Ministry of Education and Science of Ukraine
Black Sea Universities Network

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2022

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Odesa National University of Technology, 2022.

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INTRODUCTION

International Competition of Student Scientific Works “Black Sea Science” has been held annually since 2018 at the initiative of Odesa National University of Technology (formerly Odesa National Academy of Food Technologies) with the support of the Ministry of Education and Science of Ukraine. It has been supported by Black Sea Universities Network (the Association of 110 higher education institutions from 12 countries of the Black Sea Region) since 2019, and by Iseki-FOOD Association (European Integrating Food Science and Engineering Knowledge into the Food Chain Association) since 2020.

The goal of the competition is to expand international relations and attract students to research activities. It is held in the following fields:

- Food science and technologies
- Economics and administration
- Information technologies, automation and robotics
- Power engineering and energy efficiency
- Ecology and environmental protection

The jury includes both Ukrainian and foreign scientists. In the 4 years that the competition has been held, the jury included scientists from universities of 24 countries: Angola, Azerbaijan, Benin, Bulgaria, China, Czech Republic, France, Georgia, Germany, Greece, Israel, Italy, Kazakhstan, Latvia, Lithuania, Moldova, Pakistan, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, USA.

At the same time, every year the geography has expanded and the number of foreign jury members has increased: from 46 jury members representing 25 universities from 12 countries in 2018, to 73 jury members of the 46 universities from 19 countries in 2022.

More than a thousand student research papers have been submitted to the competition from both Ukrainian and foreign institutions from 25 countries: China, Poland, Mexico, USA, France, Greece, Germany, Canada, Costa Rica, Brazil, India, Pakistan, Israel, Macedonia, Lithuania, Latvia, Slovakia, Romania, Kyrgyzstan, Kazakhstan, Bulgaria, Moldova, Georgia, Turkey, Serbia.

The interest of foreign students in the competition grew every year. In 2018, the students representing 15 institutions from 7 countries have submitted 33 works. In 2021 the number of submitted works increased to 73, authored by the students of 40 institutions from 18 countries.

The competition is held in two stages. In the first stage, student research papers are reviewed by members of the jury who are experts in the relevant fields. In the second stage of the competition, the winners of the first stage have the opportunity to present their work to a wide audience in person or online.

All participants of the competition and their scientific supervisors are awarded appropriate certificates, and the scientific works of the winners are included in the electronic proceedings of the competition. Every year the competition receives a large number of positive responses from Ukrainian and foreign colleagues with the desire to participate in the coming years.

5. ECOLOGY AND ENVIRONMENTAL PROTECTION

PRODUCTIVITY OF ALFALFA OF VARIOUS SLOPES FOR SEEDS, DEPENDING ON BIO - AND BIOTIC FACTORS

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Abstract. *The scientific paper presents the results of studies of the influence of mowing on the development and formation of alfalfa seed yield when growing it on chernozems of the southern steppe of Ukraine on non-irrigated lands. Studies aimed at identifying factors that can contribute to increasing alfalfa seed productivity and improving soil fertility, reducing the pesticide load on them, are relevant. The aim of the work was to determine the influence of abiotic and biotic environmental factors (weather conditions and mowing on seeds, relationships between weeds and cultivated plants, population of agrophytocenoses with pests) on alfalfa seed productivity. It is determined that at the first mowing in the agrophytocenosis there are, on average, 12.5 specimens./ m^2 of weeds that during the growing season of alfalfa seeds of the third year of life remove 40.8 kg/ha of nitrogen, 3.5 – phosphorus, 41.3 – potassium and 9.9 kg/ha of nitrogen from the soil. calcium, and with an intermediate slope, the density of weeds is much less (9 PCs./m^2), which absorb almost 3 times less nutrients from the soil. It was found that the cultivation of alfalfa with intermediate mowing (mowing the first for green fodder at the beginning of budding) contributes to an increase in seed yield by 20.9% compared to the first, the level of profitability increases from 182.9 to 313.7%, or by 130.8 percentage points (71.5 percent. So, growing alfalfa for seeds with intermediate mowing is environmentally safer, due to a decrease in the number of pests in the agrophytocenosis, and therefore the need for insecticides, compared to the first mowing, which is proposed for introduction into production.*

Keywords: *alfalfa for seeds, weather conditions, slopes, plant growth and development, pests,.weeds, battery removal, technology efficiency.*

I. INTRODUCTION

For many decades, almost all branches of the national economy, under the guise of saving and rational use of labor, material and financial resources, ruthlessly exploited nature. They used mineral resources, land, water and plant resources, wildlife and airspace in a predatory way. For decades, it has been argued that all natural components are able to recover quickly and the possibilities of the human environment in this regard are almost limitless. Science has proven, and practice has confirmed, that in today's conditions such a statement is unacceptable, because the areas under arable land that are subject to dust and water erosion are growing, and the desert is purposefully advancing on fertile land, and an environmental catastrophe occurs. Life demands that positive changes take place in our country.One of the ways to solve this issue is to expand the area of perennial legumes, the leading place among which belongs to alfalfa.

