be available for a wide range of uses and has significant economic and agrotechnical advantages (Fig. 1). First of all, this crop, according to the biochemical composition of its vegetative mass, can be considered a highly productive fodder protein plant [18-23, 36-39]. Annual white sweet clover can be introduced into crop rotations for use on hayfields and pastures. In addition, annual white sweet clover becomes especially valuable for cultivation in areas where, due to the peculiarities of

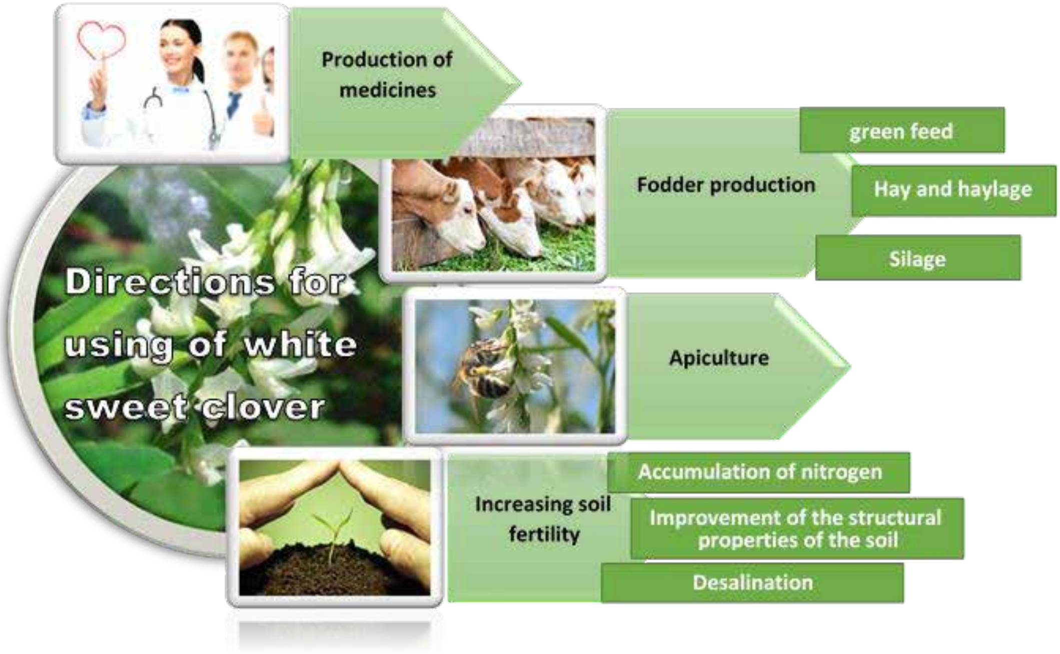

Fig. 1. Directions for using of white sweet clover

soil and climatic conditions, the cultivation of annual white sweet clover and lucerne becomes impossible [7, 14].

As is known, the nutritional value of sweet clover is somewhat inferior to lucerne and red clover, but in the early phases of vegetation the amount of nutrients is very high and is almost on the same level as other fodder legumes (Table 1). According to studies conducted by domestic scientists, 100 kg of green mass of annual white sweet clover in phase of the beginning of flowering contains 18 feed units, 2.7 kg of digestible protein and almost 40 mg of carotene. One feed unit accounts for 8.4 kg of green mass of annual white sweet clover [18, 22, 23, 38-41].

The white sweet clover leaves have the greatest nutritional value. As shown by the research of the Institute of Feeds of the NAAS conducted in 1990 -1993, the green mass of the white sweet clover at the beginning of flowering contained almost 26% of dry matter, the content of digestible protein reached 14.96%, nitrogen-free extract (NFE) reached 36.34%, fat reached 2.56%, fiber reached 36.6%, ash reached 6.54% [17, 18, 21, 38].

In addition, scientists from the laboratory of zootechnical assessment of the Institute of Feed of the NAAS have systematically studied for a long time the amino acid composition of the sweet clover protein and have established that the following ratio of amino acids to lysine (%) is inherent in feeds from sedge leaves: leucine was 123, valine was 67, trehaline was 76, isoleucine was 63, phenylalanine was 81, tyrosine was 42, histidine was 52, methionine was 14, tryptophan was 35 [9, 11].

Animals eat sweet clover well not only in the form of green mass, it can be fed in the form of hay, silage, or grass flour [6, 7, 41].

For the production of grass flour, it is recommended to mow the grass in the bud formation phase [42].

