NORWEGIAN JOURNAL OF DEVELOPMENT OF THE INTERNATIONAL SCIENCE

№58/2021

Norwegian Journal of development of the International Science

ISSN 3453-9875

VOL.2

It was established in November 2016 with support from the Norwegian Academy of Science.

DESCRIPTION

The Scientific journal "Norwegian Journal of development of the International Science" is issued 24 times a year and is a scientific publication on topical problems of science.

1000 copies

Norwegian Journal of development of the International Science

Iduns gate 4A, 0178, Oslo, Norway

email: publish@njd-iscience.com

site: http://www.njd-iscience.com

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in the bull calves kept for the production of beef showed that at the age of 18 months the protein energy value in the slaughtered animals of the Ukrainian black-speckled dairy breed under the unleashed keeping will be by 20% higher than under the leashed one ($P<0.001$), while their fatty tissue will be on the contrary higher under the leashed keeping, but under the unleashed one the quality of beef is better due to the higher amount of protein, which is a desirable factor for beef market.

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DENSITY DYNAMICS AND BIOPRODUCTIVENESS OF LEGUMINAL HERBS GROWN ON SOILS CONTAMINATED WITH HEAVY METALS

Tkachuk O.,
Doctor of Agricultural Sciences,
Associate Professor of Ecology and Environmental Protection
Vinnytsia National Agrarian University
Vinnytsia, Ukraine
Vergelis V.
Assistant of the Department of Ecology and Environmental Protection
Vinnytsia National Agrarian University
Vinnytsia, Ukraine

Abstract

In conditions of moderate soil contamination with heavy metals lead, cadmium, copper and zinc, the highest field germination of seeds at sowing is observed in alfalfa (*Medicago sativa L.*) - 58.9%. The lowest falling out of grasses of the second-fourth years of the growing season is found in the crops of Eastern goatweed (*Galega orientalis Lam.*) and bird's-foot trefoil (*Lotus corniculatus L.*). The highest average yield of green mass for all years of vegetation is provided by sowing of white clover (*Melilotus albus L.*) - 56.9 t / ha, but it grows only for two years. Among leguminous perennial grasses that grow for four years, the highest yield of green mass is provided by sowing of sand sainfoin (*Onobrychis arenaria Kit.*) - 44.6 t / ha.

Keywords: leguminous perennial grasses, heavy metals, soil, pollution, productivity, density.

Formulation of the problem

Due to the intensification of agricultural production in Ukraine, permanent and irreversible processes occurring in agroecosystems are soil degradation. Of the total arable land in Ukraine, 32.4 million hectares, dehumidification and trophic depletion are observed by 43.0%, agrophysical properties are disturbed by 39.0%, water erosion is developed by 32.1%, and soil acidification is observed by 17.7% [1].

In recent decades, due to the growing use of mineral fertilizers and pesticides, their contamination with heavy metals may be a potential threat to Ukraine's soils. This problem is especially relevant on gray podzolic soils, which cover an area of 1.99 million hectares of arable land, distributed mainly in the Central Forest-Steppe of Ukraine and are characterized by lower fertility and higher natural acidity, much worse buffering properties compared to black soil.

Forage production, in particular the cultivation of perennial legumes for green mass, is one of the factors that can stabilize the negative degradation processes occurring in soils, in particular the normalization of heavy metals. The great phytomeliorative role of perennial legumes is due to the formation of a large vegetative mass, which is able to absorb heavy metals from the soil and accumulate them in the aboveground mass. Also, perennial legumes are able due to symbiotic nitrogen fixation to increase soil fertility, neutralize its acidity, due to the strong root mass to increase the humus content, improve agrophysical properties [2].

Analysis of recent research and publications

Among the large number of substances released into the environment, a special place is occupied by heavy metals, the sources of which can be emissions from industry, vehicles, fertilizers and pesticides. Once in the environment, heavy metals are included in the biogeochemical cycle and migrate links of trophic chains [3].

Studies by many scientists have shown that the phytotoxicity of heavy metals depends on such factors as: chemical properties (valence, ionic radius, ability to form complex compounds), soil and climatic conditions (physicochemical properties of soil, temperature, moisture) and species characteristics of plants and their resistance to pollution [4 - 6].