II.THE ROLE OF ALFALFA IN THE GREENING OF AGRICULTURE (analytical literature review)

Recently, humanity has begun to perform those impossible functions that nature itself previously performed, in particular, the accumulation of food elements by biological means, strengthening the sanitary role of various organisms in the agrophytocenosis, cleaning fields, etc. The farmer, taking on all these concerns, incurs huge costs of material and technical resources with simultaneous environmental pollution. Intensification factors themselves are not unnatural, but only excessive and generally incorrect application leads to negative consequences, deterioration of soil fertility indicators [1]. The basis for reproducing soil fertility is to ensure a deficit-free balance of humus and nutrients in them, which makes it possible to maintain a certain level of their potential and effective fertility [2]. One of the ways to solve the problem of protecting and reproducing soil fertility is to introduce crop cultivation technologies with minimizing tillage and elements of agricultural biologization [3, 4]. It is already known that the main feature of perennial grasses, including alfalfa, is durability, rapid vegetative recovery after mowing, high adaptability to growing conditions and increased soil fertility [3, 5]. In the meter-long soil layer, 243.6 kg/ha of nitrogen; 38.7 kg/ha of phosphorus; 134.3 kg/ha of potassium; 102.4 kg/ha of calcium accumulate due to crop residues and alfalfa root biomass of the third year of life [5].

2.1. Origin and economic significance of alfalfa

Growing alfalfa, as a high-protein fodder crop, people began to engage in for a long time. The name of the genus *Medicago* comes from the word *medica*, or mussel grass (*Herba medica*), which Greek warriors, as a valuable forage crop, discovered in Persia in the IV century BC, during the Greco-Persian wars, in the mussel region, located in Asia Minor. Alfalfa was first introduced by the Persians to Greece, and in the IV century BC. - to the Apennine Peninsula (Italy) and only in the VIII century BC it was widely distributed in North Africa and Spain, but already with the Arabic name *alfalfa*, instead of the Roman *Melissa* [6], alfalfa began to be grown in Ukraine in the XIX century. In 1840-1860, its agrocenoses were located in the former Kiev, later (1870-1890) in the Kherson, Ekaterinoslav and Poltava provinces [7]. As of 2000, the area of alfalfa crops in Ukraine was about 500 thousand hectares [8]. Now the general state of feed production is deteriorating due to a significant decrease in technical and technological support for all branches of Agriculture [9]. Thus, the area under forage crops in 2000 (7063.1 thousand hectares) decreased by almost 20% compared to 1990, and in 2020 –by another 2.4 times, and cultivated pastures in 2000 – by 70 thousand hectares (35%), and in 2020 by another 14.3 times. The biological value of feed decreases: an average of 85 g of digested protein is produced per feed Unit [10]. In a market economy, agricultural producers neglect both the production of alfalfa seeds and their cultivation for feed. According to the State Statistics Committee of Ukraine, the area allocated for seed purposes has more than halved in five years (from 2001 to 2006) (from 123.1 to 55.2 thousand hectares). In 2020, this figure was 8.4 thousand hectares, that is, it decreased by another 6.6 times [11].

Alfalfa is grown in all countries with a developed livestock industry, since the green mass and hay of this crop contain a high amount of protein. So, 100 kg of green mass, depending on the phase of development, contains 16-22 kg of feed units, 3.5-4.8 kg of digested protein, 0.4-0.8 kg of calcium, 0.08-0.14 kg of phosphorus. Alfalfa is rich in vitamins, essential amino acids that are essential for animal life [12]. Alfalfa plays a very important role in preserving and improving soil fertility. It is able to structure it, pickle it, enrich it with organic matter (due to a well-developed root system), biological nitrogen compounds [13]. This crop meets its needs for nitrogen Nutrition up to 70% by fixing it from the atmosphere. After the alfalfa formation is developed, up to 200 kg/ha of nitrogen remains in the soil. This is Nitrogen of biological origin, it is not lost or washed out of the soil, but is fully used by subsequent crops. According to the generalized data of scientists, in the absence of manure and other organic substances, the share of alfalfa in the structure of sown areas of forage crops should increase from 35 to 50% [7]. For such an expansion of crops, farms should be provided with a sufficient amount of high-quality seed material.