Silage from the grass contains a significant amount of protein, which is characterized by fairly high digestibility values. The grass can be ensiled in its pure form, but, as evidenced by the experience accumulated by scientists at the Institute of Feed of the NAAS, it is more expedient to ensile the grass in a mixture (with corn or cereal grasses). The silage obtained from the grass contained almost 2.7% crude protein, while 1 k. u. included 10.6 kg of silage, which corresponded to 178 g of digestible protein [9, 11, 41].

It is worth noting that during the drying of the sweet clover for hay, its leaves can easily fall off, so it is more expedient to sow the sedge for hay in a mixture with cereal grasses. According to the experience of scientists, the sweet clover for hay should be mowed during the period when the lower flower buds on the plant stems begin to appear. At the same time, the hay accumulates 17.2% protein, 28.5% fiber, and 0.161% coumarin content [9, 11, 18, 21-23].

Table 1

Comparative nutritional value of sweet clover and lucerne feeds

Crop	Content in 1 kg of feed		
	Feed units, c.u.	Digestible protein, g	Digestible protein per 1 c.u.
Sweet clover	0.17	39.0	218.0
Lucerne	0.18	31.0	179.0

Studies conducted by Estonian scientists shown that when feeding silage from sedge, the milk yield of cows increased by an average of 1.2 liters of milk compared to feeding silage from a pea-oat mixture. And when feeding corn-potato silage to beef cattle, its productivity increased by 14.1-17.5%, and dairy cattle increased by 13.9-15.7%. At the same time, a decrease in feed costs per unit of production was observed by approximately 1.2-1.4 times [23].

But the disadvantages of this species are the rapid lignification of the stems and the high content of coumarin, which gives the feed a specific taste and aroma. Therefore, green feed should be harvested at the appropriate stage of plant growth.

Also, since ancient times, the rather high qualities of the sweet clover as a medicinal plant have been known, and now, it is quite successfully used as a pharmaceutical raw material in the manufacture of various environmentally safe medical preparations [39]. Preparations made from the sweet clover have a certain therapeutic effect, namely their anticonvulsant, cardiotonic, sedative, analgesic, anti-inflammatory, expectorant, emollient, carminative, anticoagulant and diuretic effects are known [39].

This plant is also very well known to beekeepers as a good honey plant. One flower of the sweet clover is capable of secreting 0.15-0.50 mg of nectar, while its sugar content reaches almost 0.05 mg, and the concentration of sugar in the nectar is up to 55%. It is known that the honey productivity of the sweet clover ranges from 120-200 kg/ha.

As beekeepers have observed, the secretion of nectar by the sweet clover also occurs in dry weather, unlike other honey plants, which allows bees to work on it throughout the day. The plant secretes a lot of coumarin, which strongly attracts insects.

Due to the peculiarities of the structure of the sweet clover flower, the secreted nectar is almost not subject to washing out and evaporation. The sweet clover produces light honey, which beekeepers consider one of the best for feeding bees in winter.

Honey from the white sweet clover has a rich aroma, contains 37% glucose and 40% fructose. The use of sweet clover honey for the treatment of influenza, colds, etc. has long been known. It is also known that the use of honey from sweet clover helps to increase the content of hemoglobin and the number of red blood cells in the blood. And the enzymes that make up this honey are able to somewhat improve the functioning of the digestive organs.

In addition to the above advantages, white sweet clover is one of the best sideral crops that has nitrogen fixation functions. Such features certainly allow it to be successfully introduced into modern short-rotation crop rotations of the Steppe of Ukraine.

The purpose of the article was to systematize scientific research data on the morphobiological features and economic importance of annual white clover and to analyze existing agrotechnical measures in the cultivation of annual white sweet clover.

Research results. ***Morphological features.*** In terms of its structure, annual white sweet clover (*Melilotus albus Medik.*) is almost the same as biennial white sweet clover [41, 43, 44]. The only significant difference is that this type of sweet clover is a spring-type plant [45]. Annual white sweet clover plants bloom and produce seeds in the year of sowing. The productivity of this type of sweet clover is 15-20% lower than that of biennials, because the plants almost do not grow back after mowing in the budding-flowering phase.

Plants of annual white sweet clover (*Melilotus albus Medik.*) reach a height of 80-200 cm, have erect green stems (may have a reddish color from below), which branch (Fig. 2). On one stem of this plant, up to 70 inflorescences are usually formed, in which there are up to 3-5 thousand flowers. On one plant of the annual white sweet clover the simultaneous blooming of almost 30-50 flowers is usually observed, and during the period when mass flowering occurs, the number of opened flowers reaches 80-200.