The influence of heavy metals on the soil-plant system depends on the type and chemical properties of the pollutant, forms of heavy metal compounds in soils and their transformation, composition and properties of soil, biological and physiological characteristics of plants, their phenological phase [7 - 9].

The results of studies of the effect of heavy metals on clover plants have shown that the content of heavy metals in plant raw materials exceeds the maximum allowable concentrations, which indicates a high level of accumulation of metal ions. During the study period, the intensity of Zn ion accumulation in plants decreases, and for Cu the biological absorption coefficient increases. This can be explained by the process of adaptation of meadow clover to growing conditions, and, as a consequence, the increase in the level of biological resistance of plants to pollution. The property of clover to accumulate heavy metals can be used as one of the methods of phytomonitoring and phytoremediation of the environment [10].

The efficiency of the transition of individual heavy metals into plant tissues varies significantly depending on their type [11]. Plants that are able to accumulate heavy metals in large quantities can be used for biological purification of soil [12]. *Thalaspi caerulescens* is an effective zinc hyperaccumulator, it is able to accumulate without harm more than 10 g of zinc per 1 kg of biomass [13]. *Brassica juncea* (Indian mustard) accumulates a lower concentration of heavy metals, but due to its large biomass and growth rate is also an effective soil purifier. *E. splendens* is a wild grass of China capable of accumulating copper in large quantities, as a result of which it is the main type of vegetation around copper mines [14]. Another Chinese plant, *Sedum alfredii*, accumulates large amounts of zinc and cadmium. When growing *Sedum alfredii* on soils with a high content of zinc or cadmium, their concentration in the green mass reaches 1 - 2% in the absence of negative impact on plant life [15]. Changes in the content of heavy metals in soils due to reclamation measures vary widely, depending on the region [16].

Recently, many researchers have focused on elucidating the mechanisms by which plants absorb heavy metals from the soil in order to effectively clean it. This issue is extremely important for Ukraine. Therefore, the selection of effective absorbing plants for such regions is of great scientific and practical importance.

Selection of previously unsolved parts of the overall problem

At the same time, recent scientific studies prove the possibility of using perennial legumes as phytoremediators contaminated with heavy metals soils. Due to the formation of a large vegetative mass, they are able to accumulate lead, cadmium, copper and zinc in their tissues, which will help reduce their soil contamination. However, it has not been studied how soil contamination with heavy metals will affect the peculiarities of the accumulation of vegetative mass by perennial legumes and whether their suppression by toxic substances will be observed. These questions have not been studied by scientists, so they became the subject of our further experiments.

The purpose of the article

The aim of the study was to identify the effect of soil contamination with heavy metals on the dynamics of plant density and yield of green mass of leguminous perennial grasses during the four years of their cultivation. Six species of perennial legumes were studied: alfalfa (*Medicago sativa L.*), meadow clover (*Trifolium pratense L.*), sand sainfoin (*Onobrychis arenaria Kit.*), white clover (*Melilotus albus L.*), bird's-foot trefoil (*L. Lotus corniculat*).) and eastern goatweed (*Galega orientalis Lam.*).

The research was carried out in the Research Farm "Agronomichne" of Vinnytsia National Agrarian University (Ukraine) on gray podzolic medium loam soils in the conditions of intensive agriculture of the Central Forest-Steppe with a high level of chemicalization in crop production in the cultivation of major field crops.

Laboratory analysis of the content of heavy metals in the soil of the experimental area revealed the content of mobile forms of lead and cadmium, which corresponds to the maximum permited concentration (MPC), and copper - was 2.3 times higher than the MPC (Table 1).

This level of lead and cadmium is defined as a moderately dangerous degree of soil contamination. The area of such lands in Ukraine, according to Grabak N.Kh. (2014), is 789,000 hectares [17]. The level of copper content corresponds to a highly dangerous degree of soil contamination. The area of such soils in Ukraine is 285,000 hectares (Table 2).