2.2. Biological and morphological features of alfalfa

Alfalfa (*Medicago* L.) belongs to the legume family (*Fabaceae, Leguminosae*), the order of legumes *(Fabales*). This genus includes 21 perennials and 43 annual species. In the Culture, three types of tetraploid alfalfa are most common: seed, or blue (M. *sativa* L.), variable, or hybrid (M. *Varia* Mart) and sickle-shaped or yellow (M. *falcate* L.) [7]. Plants are quite winter - and frost – resistant-in the absence of snow cover, they can withstand frosts up to 20 – 25 °C, and with a constant snow cover-up to minus 40 °C. Alfalfa is a moisture-loving and drought-resistant crop, optimal conditions for the growth and formation of the mass crop are created at a soil humidity of 60-80% HB. The best soils for it are chernozems, chestnut, brown, it grows well on sod-carbonate and sod-podzolic [7, 13]. The growth and development of alfalfa is significantly affected by the temperature regime [14]. Alfalfa seeds begin to germinate at a temperature of 5-6 °C, and plant growth in spring – at a temperature of 7-9 °C. A close inverse correlation was established to a high degree ($r = -0.87$) between the duration of the sowing–germination period (in spring) and the air temperature [15]. Alfalfa grows and develops better at a soil humidity of 70-80% HB. To create 1 kg of dry weight, it spends from 700 to 1200 kg of water. During the two months of vegetation, the alfalfa root system is buried in the soil by an average of 90-100 CM. Alfalfa is a crop that is most sensitive to light in the period from emergence to the beginning of stemming and during flowering. When forming a crop of green mass, as well as seed herbage, not only the amount of light is important, but also the depth of its penetration into different tiers of crops [7, 13].

2.3. Harmfulness of weeds and pests in alfalfa crops

A negative factor is the spread of weeds, especially parasitic plants, in agrophytocenoses. The intensification of feed production creates favorable conditions for the growth and development of not only cultivated plants, but also weeds, which consume up to 50% of the nutrients that are applied with mineral fertilizers [16]. Weeds are better adapted to unfavorable conditions, grow more intensively and often predominate in the development of cultivated plants, especially in the juvenile period [17]. Both annual and two - and perennial weeds clog up crops.

Alfalfa damages many types of harmful insects. Damage, first of all, to generative organs is caused by the alfalfa thick-legged (*Bruchophagus roddi* Guss), alfalfa yellow seed eater, or tuchius (*Tuchius flavus* Beck), alfalfa scoop (*Chloridea viriplaca* Hfn, as well as the alfalfa root (nodule) weevil (*Sitona longulus* Gyll.), leaf alfalfa weevil, or fitonomus (*Fitonomus transsilvanicus* Petri) and others [18, 19].

III. OBJECT, SUBJECT AND METHODS OF RESEARCH

The object of research is the processes of growth, development and regularities of alfalfa seed crop formation under the influence of certain abiotic and biotic factors, in particular mowing.

The subject of the study is alfalfa for seed purposes, biological features, Southern chernozem, crop changes depending on slopes, economic and energy efficiency of technologies.

The research was conducted in the fields of the Nikolaev NAU in 2020-2021 and in the Vitovsky District (Southern Steppe). The terrain of the sections is flat. Soil - southern chernozem residual slightly saline heavy loamy. The depth of the humus horizon is 28-30 CM, its transition in some places up to 36 cm. The arable layer of 0-30 CM contains 2.8-3.0% humus. The acidity is close to neutral (pH 6.4–6.7). Ground water lies deeper than 20 meters. 100 g of soil contains an average of 1.2 mg of nitrates, 8.5 mg of mobile phosphorus and 18 mg of exchange potassium, wilting humidity-11.4%.

The average monthly air temperature in March 2021 (3.9°c) was significantly lower compared to 2020 (7.7°C). At the same time, this indicator of heat supply during the alfalfa growing season was almost the same in both years (in 2021, 0.1°C less compared to 2020. March-August was more saturated in 2021: 305.5 mm of precipitation fell at a rate of 422. significantly less of it was observed during 2020 (185.3 mm). Thus, the temperature conditions, amount and nature of precipitation distribution were more or less favorable for the normal growth and development of alfalfa plants. It should also be noted that the dry periods of the year coincided with critical periods in the phenology of crop plant development, which affected their productivity and depended on the period of mowing for seeds.

The following options were included in the scheme of the experiment to study the productivity of alfalfa testicles depending on the slope: 1. First mowing for seeds – control; 2. Intermediate mowing for seeds: first mowing for green food at the beginning of budding; 3. second mowing for seeds: mowing the 1st mowing for green food during budding-the beginning of flowering. The area of the sown area is 30, the accounting area is 10 m^2. Repeat four times. The cutting height when cutting alfalfa for green fodder is 8-10 CM.

The seed yield was taken into account by the method of continuous threshing of plots. Field and laboratory studies were performed according to the methods [22, 23], phenological observations of alfalfa growth and development-according to the method of V. V. Koperzhinsky (1950). The contamination of alfalfa crops was recorded on 4 fixed sites measuring 0.5 x 0.5 m (0.25 m^2) on each variant by quantitative and weight method during mass weed germination and during alfalfa seed harvesting according to the method [23, 24]. In accounting mowing, 100 single swings of the net were used [19, 24]. The pest population of plants was determined by collecting insects on individual plants. For analysis, 10 plants were selected in 10 places along the diagonal of the field in different districts and farms of the region. The structure of the crop was determined by the method [23]. Economic efficiency was evaluated according to generally accepted indicators. considering typical performance standards. The variance analysis was carried out using the software and Information complex PIK "Agrostat" [25].