Annual white sweet clover plants have a strong taproot system. Roots of these plants are well developed, have branches, and are able to penetrate the soil to a depth of 4-5 m. Plants successfully resist droughts, using moisture in deep soil horizons [43-46].

The leaves of these plants have a tripartite shape, characteristic of other legumes, and are serrated along the entire edge (Fig. 2, 3). The lower and middle leaves of the annual white sweet clover consist of three rhomboid-ovate leaflets, and the upper ones have an elongated-lanceolate shape [43-48].

Annual white sweet clover plants have bisexual, zygomorphic, small white flowers on short pedicels. The flowers of the plant (Fig. 4) are collected in long (5-10 cm) multi-flowered inflorescences (axillary racemes). The flowers bloom gradually from the bottom up. Depending on the plant's growth conditions, the flowering phase of one flower can last 2-6 days, while the raceme blooms for up to 8-14 days [16, 45-48].

Fig. 2. Annual white sweet clover (Melilotus albus Medik) stem

Source: https://identify.plantnet

Fig. 3. Annual white sweet clover: a – seedlings; b – plant in the branching phase

Source: own photos

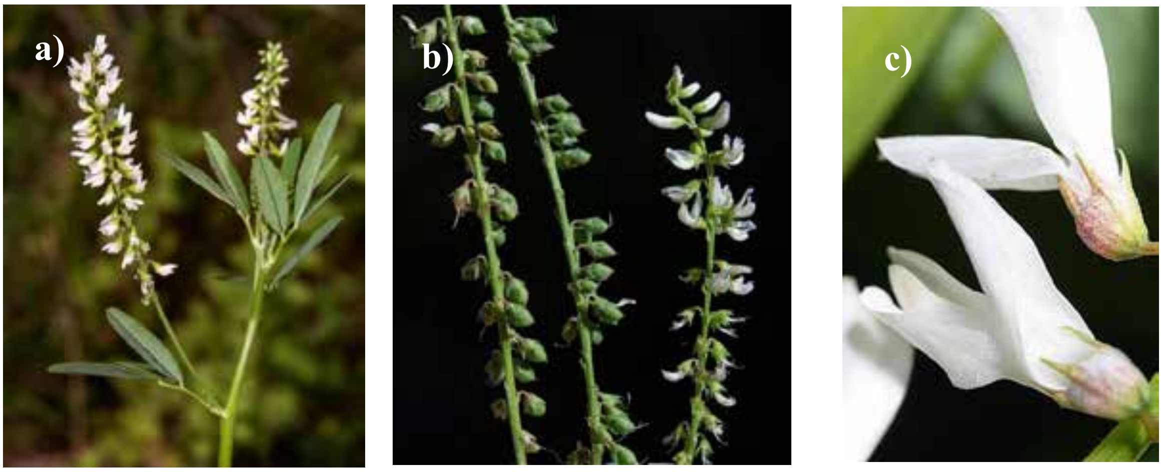

Fig. 4. Appearance of the inflorescence and flower of the white sweet clover: a – flowering phase; b – phase of fruit and seed formation c – flower

Source: https://www.florandalucia.es

Inflorescences of the annual white sweet clover are usually formed unevenly. During development, new branches with inflorescences are formed in the leaf axils. On one inflorescence of the annual white sweet clover can be formed from 40 to 120 flowers. The flowering of the plants lasts during June-July [14, 16, 41, 43-48].

The fruit of the white sweet clover is a round-ovate or elliptical 2-3-seeded pod, which is usually light yellow or brownish-gray in color (Fig. 5). Most often, the fruit is indehiscent [16, 43, 45]. The annual white sweet clover reproduces by seeds, the germination of which does not lose for more than 10 years [45-48].

The seeds of the annual white sweet clover are heart-shaped, yellow in color, sometimes with a greenish tint (Fig. 6). The surface of the seed is matte or slightly shiny.

One plant of the annual white sweet clover is capable of producing up to 17 thousand seeds. The size of the seeds is 1.7-2.2 mm. The seed scar is small, round. The mass of 1000 seeds varies within 1.8-2.2 g [16, 48].

The seeds of annual white sweet clover are distinguished by their hard shell; therefore, they require scarification and begin to germinate at a temperature of 3-5°C. As producers note, this plant seedlings are able to withstand slight frosts (down to minus 3-5°C). The optimum temperature for successful vegetation of annual white sweet clover is 25-27°C [16, 45, 48].