Table 1

The content of mobile forms of heavy metals in the soil of SRE " Agronomichne " in intensive agriculture

Heavy metals	Actual content, mg / kg	MPC, mg / kg	Estimation of contamination
Pb	5,9	6,0	1,0 MPC
Cd	0,6	0,7	0,9 MPC
Cu	6,8	3,0	2,3 MPC
Zn	9,1	23,0	0,4 MPC

One of the reasons for such contamination of soils with heavy metals, in addition to emissions from industry and motor transport, is the significant level of chemicalization of agriculture in the cultivation of major field crops in the form of high rates of mineral fertilizers.

Table 2

Distribution and area of soils of Ukraine according to the degree of heavy metal pollution (according to Grabak NA, 2014)

Degree of pollution	Degree criterion	Area of distribution
Extremely dangerous	More 2,5 MPC	57000
Highly dangerous	1,5–2,5 MPC	285000
Moderately dangerous	0,5–1,5 MPC	789000

The experiment was repeated four times. The estimated area of the field experiment is 50 m^2, the total area of the plot is 70 m^2. Variants in the experiment are placed systematically in 6 blocks.

Conducted the following observations, records and measurements:

- determination of soil contamination by mobile forms of heavy metals was carried out in certified and accredited laboratories: Testing Center of Vinnytsia Branch of the State Institution "State Soil Protection" of the Ministry of Agrarian Policy and Food of Ukraine and Scientific Measuring Agrochemical Laboratory of the Department of Ecology.

- soil samples were taken from a layer of 0–20 cm in accordance with DSTU ISO 10381-1: 2004;

- determination of the content of gross forms (after extraction of 1.0 n HCl) and mobile forms (after extraction with acetate-ammonium buffer solution pH 4.8) of heavy metals in the soil: lead, cadmium, copper and zinc - by atomic absorption spectrophotometry according to DSTU 4362: 2004, DSTU 4770 (2, 3, 9): 2007 [18];

- accounting for plant density was performed on certain sites of 1 m2 during all periods and years of observations [19];

- accounting for the yield of green mass of perennial legumes was carried out in a continuous manner by mowing and weighing all the green mass from the accounting area [19].

Presenting the main material

Plant density is an important indicator of agroecological stability of phytocenoses during all years of life. After all, the greater the number of plants per unit area - the more dominant role this species plays in the agrocenosis and is a strong edificatory (influential) component of the biocenosis.

All types of perennial legumes have formed the required density in the year of sowing for high productivity. It was the largest in *Lotus corniculatus L.* - 468 pieces / m^2, and the smallest - in sand sainfoin (*Onobrychis arenaria Kit.*) - 198 pieces / m^2. However, it should be noted that different types of perennial legumes have different sowing rates, which is influenced by the habitus (size, power) of plants and the size of their seeds. Other types of leguminous perennial grasses formed a density of 300–450 pcs / m^2 (Table 3).

Table 3

Dynamics of grass density of leguminous perennial grasses depending on the years of vegetation (2013-2017)

leguminous perennial grasses	Vegetation years							
	1		2		3		4	
	density, pcs / m^2	field germination,%	density, pcs / m^2	falling out, %	density, pcs / m^2	falling out, %	density, pcs / m^2	falling out, %
alfalfa (*Medicago sativa* L.)	420	58,9	198	52,9	59	70,2	12	79,7
meadow clover (*Trifolium pratense* L.)	442	49,6	224	49,3	0	100	-	-
sand sainfoin (*Onobrychis arenaria* Kit.)	198	41,7	172	13,1	53	69,2	26	50,9
white clover (*Melilotus albus* L.)	337	37,8	185	45,1	0	100	-	-
bird's-foot trefoil (*Lotus corniculatus* L.)	468	52,5	277	40,8	145	47,7	77	46,9
eastern goatweed (*Galega orientalis* Lam.)	290	40,7	284	2,1	112	60,6	91	18,8

Field germination in perennial legumes was 38–59%. It was the largest in alfalfa (*Medicago sativa L.*), and the smallest - in white clover (*Melilotus albus L.*), eastern goatweed (*Galega orientalis Lam.*) and sand sainfoin (*Onobrychis arenaria Kit.*).

The decrease in field germination relative to the laboratory in most species of leguminous perennial grasses was 32–40% and only in the bird's-foot trefoil (*Lotus corniculatus L.*) - 11.5%.