IV. RESULTS OF RESEARCH

4.1. Weather conditions and duration of alfalfa interphase periods depending on the slopes

It is well known that our region belongs to the zone of risky crop production due to unfavorable weather conditions for agriculture. Due to the biological characteristics of alfalfa, its seeds can be obtained from various slopes, reducing the negative impact of such conditions. The duration of interphase periods in alfalfa plants of the third year of life depended on weather conditions and on average for two years of research was as follows: the period of vegetation recovery–budding lasted for alfalfa of the first mowing for seeds 70 days; intermediate – 32, second – 27 days. The duration of the growing season reached 134, 86 and 81 days, respectively, for mowing (table 4.1).

Table 4.1.Duration of interphase periods in alfalfa Veselka depending on the bite for seed purposes (average for 2020-2021)

Slope on seeds	Slope for seeds, the number of days from the resumption of spring vegetation (regrowth)			Number of days per period	
	budding	flowering	seed ripeness	budding-flowering	flowering -seed ripeness
First	70	90	134	20	44
Medium	32	50	86	18	36
Second	27	44	81	17	37

The cold, prolonged spring of 2021 did not allow for the formation of a sufficient amount of aboveground biomass for the month of May, and alfalfa was first mowed down in experiments on May 18 for green fodder (a variant of intermediate mowing for seeds). On June 3, alfalfa was mowed down for green fodder in the areas of the "second mowing for seeds" option, while in 2020 – on May 14 and June 2, respectively. The duration of these periods of plant development depended on the temperature regime during the growing season of alfalfa of various slopes for seeds.

The lowest average daily air temperatures were observed during the initial period of development to the budding phase: 11.2-21.4 (table 4.2).

Table 4.2. Average daily air temperatures during the growth and development of alfalfa seeds, depending on its mowing for seeds, °C (average for 2020-2021)

Mowing on seeds	Restoration of spring vegetation (regrowth)		
	budding	flowering	seed ripeness
First	11,2	13,5	16,7
Medium	18,3	20,0	21,7
Second	21,4	22,2	22,6

A slightly higher temperature regime was typical for the period of renewal of vegetation–alfalfa flowering on all slopes. The average daily air temperatures during this period of growth and development of the crop ranged from 13.5 (first) to 20.0 (intermediate) and 22.2 (second mowing for seeds). During the growing season, this indicator was 16.7; 21.7; 22.6°C, respectively.

4.2. Formation of alfalfa seed yield of various slopes

It is known that a necessary condition for the growth and development of any living organism is water supply. Different weather conditions over the years, months, and slopes affected the linear growth of alfalfa. On average, for two years of research, the height of plants of the first mowing for seeds in the budding phase was at the level of 62, intermediate – 54 and second – 45 cm (table 4.3).

Table 4.3. Dynamics of linear growth of alfalfa plants in height depending on the snake bite for seed purposes, CM (average for 2009-2010)

Mowing on seeds	**Phase**		
	budding	**flowering**	**seed ripeness**
First	62	72	93
Medium	54	65	76
Second	45	56	68

During the seed ripeness period, the above indicators for the first, intermediate and second slopes were 93, 76, 68 cm, that is, they decreased depending on the slope and air temperatures during the growing season and providing plants with soil moisture and precipitation.

The results of observations show that the largest aboveground biomass is formed in the first class for seeds (3.25 t/ha), and in the second mowing this indicator is almost halved (table 4.4).

Table 4.4. Yield of dry aboveground alfalfa biomass of various slopes for the period of seed ripeness, (average for 2020-2021)

Mowing on seeds	**Dry biomass, c/ha**
First	32,5
Medium	24,6
Second	16,6
NIR05, c/ha	1,6

The difference in the formation of aboveground biomass is caused by different precipitation and temperature conditions over the years of research.

When growing alfalfa for seeds, you can also get an additional green mass to increase the overall productivity of the agrophytocenosis, replenish the feed base of livestock with feed protein, the deficit of which in Ukraine is about 25-30%.

The highest collection of green mass during mowing, on average for two years of research, was formed: for the second mowing for seeds – 129, and for the intermediate – 106 centners/ha. After harvesting the first mowing for seeds, the Otava for the strut did not grow back. Therefore, if the first mowing is left on the seeds, then after it there is almost no satisfactory regrowth of alfalfa in non-irrigated conditions. In addition, it is known that alfalfa can no longer be mowed down if there are three to four weeks left before the first frost. During this period, the vital activity of plants slows down, the dormant period begins and they accumulate a supply of carbohydrates for breathing during the winter. It was found that the leafiness of plants is highest during the beginning of budding for all slopes (table 4.5).

Table 4.5. Leafiness of alfalfa plants of various slopes on seeds (average for 2020-2021)

Slope	**Leafiness of plants (%) in the period**		
	beginning of budding	**beginning of flowering**	**end of flowering**
First	42,6	39,7	27,8
Medium	40,5	37,8	26,6
Second	38,4	33,4	26,2

With intermediate mowing, the mass of leaves in aboveground biomass during the two years of research was lower compared to the first mowing. Even lower at the beginning of budding was leafiness at the second mowing and averaged 38.4%. At the beginning of alfalfa flowering, this indicator decreased for all mowing, but the pattern between them was the same as during the beginning of budding: the highest percentage of leaves in biomass for the first mowing and its gradual decrease for the intermediate, and its smallest value – for the second mowing for seeds. Significantly less leaves are contained in the aboveground mass of agrophytocenosis at the end of flowering for all slopes. Therefore, during the period of harvesting alfalfa for green mass, it is necessary to prevent the loss of leaves, as the most valuable part of plants.