Plants of annual white sweet clover are drought-resistant. It does not grow well on acidic soils, but is able to grow well on poor light sandy saline and salt marsh soils, while the plants even improve soil fertility.

The growing season of the annual white sweet clover lasts 120-146 days. The flowering period lasts 2-2.5 months. The plant is cross-pollinated by bees, wasps, bumblebees [16, 43-45].

Annual white sweet clover has good resistance to damage by phytophagous and diseases. According to many years of observations, the shoots of this plant can be damaged by bulb weevils, the leaf apparatus by caterpillars of the meadow butterfly, and the seeds by larvae of the trichiurus, but they do not cause significant damage [16, 43-48].

Cultivation technology. The yield of any crop, including annual white sweet clover, is influenced by a number of significant factors: biological characteristics of the variety, soil and climatic conditions, preparation conditions, sowing dates and methods, soil preparation, fertilization, the presence of pests and diseases, harvesting dates and methods [1, 4, 8, 26].

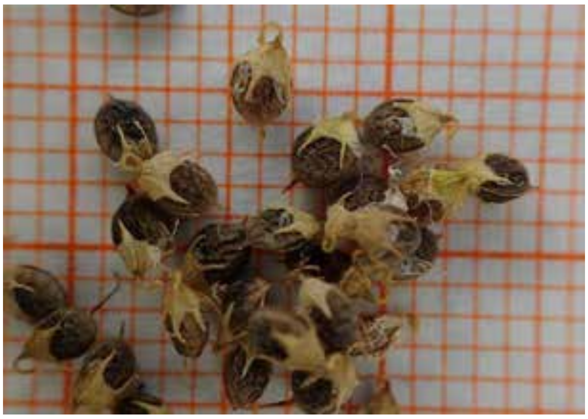

Fig. 5. The fruit of the white sweet clover

Source: https://inpn.mnhn.fr

Fig. 6. White sweet clover seeds

Source: https://www.minnesotawildflowers.info

As is known, the structural elements of the seed yield of legumes include the density of plants per unit area, the total number of branches and inflorescences per plant, the average number of seeds that one inflorescence is capable of producing, and the mass of 1000 seeds [4, 8]. The formation of the maximum seed yield occurs under the condition of the optimal ratio of these indicators [1, 4]. In the case of insufficient development of one or more of the structural elements, the crop yield can be compensated at the expense of others. For the successful development of individual structural elements of the crop, different agrotechnical conditions are required, since their formation occurs at different stages of ontogenesis [1, 4, 8, 43, 49-52].

Features of sowing annual white sweet clover. Studies conducted by scientists of the Institute of Irrigated Agriculture of the NAAS of Ukraine in 2015-2017 prove that in the conditions of the Southern Steppe of Ukraine, the seed productivity of annual white sweet clover of the Pivdenniy variety was formed under the influence of weather conditions of the year, and depended on the sowing dates and sowing rates. Thus, it was established that the formation of the highest seed yield and the best structural elements of the annual white sweet clover crop was observed when sowing was carried out during the first decade of April with a sowing rate of 2.5 million pcs./ha [49, 50].

Studies conducted in 2016-2018 at the research field of the Institute of Irrigated Agriculture of the NAAS by scientists of the Department of Primary and Elite Seed Production, which involved studying the influence of row spacing and nitrogen fertilizer application rates on the formation of yield of two varieties of annual white sweet clover, Pivdenniy and Donetskiy, showed that the highest yield (556 kg/ha) for the Pivdenniy variety and for the Donetskiy variety (478 kg/ha) was obtained with a row spacing of 45 cm and a fertilizer application rate of N60. At the same time, the influence of the nitrogen application rate factor had the greatest weight (71%) [50-54].

Studies conducted by Sowa-Borowiec P. in 2018-2020 in Rzeszów, Poland, also confirm the fact that increasing the seeding density contributed to a significant increase in the plant population after emergence, an increase in green mass and the content of dry matter in it. However, this did not affect the content of total protein, crude fat, crude fiber, ash, macronutrients and trace elements, coumarin. Harvesting plants in the flowering phase increased the height of plants and the yield of green fodder. Plants harvested in the budding phase were characterized by the largest proportion of leaves (40.3%), were the richest in protein (21.7%) and minerals (ash content 12.71%). Unfortunately, sweet clover at this stage of growth contained the highest level of coumarin, which limits its use in animal feed [55].