In the second year of the growing season, most leguminous perennial grasses reduced their density compared to the first year by 40.8–52.9%, only the liquefaction of sand sainfoin (*Onobrychis arenaria Kit.*) Was 13.1%, due to the formation of powerful and strong plants that withstand competition from weeds,

diseases, pests and are resistant to adverse environmental factors. Insignificant liquefaction by grass of the eastern goatweed (*Galega orientalis Lam.*) - 2.1%, is explained by the growth of shoots from mother plants, which causes the formation of its individual plants in between rows and free space of the soil.

The highest actual plant density of legumes of perennial grasses of the second year of vegetation was observed in crops of eastern goatweed (*Galega orientalis Lam.*) and bird's-foot trefoil (*Lotus corniculatus L.*) - 284-277 pieces / m^2 of plants, and the lowest - in white clover (*Melilotus albus L*). .) and sand sainfoin (*Onobrychis arenaria Kit.*) - 185–172 pcs / m^2 of plants. The density of sowing alfalfa (*Medicago sativa L.*) and meadow clover (*Trifolium pratense L.*) was similar and amounted to 198–224 pieces / m^2 of plants.

The plant density of leguminous perennial grasses does not play a significant role in the formation of the value of the vegetative mass, as each plant forms a bush, which may consist of several dozen stems.

At the beginning of the third year of the growing season, the plants of white clover (*Melilotus albus L.*) and clover (*Trifolium pratense L.*) completely fell out. The death of white clover (*Melilotus albus L.*) plants began after the first mowing of the second year of the growing season and this is fully consistent with its biological characteristics. Meadow clover (*Trifolium pratense L.*) can develop in the third year of the growing season. However, due to the uncovered method of its creation by grass and the formation of a high yield of green mass in the second year of the growing season, it completely fell out.

The plant density of perennial legumes at the beginning of the third year of life was 53–145 units / m^2. Crops of sainfoin (*Onobrychis arenaria Kit*.) And alfalfa (*Medicago sativa L.*) had the lowest density, and the highest density was found in *Lotus corniculatus (L.)* and eastern goatweed (*Galega orientalis Lam.*).

Liquefaction of perennial legumes, compared to the second year of the growing season, amounted to 47.7-70.2%. The most dead plants were alfalfa (*Medicago sativa L.*) and sainfoin (*Onobrychis arenaria Kit.*), and the least - bird's-foot trefoil (*Lotus corniculatus L.*).

In the fourth year of vegetation of leguminous perennial grasses there is a further decrease in plant density. It was the lowest in crops of alfalfa (*Medicago sativa L.*) - 12 pieces / m^2, while the density of plants of bird's-foot trefoil (*Lotus corniculatus L.*) was 77 pieces / m^2, and goatweed (*Galega orientalis Lam.*) - 91 pcs / m^2.

Falling out of leguminous perennial grasses, compared to the third year of the growing season, amounted to 18.8-79.7%. The largest number of plants was alfalfa (*Medicago sativa L.*), and the smallest was the eastern goat (*Galega orientalis Lam.*). Significant liquefaction of grasses was also observed in crops of sand sainfoin (*Onobrychis arenaria Kit.*) and bird's-foot trefoil (*Lotus corniculatus L.*).

Analysis of falling out of leguminous perennial grasses during four years of vegetation showed that the decrease in grass density of alfalfa (*Medicago sativa L.*) increases from 52.9 to 79.7% compared to the previous year evenly over all years with an increase in the proportion of plants that died from increasing life expectancy of grasses.

The highest liquefaction of sand sainfoin (*Onobrychis arenaria Kit.*) was observed in the third year of life - 69.2%. Having reached the maximum liquefaction, in the fourth year of the growing season it decreases by 20% compared to the third year. At the same time, for the second year of vegetation of sand sainfoin (*Onobrychis arenaria Kit.*), its falling out was insignificant.

Grass falling out of *Lotus corniculatus L.* was uniform during all vegetation years and amounted to 40.8–47.7%.