4.3. Dynamics of pest populations in alfalfa crops

One of the reasons for the decline in seed yield is the large number of pests. Of the total number of 130-140 species of alfalfa phytophagous insects registered in Ukraine, 30-50 of them reproduce en masse and are dangerous for this crop [19, 26], and the seed yield decreases by 20-30, and sometimes by 50%.

In this work, which was carried out in 2020-2021, considerable attention is paid to determining the species composition of alfalfa phytophages.

Significant damage to crops is caused by nodule weevils. At the first mowing, their density at the beginning of the growing season reached 2.4, while at the second – only 1.2 copies/100 P.s.

Alfalfa root (nodule) weevil beetles overwinter in the upper layer of soil under plant remains. Alfalfa is damaged by both beetles and larvae. The economic threshold of harmfulness (hereinafter referred to as EPH) is 5-8 individuals/m^2. The greatest number of them was observed during the budding and flowering period of alfalfa and exceeded the EPH, especially during the first mowing for seeds. The larvae feed on the roots and bulbs that are on it.

One of the main harmful and widespread phytophages in our region is the Alfalfa bug (*Adelphocoris lineolatus* Goeze), which develops in 1-3 generations.

Alfalfa bedbug egg laying ends in September. Eggs overwinter in the shoots of perennial grasses (table 4.6).

Table 4.6. Specific structure of pest populations in different periods of development alfalfa depending on its mowing for seeds (average for 2020-2021)

Pests	Of the total number (%) within the time frame for determining			
	spring (post-autumn) regrowth	mass budding	mass flowering	mowing ripeness seeds
1st slope				
Nodule weevils	50,0	41,7	32,8	6,0
Phytonomus	21,7	26,9	26,3	18,8
Alfalfa bug	28,3	31,4	37,6	61,8
Others	0,0	0,0	3,6	13,4
Total	100,0	100,0	100,0	100,0
2nd slope				
Nodule weevils	76,9	22,0	21,5	17,7
Phytonomus	0,0	10,2	14,6	7,0
Alfalfa bug	0,0	55,1	48,7	61,7
Others	23,1	12,7	15,1	13,6
Total	100,0	100,0	100,0	100,0

One of the main harmful and widespread phytophages in our region is the Alfalfa bug (Adelphocoris lineolatus Goeze), which develops in 1-3 generations. Alfalfa bedbug egg laying ends in September. Eggs overwinter in the shoots of perennial grasses. The number of alfalfa bedbugs in the spring during the Alfalfa regrowth period, on average for 2020-2021, according to the general quantitative accounting of various types of seed pests, was 28.3% at the first mowing, and at the second - in the initial period of plant growth, it was not observed.

It is also advisable to provide data on the population of alfalfa crops with entomophages (table. 4.7). On average, over three years of observations, the number of these beneficial insects was always higher in the alfalfa flowering phase with the first mowing for seeds – 14 individuals/100 P. S., while in the second mowing – in the budding phase. Given the significantly higher number of phytophages in the first class, the ratio between predators and their victims was different. Thus, during the budding period, the ratio of entomophages to pests was 1:2.3 in the first slope, 1:2.8 in the second. A large difference between the first and second mowing in the ratio between entomophages and phytophages occurred during the mass flowering phase – 1:3.0 and 1:5.1, respectively.

Table 4.7. Ratio of the number of pests and entomophages in alfalfa crops in different periods of its development, depending on the slope (average for 2020-2021)

Phases of growth	First slope			Second slope		
	pests	entomophages	entomophages : pests	pests	entomophages	entomophages : pests
Regrowth in spring	4,6	7	1:0,7	1,3	0	-
Budding	22,3	9,7	1:2,3	36,3	13	1:2,8
Mass flowering	41,8	14	1:3,0	47,8	9,3	1:5,1
Mowing ripeness seeds	33,5	9,7	1:3,5	24,3	4,3	1:5,7

During the seed ripeness period, this ratio was 1:3.5 – in the first mowing and 1:5.7 – in the second mowing. So, a significant role in the formation of seed yield is played by the harmfulness of phytophages and the population of crops with entomophages and pollinating insects. It is necessary to note a significant decrease in beneficial entomophagous insects in recent years, which is explained not only by unfavorable weather conditions for their existence in nature, but also by the deterioration of the environment. Mowing significantly reduces the growing season of alfalfa and, consequently, the period of insect harm. It was found that intermediate mowing is more environmentally friendly compared to the first: alfalfa plants of intermediate mowing were treated with insecticides only 1-2 times, while agrocenoses of the first mowing had to be sprayed against pests 4-5 times during the growing season. It should be noted that in the first mowing (control), 2.53% of seeds were damaged by pests, in the intermediate – 1.89% and the least (1.57%) – in the second mowing.