Tillage system. Timely and qualitatively carried out necessary agrotechnical measures can significantly improve the growth and development of plants, reduce the effect of stress factors. It is known that the main tillage is able to improve the conditions for the development of the root system of plants, which in turn will contribute to the formation of higher seed yields and improving its quality. The effectiveness of the main tillage is manifested through a change in the structure of the upper soil layer, as well as through the presence of weeds at the beginning of the crop vegetation [1, 56-63].

Thus, studies conducted by Vlashchuk A.M. et al. indicated that optimal conditions for the growth and development of annual white sweet clover plants were created when plowing was carried out to a depth of 25-27 cm, while the average seed yield was 0.80 t/ha ($LSD_{05}A$ = 0.04 t/ha). Disking to a depth of 12-14 cm showed slightly worse results. Continuing their research, the authors established that the highest yield of annual white sweet clover seeds (0.77 t/ha) in 2019 was obtained by direct harvesting using the desiccant Reglon Super 150, SL, PK at an application rate of 6.0 l/ha. ($LSD_{05}B$ = 0.06 t/ha). The final indicator of economic efficiency such as the level of profitability was the highest and amounted to 668% [56-59].

Fertilization system. Providing plants with all the necessary nutrients is the key to obtaining stable yields.

Fertilization plays a decisive role in the restoration and increase of soil fertility. The most reliable source of increasing the humus content in the soil has always been manure (50-55 kg of humus is formed from each ton of litter manure). From 20 tons of manure per hectare, an average of 100 kg of nitrogen, 50 kg of phosphorus, 120 kg of potassium, 330 kg of calcium and magnesium, trace elements:

cobalt, zinc, iron, manganese, copper are supplied. Manure improves the structure of the soil, increases its water-holding capacity, available moisture content, porosity and moisture filtration, reduces density, creates conditions for the growth of the plant root system, improves the thermal regime, replenishes humus reserves and thereby increases the absorption capacity of the soil. By adding manure to the soil, the living flora and fauna useful for plants are enriched, biological activity is enhanced, and plants are provided with carbon dioxide necessary for photosynthesis [1, 4].

The combined application of manure with mineral fertilizers increases their efficiency, stabilizes the obtaining of high yield increases regardless of weather conditions. Recently, farmers have been interested in the use of organo-mineral fertilizers. This is due to the fact that the use of only mineral fertilizers suppresses the activity of soil microflora and reduces the possibility of using nutrient reserves from organic matter (crop and root residues and by-products of plants), which increases costs. The addition of phosphorus fertilizers to manure (including phosphogypsum on saline soils) during its storage in piles reduces nitrogen losses in free gaseous form [1, 4, 8].

As organo-mineral fertilizers, manure composts with mineral fertilizers are used, the introduction of which increases the effectiveness of both components.

Microbiological and fungal preparations are able to enrich the soil with nitrogen, break down poorly soluble phosphorus compounds in the soil, and enhance the microbial phytopathogenic activity of soil biota. It is advisable to treat seeds with them before sowing in order to populate them with beneficial microflora before harmful pathogens and thus increase the effectiveness of the introduced bacteria [60].

Plant growth regulators (PGRs) as natural biologically active substances increase the yield of agricultural crops under appropriate conditions, terms and methods of use. PGRs are used for seed treatment or for spraying crops, their effectiveness is confirmed by international certificates “Organic Standard”. They activate the work of nitrogen-fixing and phosphate-mobilizing bacteria, improve product quality by immobilizing heavy metals, radionuclides and pesticides, increase plant resistance to diseases, pests, droughts and frosts.

Phosphorus (P) deficiency is known to be a major factor limiting plant growth. The use of phosphate solubilizing microorganisms (PSM) in interaction with the plant root system, which supplies soluble phosphorus to plants, is an environmentally friendly and effective way to utilize it. Song, M. et al. in their study, used *Trichoderma viride* (*T. viride*), which is a biocontrol agent that can solubilize soil nutrients, to inoculate *Melilotus officinalis* (*M. officinalis*) at different levels of phosphorus and to investigate the effect of the drug on phosphorus uptake and plant growth. The results showed that *T. viride* could not only solubilize insoluble inorganic phosphorus but also mineralize insoluble organic phosphorus. In addition, the mineralization ability of insoluble organic phosphorus was stronger. At different phosphorus levels, seeds inoculation by *T. viride* was shown to promote the growth of aboveground parts of plants and regulate root morphology, thus increasing the dry weight of plants. The effect of *T. viride* on seedling growth was also reflected in the increase of chlorophyll fluorescence parameters and photosynthetic pigment content. In addition, compared with uninoculated seeds, inoculation by *T. viride* also increased the phosphorus content of plants. Therefore, the use of *T. viride* to inoculate *Melilotus officinalis* seeds contributed to the increase of the synergistic phosphorus uptake and plant growth [60].