The decrease in plant density of the eastern goatweed (*Galega orientalis Lam.*) was the largest in the third year of the growing season - 60.6% with insignificant falling out in the second and fourth years.

Summarizing the results of research to study the peculiarities of changes in the density of legumes of perennial grasses grown in soil contamination with heavy metals, it should be noted:

- all leguminous perennial grasses are characterized by low field germination of seeds - 37.8-58.9%;
- starting from the second year of vegetation, all leguminous perennial grasses are fallen out by grasses. Most plants fall in the third year of the growing season;
- at the beginning of the second year of vegetation, the density of plants of Eastern goatweed (Galega orientalis Lam.) and sand sainfoin (*Onobrychis arenaria Kit.*) almost does not change compared to the first year;
- for coverless cultivation, after two years of vegetation white clover (*Melilotus albus L.*) and meadow clover (*Trifolium pratense L.*) completely fall out with grass, after four years - alfalfa (*Medicago sativa L.*) and sainfoin sandy (*Onobrychis arenaria Kit* .), but continue to develop bird's-foot trefoil (*Lotus corniculatus L.*) and eastern goatweed (*Galega orientalis Lam.*);
- according to the period of growth, white clover (*Melilotus albus L.*) and meadow clover (*Trifolium pratense L.*) are perennial, alfalfa (*Medicago sativa L.*) and sand sainfoin (*Onobrychis arenaria Kit.*) - to the middle, and bird's-foot trefoil (*Lotus corniculatus L.*) and eastern goatweed (*Galega orientalis Lam.*) - to perennial legumes.

In the year of sowing of perennial grasses in the first mowing, the highest yield of green mass is provided by white clover (*Melilotus albus L.*) - 38.7 t / ha, but the level of its yield significantly depends on the time of mowing. After all, in the year of sowing white clover (*Melilotus albus L.*) does not enter the budding phase and has unlimited vegetative growth. Therefore, the later the mowing of its vegetative mass - the greater its yield is formed. But over time, the vegetative mass of white clover (*Melilotus albus L.*) becomes coarse, which impairs the nutritional value of its green mass. As a result, the mowing time of white clover (*Melilotus albus L.*) is usually moved to the initial phase, which, accordingly, leads to a decrease in the yield of its green mass. Sand sainfoin (*Onobrychis arenaria Kit.*) In the first cut formed a yield of green mass of 30.0 t / ha, which is 22.5% less than the yield of white clover (*Melilotus albus L.*); alfalfa (*Medicago sativa L.*) - 26.0 t /

ha, which is 13.0% less than sand sainfoin (*Onobrychis arenaria Kit.*); meadow clover (*Trifolium pratense L.*) - 24.8 t / ha, which is 17.3% less, and bird's-foot trefoil (*Lotus corniculatus L.*) - 18.4 t / ha, which is 38.7% less than yield of green mass of sand sainfoin (*Onobrychis arenaria Kit.*) (Table 4).

In the second cut, the highest yield of green mass was also observed in white clover (*Melilotus albus L.*) - 20.7 t / ha, other perennial legumes, with the exception of eastern goatweed (*Galega orientalis Lam.*), formed a green mass yield of 34.8 –56.5% lower - 9.0–13.5 t / ha. In addition, crops of *Lotus corniculatus L.* formed the third cut of green mass with a yield of 8.7 t / ha.

In general, during the growing season in the year of sowing, the largest yield of green mass was provided by white clover (*Melilotus albus L.*) - 59.4 t / ha. According to this indicator, it does not show a significant decrease in yield in the year of sowing, as in other leguminous perennial grasses and it develops as an annual crop.

Sand sainfoin (*Onobrychis arenaria Kit.*) formed a green mass yield of 43.5 t / ha, which is 26.8% less than white clover (*Melilotus albus L.*). Alfalfa (*Medicago sativa L.*), bird's-foot trefoil (*Lotus corniculatus* (L.) and meadow clover (*Trifolium pratense L.*) formed a vegetative mass with yields of 38.2 t / ha, 36.6 and 33.8 t / ha, respectively. which is quite high for the first year of growing perennial legumes. The lowest yield of green mass - 13.0 t / ha - was noted in the eastern goat weed (*Galega orientalis Lam.*).