4.4. Contamination of alfalfa crops of various slopes

When growing alfalfa seeds in coverless crops, it is characteristic that agrophytocenoses are clogged with weeds to a high degree and if certain measures are not followed to regulate undesirable plants to an economically imperceptible level, alfalfa plants form a low yield of both aboveground mass and seeds.

The highest density of weeds (12.5 copies)/m^2) was formed during the growing season of alfalfa seeds of the third year of life of the first mowing. A significant decrease in crop contamination compared to the first mowing was observed with intermediate and second alfalfa mowing for seeds: 9.0 and 7.2 PCs./m^2, respectively. Between the intermediate and second mowing, the difference in the number of weeds was insignificant. It was found that the biomass of weeds, when leaving the first mowing of alfalfa for seed purposes, in the raw mass for the period of seed ripeness reached 645, and in the air-dry – 216 g/m^2. With an intermediate slope, these indicators decreased to 219 and 73 g/m^2, respectively, or almost 3 times compared to the first one (table. 4.8).

Table 4.8. Contamination of alfalfa crops during seed ripeness depending on the slope (average for 2020-2021)

Slope	Number of weeds, PCs./m^2	Weed biomass, g/m^2	
		raw	air-dry
First	12,5	645	216
Medium	9,0	219	73
Second	7,2	151	68

Even less weed component is formed in the agrophytocenosis during the second mowing of seeds – 151 g/m^2 of raw, or 68 g/m^2 of dry matter, which is 4-6 times less than in the first mowing. As you know, the harmfulness of weeds is manifested in the fact that they absorb a significant amount of moisture and nutrients.

It was found that at the first mowing, weeds remove 40.8 kg/ha of nitrogen DW, 3.5 – phosphorus, 41.3 – potassium and 9.9 kg/ha of calcium DW from the soil (table. 4.9).

Table 4.9. Absorption of nutrients by weeds depending on alfalfa mowing for seeds (average for 2020-2021)

Slope	Plant weight, g/m^2	Content in 1 kg of dry matter of weeds, G *				Absorption of elements nutrition, kg/ha			
		N	P_2O_5	K_2O	Ca	N	P_2O_5	K_2O	Ca
The first - control	216	18,9	1,6	19,1	4,6	40,8	3,5	41,3	9,9
Medium	73	18,9	1,6	19,1	4,6	13,8	1,2	13,9	3,4
Second	68	18,9	1,6	19,1	4,6	12,9	1,1	13,0	3,1

Note. * according to the data [27].

During intermediate mowing, weeds removed 3 times less nutrients from the soil. Even less harm is caused by these undesirable neighbors by the agrophytocenosis of the second mowing of alfalfa for seed purposes.

4.5. Influence of slopes on alfalfa seed yield and yield structure

The main indicator that characterizes the feasibility of an agricultural measure is crop yield. According to the law of minimum (J. Liebig), biotic potential, ie viability, productivity of the organism, is limited by those of environmental factors that are at a minimum, although other conditions are favorable.

Under very arid conditions in 2020, the highest seed yield was formed by alfalfa of intermediate slope - 2.45 c/ha, the lowest - 1.86, for the first. A similar pattern was observed in alfalfa crops in 2021, but the productivity of seed crops was much higher. Yields for the technology, which included intermediate mowing for seeds, reached 2.94 at a control value of 2.48 c/ha (Table 4.0).

Table 4.10. Alfalfa seed yield depending on bite, c/ha

Slope	2020	2021	Average	Increase to control
First mowing for seeds - control	1,86	2,68	2,27	0
Intermediate mowing for seeds: mowing alfalfa on the railway station on the beginning of budding	2,45	3,29	2,87	0,60
Second mowing for seeds: mowing the first slope on the railway station in budding period – the beginning of flowering	1,99	2,78	2,36	0,07
NIR_{05}, c/ha	0,11	0,32	0,18	**-**

The low productivity of alfalfa in 2020 was due to less precipitation during the growing season and high temperatures during the summer months of vegetation. On average, over the years of research, the largest amount of alfalfa seed material of intermediate mowing was also obtained – 2.87 centners/ha. At the first mowing for seeds, the yield was 2.27, and at the second – 2.36 c/ha with the smallest significant difference of 0.18 c/ha. It is determined that the seed productivity of the crop in our zone strongly depends on the amount of precipitation in the period from flowering to maturation of alfalfa seeds: for the first mowing, the correlation coefficient r = 0.77, for the intermediate one – 0.75, and for the second – 0.84.

The results of the analysis of sheaf samples indicate a positive effect of intermediate mowing on the formation of individual elements of the crop structure. It was found that when mowing the first slope on the green mass at the beginning of budding and obtaining seeds from the intermediate slope, 111 generative stems/m^2 were formed with this alfalfa cultivation option (table 4.11).

At the control sowing, without preliminary mowing of plants for green fodder, there were 98 seeds for the period of seed collection. generative stems/m^2. So, with an intermediate slope, they were formed into 13 PCs./ m^2, or 13.3% more than at the first mowing of alfalfa for seeds. According to the analysis of sheaf samples of seed herbage, it was determined that alfalfa of intermediate mowing formed 4.6% more brushes on 1 stalk and 20.2% more full-fledged seeds in one brush compared to the control.