According to studies conducted in 2016-2018 by Lavrynenko Yu.O. et al. in the conditions of the Southern Steppe of Ukraine, the use of nitrogen fertilizer at a dose of N_{60} contributed to an increase in seed yield by an average of 10.4-36.4%. In general, the nitrogen fertilizer dose factor had the greatest impact on the seed productivity of the crop compared to other studied factors [61].

In studies conducted by Nogues et al., which investigated the effect of different rates of organic and mineral fertilizer application on the germination and chemical composition of sweet clover plants, it was shown that maximum germination was obtained in soils with a high compost content (71%) and in soils with inorganic fertilizers (68%). The percentage of germinated seeds was similar in the control and in low-dose composted soil (59% and 57%, respectively). As for the germination rate, it was also higher in soils with a high compost content and in soils with inorganic fertilizers. It is noticeable that the lowest germination rate was found in soils with a low compost content. The study also provides new insights into the metabolic changes in sweet clover plants, and the response of plants to different rates of organic and mineral fertilizer application. These changes may have implications for the cultivation of sweet clover plants for phytoremediation purposes. On poor soils, the restoration of soil fertility can be facilitated by growing sweet clover against the background of high doses of organic fertilizers [30-31].

In their studies conducted at the research station of the National University of Life Resources and Environmental Sciences of Ukraine in 2015-2017, Demydas G. et al. focused on studying the features of leaf surface formation of white sweet clover grown in pure sowing and in a mixture with annual cereals at different seeding rates of this species and at different levels of fertilization. During the studies, white sweet clover was sown in pure sowing and in a mixture with corn, millet, Sudan grass and sorghum using four seeding rates (16, 18, 20 and 22 kg/ha). Four doses of NPK fertilization were used in the studies (0 – control treatment without fertilization, $N_{45}P_{45}K_{45}$, $N_{60}P_{60}K60$ and $N_{60}P_{90}K_{90}$). The smallest leaf surface area was formed by white sweet clover without fertilization in pure sowing at the highest seeding rate of this species. When mineral fertilizers were applied, the leaf surface area of the studied species increased by 7-16% with increasing fertilizer application rate. The best leaf surface area indicators ($52.3 \cdot 10^3$ m^2/ha) were recorded when growing white sweet clover in mixed crops with Sudan grass at a seeding rate of 16 kg/ha and fertilizer application with a dose of $N_{60}P_{90}K_{90}$ [62].

Crop care. Annual white sweet clover plants are almost not affected by diseases and are quite resistant to the main types of legume pests [63-69]. The main problem when caring for annual white sweet clover crops is the presence of segetal vegetation, which can significantly inhibit the development of the main crop. Therefore, herbicides are used when growing annual white sweet clover [30, 56, 57, 70, 71].

Scientists from the Department of Primary and Elite Seeds of the Institute of Climate Smart Agriculture of the National Academy of Agrarian Sciences of Ukraine studied the effect of different rates of application of the soil herbicide Trifluralin 480 EC (the active ingredient trifluralin of 480 g/l) and the systemic herbicide Pulsar 40 (the active ingredient imazamox of 40 g/l) on the dynamics of weed infestation and yield of annual white sweet clover in the conditions of the Southern Steppe of Ukraine. During the research, it was found that the most productive for white sweet clover plants was the use of the herbicide Trifluralin 480 EC with an application rate of 3.0 l/ha, the percentage of weed death in this variant is 62%, the reduction in the fresh weight of weed plants decreased by 51% compared to the control. It was also noted that if the control had a total weed mass of 377.0 g/m² and in the variant with a minimum application rate of 0.5 l/ha of herbicide Pulsar 40 it was 168.6 g/m², while using a minimum dose of herbicide Trifluralin 480 EC, the total fresh mass was 192.2 g/m². This indicates a significant phytotoxic effect of Pulsar 40 on weeds. During this study, it was also found that due to the sequential application of the studied herbicides Trifluralin 480 EC and Pulsar 40 at different application rates, a maximum (740.0 kg/ha) was achieved when using herbicide Trifluralin 480 EC at an application rate of 3.0 l/ha, which was per 273.33 kg/ha more than in the control [70, 71].