Table 4.11. Indicators of alfalfa crop structure depending on the seed bite (average for 2020-2021)

Slope	Quantity, pcs.						
	productive stems per 1 m^2	brushes on 1 stalk	in one brush				full-fledged seeds per 100 beans
			beans	seeds			
				total	including a full-fledged one		
					pcs.	%	
First - control	98	19,7	6,6	15,0	9,4	62,7	142
Medium	111	20,6	6,4	17,8	11,3	63,5	177
Second	104	19,1	6,8	14,6	9,5	65,1	140

In total, 63.5% of full – fledged seeds were counted for intermediate mowing, while only 62.7% were counted for the first mowing.

An important indicator of the productivity of seed crops is the number of full-fledged seeds per 100 beans; 177 units were formed along the intermediate slope, while for the first-142 pcs.; full-weight seeds per 100 beans, or 24.6% less.

There was no significant difference between the first and intermediate mowing by weight of 1000 seeds (2.11 and 2.13 g, respectively).

4.6. Economic assessment of alfalfa seed cultivation technologies depending on the slope

The analysis of economic efficiency indicators allows us to state that under non-irrigated conditions of crop cultivation, intermediate mowing for seeds has an advantage, compared to the first and second.

Although the total cost of this mowing increases from 9063 to 9845 UAH/ha (by 8.6%) compared to the first, at the same time the cost of 1 centner of seeds decreases by 14.1%, which is explained by a decrease in the cost of protecting crops from pests. Net profit under the intermediate slope increases by 85.6% compared to the control, which received only UAH 13,637/ha, and the level of profitability increases from 150.5 to 257.0% (by 70.8%) or by 106.5 percentage points (table 4.12).

The performance indicators of the second slope are slightly worse than those of the intermediate one, but they are significantly higher than those of the first slope.

Table 4.12. Economic assessment of alfalfa seed cultivation technologies depending on the slope (average for 2020-2021)

Indicators	Slope			± to slope control, %	
	the first - control	medium	second	medium	second
Seed yield [1], c/ha	2,27	2,87	2,36	26,4	4,0
Green mass Yield [2], c/ha	0	129,0	136,0	-	-
Cost of seed harvest, UAH/ha	22700	28700	23600	26,4	4,0
Cost of harvesting green mass UAH/ha	0	6450	6800	-	-
Cost of the entire crop, UAH/ha	22700	35150	30400	54,8	33,9
Total expenses per 1 ha, UAH	9063	9845	9826	8,6	8,4
Cost of 1 Centner of seeds, UAH	3993	3430	4164	-14,1	10,6
Net profit, UAH/ha	13637	25305	20574	85,6	50,9
Profitability level, %	150,5	257,0	209,4	70,8	39,1

Notes: 1.the cost of 1 Centner of seeds is 10000 UAH.
2.the cost of 1 Centner of green mass is 50 UAH.

Thus, the profitability of growing alfalfa for the second mowing is 209.4%, which is 39.1% higher compared to the first, but it is slightly less compared to the intermediate mowing for seeds (257.0%).

CONCLUSIONS

Based on studies conducted during 2020-2021 on the impact of various slopes and weather conditions on alfalfa seed productivity, the following conclusions can be drawn:

1. Productivity of alfalfa crops significantly depends on abiotic factors, especially weather conditions. Thus, under unfavorable very arid conditions in 2020, the yield of alfalfa seeds in the third year of life in the control (the first mowing of seeds) was 1.86, and for intermediate mowing - 2.45 c/ha. In the more favorable 2021 (arid conditions) the yield was much higher: 2.68 and 3.29 c/ha of conditioned seeds, respectively.

2. Seed productivity increases by 0.60 c/ha (on average for two years of research) or by 26.4% compared to the control (2.27 c/ha) for the technology that includes intermediate mowing. At the same time it is possible to receive in addition at mowing at the beginning of a budding phase of 129,0 c/ha of green weight for providing animals with high-quality forage.

3. During the first mowing in the agrophytocenosis there are, on average, 12.5 specimens/m^2 of weeds, which during the vegetation period of seed alfalfa of the third year of life remove from the soil 40.8 kg/ha of nitrogen, 3.5 - phosphorus, 41.3 -

potassium and 9.9 kg/ha d.r. calcium, and at the intermediate slope the density of weeds is much lower (9 pcs./m^2), which absorb from the soil almost 3 times less nutrients.

4. Net profit on the intermediate slope increases by 85.6% compared to the control, which received only 13637.0 UAH/ha, and the level of profitability increases from 150.5 to 257.0%, or 70.8 percent. The cost of 1 quintal of seed for this slope is 14.1% less than the first mowing for seeds.

5. Growing alfalfa seeds on an intermediate slope is more environmentally friendly, due to the reduction in the number of pests in the agrophytocenosis, and hence the need for insecticides, compared to the first mowing, which is proposed for implementation in production.

REFERENCES

1. Scientific bases of ecological agriculture / VM Krut, GP Fesenko (head of the author's collection) [V. M. Krut, GP Fesenko, TS Alekseenko, LK Antipova, etc.] Kiev: Harvest, 1995. S. 159-163.

2. Tikhonenko DG, Degtyarev VV Colloid-chemical diagnostics of accumulative soil formation and fertility of chernozems of Ukraine. Agrochemistry and soil science. Special issue for the VIII Congress of UTGA, room 1. Kharkiv, 2010. S. 163-172.

3. Yulia Nazarenko. Your niche: how to make money on alfalfa. 2018. URL: https://agravery.com/uk/posts/show/svoa-nisa-ak-zarobiti-na-lucerni

4. Petrichenko VF Substantiation of technologies for growing fodder crops and energy saving in field fodder production. Bulletin of Agricultural Science. 2003. № 10. Special issue. Pp. 6-10.

5. Antipova LK Production of alfalfa seeds in the steppe of Ukraine: monograph. Mykolaiv: Moscow State Agrarian University, 2009. 227 p.

6. Ivanov AI Lucerne. Moscow: Kolos, 1980. 323 p.

7. Zharinov VI, Klyuy VS Lucerne. Kyiv: Urozhay, 1983. 240 p.

8. Goloborodko SP, Snow VS, Sakhno VG Lucerne: scientific and methodological publication. Kherson: Aylant, 2007. 328 p.

9 Cherenkov AV, Andrienko OO Forage and seed productivity of cover and cover crops of alfalfa. Feed and feed production. Intern. Science. coll. Vinnytsia: Thesis, 2003. № 50. P. 27–33.

10. Formation and functioning of the market of agro-industrial products (practical guide) / [ed. P. T. Sabluka]. Kyiv: IAE, 2000. 556 p.

11. Statistical information of the State Statistics Service. URL: http://www.mk.ukrstat.gov.ua

12. Ermakova L., Ivanivska R. Lucerne - your good choice. Offer. 2003. № 8/9. Pp. 42-43.

13.Babych AA Fodder and medicinal plants in the XX-XXI centuries. Kyiv, "Agrarian Science", 1996. 822 s.

14. Bernier J., Kine J.-M., Sachs R. M. Physiology of flowering: in 2 volumes. THOSE. Factors of flowering / Per. with English LV Kovaleva and VZ Podolny; Ed. and with preface. NP Aksenova and TN Konstantinova. Moscow: Agropromizdat, 1985. 192 p.

15. Petrychenko VF, Antipova LK Features of formation of agrocenoses of alfalfa seeds depending on weather conditions and sowing dates. Feed and feed production: interdepartmental. topic. Science. coll. Vinnytsia, 2008. Issue. 63. S. 3–9.

16. Kutuzov GP, Krasavina N. Yu., Truzina LA, etc. System of measures to control weeds with intensive technologies of forage cultivation. Intensive technologies of forage crops cultivation: Theory and practice. Moscow: VO "Agropromizdat", 1990. P. 37.

17. Uteush Yu. A., Lobas MG Forage resources of the flora of Ukraine. Kyiv: Naukova Dumka, 1996. 222 p.

18. Grikun OA, Antipova LK, Krivoguz VS Entomocomplex in alfalfa crops. Formation at different slopes on seeds in the conditions of the South of Ukraine. Quarantine and plant protection. 2008. April. Pp. 16–19.

19. Handbook of plant protection / [L. I. Bublyk, GI Vasechko, VP Vasiliev and others]; for ed. MP Forest. Kyiv: Urozhay, 1999. 744 p.

20. Bulygin S. Yu., Degtyarev VV, Krokhin SV Humus state of chernozems of Ukraine. Bulletin of Agricultural Science. 2007. № 2. S. 13–16.

21. Kuzmenko OB The problem of preservation and reproduction of humus in the soils of the Nikolaev area. Scientific works: Scientific method. magazine. Nikolaev: Publishing house of Moscow State University named after P. Mogili, 2008. T. 81. Vip. 68. Ecology. Pp. 95–98.

22. Dospekhov BAMethods of field experience. Moscow: Agropromizdat, 1985. 351 p.

23. Methods of experiments on feed production: ed. A. O. Babich. Vinnytsia, 1994. 87 p.

24. Methods of testing and application of pesticides // SO Tribel, DD Sigareva, MP Sekun, OO Ivashchenko [etc.]; for ed. prof. S.O. Tribelya. K .: The world. 2001. 448 p.

25. Ushkarenko VO Dispersion and correlation analysis of the results of field experiments / VO Ushkarenko, VL Nikishenko, SP Goloborodko, V. Kokovikhin. Monograph. Kherson: Aylant, 2008. 372 p.

26. Artokhin KS Harmfulness of phytophages on alfalfa. Feed production. 2006. № 2. S. 26–27.

27 Norms and rations for feeding farm animals: Reference manual / AP Kalashnikov, NI Kleimenov, VN Bakanov [etc.]. Moscow: Agropromizdat, 1985. 352 p.