Harvesting. One of the most responsible and final periods in the technology of growing annual white sweet clover is harvesting. Only with clear planning and high organization of harvesting operations using high-performance combines can the crop be harvested without losses and preserve its high seed and food qualities. Harvesting annual white sweet clover is more difficult than grain crops due to the fact that the seeds of the crop are very small and loose [8, 55, 72].

It is very important to correctly determine the time of the beginning of harvesting the seeds of the crop. Harvesting maturity was determined by the number of ripe seeds on the panicle. The optimal harvesting phase of the seeds is the ripening of 1/3 of the pods, at which the seeds lose their original green color and acquire a yellow tint. Pods with fully ripened seeds easily fall off, which causes a significant loss of yield [55, 72].

Seed ripening in most species of legumes is uneven, so incorrect determination of the harvesting time leads to significant losses [8, 14, 43]. In all legumes, overripe pods easily crack, which leads to shedding of seeds. The harvesting time of legumes is determined by the degree of browning of the fruiting bodies. When the pods on the tassels of the legume plants are browned within 35-40%, the seeds of the crop have a high germination energy and seed germination rate. Harvesting of annual white sweet clover seeds can be carried out both separately and by direct combining. If the weather conditions of the region are such that ripening occurred early and evenly, then weed-free seed and commercial crops can be harvested by direct combining. The choice of harvesting methods depends on the biology of the crop, the condition of the crops and growing conditions [72].

Post-harvest processing and storage. In seed farms, thorough primary seed processing is carried out at specialized seed cleaning plants which brings it to sowing conditions. The seeds coming from the combine are immediately dried, which prevents them from warming up. In adverse weather, they are dried on special drying units or devices equipped with active ventilation. It is especially important to maintain the seed heating temperature within the limits of no more than 40-45°C. Final seed cleaning should be carried out on machines such as “Petkus-Gigant k531”, “Petkus-Electra k218”. Very clogged seed batches cannot always be cleaned on wind-screen machines so that they meet the sowing standards of the General State Technical Regulations of Ukraine. It has been established that many types of weeds have the same seed sizes as cultivated grasses. For further cleaning of such seeds, special triers, pneumatic and sorting tables, and electromagnetic cleaning machines are additionally used. Pneumatic sorting tables make it possible to separate weed seeds and also sort seeds into fractions [4].

A technological scheme of cleaning is selected for each crop. After drying, the seeds enter the main cleaning machine, where they are finally brought to sowing conditions, or sent to sorting tables and electromagnetic machines. Completely cleaned and dried to a moisture content of 12-13%, the seeds are packed in standard double bags, with appropriate marking of seed batches and stored in stacks in warehouses. Each batch of seeds is placed in separate stacks on a wooden floor 10-12 cm high from the floor. The height of the stack should not exceed 4-5 bags, the distance between the stacks and walls should be at least 0.75 m, and between individual stacks should be per 1 m. During long-term storage of seeds, the premises are ventilated, the bags are periodically rearranged every four months and constant control over the moisture content of the seeds is established [4].

After labeling and certification, seed batches are ready for sale. Labeling and certification of seeds is carried out with the participation of the State Enterprise “State Center for Certification and Expertise of Agricultural Products” [4].

Conclusions. Annual white sweet clover (*Melilotus albus Medik*) is a drought-resistant legume. Plants of this crop have the functions of a supplier of organic matter (nitrogen). As evidenced by studies conducted by domestic scientists, annual white sweet clover also has ameliorative properties on saline soils. Therefore, this crop can be considered very attractive for cultivation and multipurpose use in the conditions of risky agriculture of the Southern Steppe zone of Ukraine.

The issue of seed propagation of annual white sweet clover is relevant for further research, which will allow obtaining high-quality seed material. One of the directions that will contribute to obtaining high-quality seed material is the use of biological products in the cultivation of annual white sweet clover, which will contribute to increasing the potential productivity, plasticity, resistance to abiotic and stress factors, consumer and technological properties of the plant.

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Ivanov H.M., Valentiuk N.O. Prospects for growing and features of agrotechnology of annual white sweet clover (*Melilotus albus Medik.*) in the conditions of the Southern Steppe of Ukraine

Purpose. The purpose of the work was to systematize the data of scientific research on the morphological and biological features, economic value of annual white sweet clover and to analyze existing agrotechnical measures in growing this crop. **Results.** Plants (*Melilotus albus Medik.*) reach a height of 80-200 cm, have erect green stems (may have a reddish color from below), which branch. Up to 70 inflorescences are usually formed on one stem of this plant in which there are up to 3-5 thousand flowers. Plants have a strong taproot system. The fruit of annual white sweet clover is a round-ovate or elliptical, 2-3-seeded pods. One plant is capable of producing up to 17 thousand seeds. Annual white sweet ckover has good resistance to drought and damage by phytophagous and diseases. The best results of seed productivity are obtained when sowing during the first decade of April with a seeding rate of 2.5 million pcs./ha and a row spacing of 45 cm. The application of nitrogen fertilizers (N_{60}) has a positive effect on the cultivation of annual white sweet clover. Optimal conditions for the growth and development of annual white sweet clover plants are ensured by plowing to a depth of 25-27 cm. The main problem when caring for annual white sweet clover crops is the presence of segetal vegetation, which can significantly inhibit the development of the main crop. Therefore, when growing this crop the herbicides (Trifluralin 480 EC and Pulsar 40) are used with an application rate of 3.0 l/ha. Harvesting annual white sweet clover seeds can be carried out both separately and by direct combining. **Conclusions.** Annual white sweet clover (*Melilotus albus Medik*) is a drought-resistant legume crop, attractive for cultivation and multipurpose use in the conditions of risky agriculture of the Southern Steppe zone of Ukraine. Plants have the functions of a supplier of organic matter (nitrogen). On saline soils, the plant exhibits ameliorative properties. The issue of seed propagation of Melilotus albus is relevant for further research, which will allow obtaining high-quality seed material. One of the directions that will contribute to obtaining high-quality seed material is the use of biological products for the cultivation of this crop, which will contribute to increasing the potential productivity, plasticity, resistance to abiotic, stress factors, consumer and technological properties of the plant.

Key words: forage legumes, biological features, plant growth and development, cultivation technology.

Іванов Г.М., Валентюк Н.О. Перспективи вирощування та особливості агротехнології буркуну білого однорічного (*Melilotus albus Medik.*) в умовах Південного Степу України

Мета. Метою роботи було систематизувати данні наукових досліджень стосовно морфобіологічних особливостей, господарського значення буркуну білого однорічного та провести аналіз існуючих агротехнічних заходів у вирощуванні буркуну білого однорічного. **Результати.** Рослини (Melilotus albus Medik.) сягають висотою від 80-200 см, мають прямостоячі зелені стебла (знизу можуть мати червонувате забарвлення), що розгалужуються. На одному стеблі даної рослини зазвичай формується до 70 суцвіть, в яких налічується до 3-5 тис. квіток. Рослини мають міцну стрижневу кореневу систему. Плід буркуну білого однорічного – округлояйцеподібний або еліптичний, 2-3 насінний біб. Одна рослина буркуну однорічного спроможна дати до 17 тис. насінин. Буркун білий однорічний володіє доброю стійкістю до посухи та ушкоджень фітофагами і хворобами. Найкращі результати насіннєвої продуктивності отримують за сівби протягом першої декади квітня із нормою висіву 2,5 млн шт./га та шириною міжрядь 45 см. Позитивний вплив при вирощуванні буркуну білого однорічного чинить внесення азотних добрив (N_{60}). Оптимальні умови для росту і розвитку рослин буркуну білого однорічного забезпечуються за проведення оранки на глибину 25-27 см. Головну проблему під час догляду за посівами буркуну білого однорічного складає наявність сегетальної рослинності, що здатна значно пригнічувати розвиток основної культури. Тому під час вирощування буркуну білого однорічного використовують гербіциди Трефлан 480 та Пульсар 40 з нормою внесення 3,0 л/га. Збирання насіння буркуну білого однорічного можливо проводити як роздільним способом так і прямим комбайнуванням. **Висновки.** Буркун білий однорічний (*Melilotus albus Medik.*) – посухостійка бобова культура, приваблива для вирощування і багатоцільового використання в умовах ризикованого землеробства зони Південного Степу України. Рослини володіють функціями постачальника органічної речовини – азоту. На солонцюватих ґрунтах рослина проявляє меліоративні властивості. Актуальним для подальших досліджень є питання розмноження насіння буркуну білого однорічного, що дозволить отримати якісний насіннєвий матеріал. Одним з напрямків, що сприятимуть отриманню якісного насіннєвого матеріалу є використання при вирощуванні буркуну білого однорічного біопрепаратів, що сприятиме підвищенню потенційної продуктивності, пластичності, стійкості до абіотичних, стресових факторів, споживчих та технологічних властивостей рослини.

Ключові слова: кормові бобові трави, біологічні особливості, ріст і розвиток рослин, технологія вирощування.

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