As a rule, in the year of sowing, perennial legumes are not characterized by a high yield of green mass, which is 10.0–25.0 t / ha. However, our research shows the opposite. This can be achieved by fulfilling a set of conditions that provide intensive initial growth of leguminous perennial grasses in favorable conditions. These include uncovered cultivation, early spring sowing provided weed protection, growing plants in areas with a neutral soil solution with sufficient nutrients and moisture. In particular, soil liming was carried out, which contributed to obtaining an acidity index of pH 7, at a hydrolytic acidity of 0.53 mg.-eq./100 g of soil. Weather conditions were marked by sufficient and excess moisture at moderate temperatures.

Table 4

Bioproductivity of agrocenoses of leguminous perennial grasses (2013-2017 pp.)

leguminous perennial grasses	Vegetation years	Green mass yield, t/ha			
		cuts			Total, M±m
		1	2	3	
alfalfa (*Medicago sativa* L.)	1	26,0	12,2	-	38,2±0,28
	2	22,7	15,3	12,8	50,8±0,85
	3	27,0	8,0	8,0	43,0±1,41
	4	23,0	9,0	-	32,0±1,41
	average	*24,7*	*11,1*	*6,2*	*42,0±0,28*
meadow clover (*Trifolium pratense* L.)	1	24,8	9,0	-	33,8±0,57
	2	22,5	17,0	4,3	43,8±0,28
	average	*23,7*	*13,0*	*2,2*	*38,9±0,28*
sand sainfoin (*Onobrychis arenaria* Kit.)	1	30,0	13,5	-	43,5±0,71
	2	34,7	17,0	7,7	59,4±0,57
	3	36,0	5,2	-	41,2±0,28
	4	26,0	8,0	-	34,0±0,41
	average	*31,8*	*10,9*	*1,9*	*44,6±0,42*
white clover (*Melilotus albus* L.)	1	38,7	20,7	-	59,4±0,57
	2	54,3	-	-	54,3±0,42
	average	*46,5*	*10,4*	-	*56,9±0,64*
bird's-foot trefoil (*Lotus corniculatus* L.)	1	18,4	9,5	8,7	36,6±0,57
	2	28,4	11,1	9,4	48,9±0,14
	3	28,5	5,0	7,5	41,0±1,41
	4	12,0	6,0	-	18,0±1,41
	average	*21,8*	*7,9*	*6,4*	*36,1*±0,42
eastern goat weed (*Galega orientalis* Lam.)	1	13,0	-	-	13,0±0,28
	2	30,2	11,1	-	41,3±0,42
	3	28,0	5,5	-	33,5±0,57
	4	15,0	3,0	-	18,0±0,71
	average	*21,6*	*4,9*	-	*26,5±0,42*

In the first cut of the second year of vegetation of leguminous perennial grasses, the highest yield of green mass was formed by crops of white clover (*Melilotus albus L.*) - 54.3 t / ha. The remaining perennial legumes formed a much smaller biological mass. In particular, sand sainfoin (*Onobrychis arenaria Kit.*) Had a yield of green mass of 34.7 t / ha, which is 36.1% less than white clover (*Melilotus albus L.*), eastern goatweed (*Galega orientalis Lam.*) - 30.2 t / ha, which is 13.0% less than sand sainfoin (*Onobrychis arenaria Kit.*); bird's-foot trefoil (*Lotus corniculatus L.*) - 28.4 t / ha, which is 18.2% less than sand sainfoin (*Onobrychis arenaria Kit.*). The yield of green mass of alfalfa (*Medicago sativa L.*) and meadow clover (*Trifolium pratense L.*) was the lowest in the first cut among perennial legumes and amounted to 22.7–22.5 t / ha,

which is 35.0% less, than the yield of green mass of sand sainfoin (*Onobrychis arenaria Kit*.).

Based on the analysis of yield levels of green mass of leguminous perennial grasses in the first cut of the second year of vegetation, it is established:

- the highest yield of green mass is formed by white clover (*Melilotus albus L*.), as a biennial crop. After mowing the first cut, it dies. It is the high productivity of white clover (*Melilotus albus L*.) plants both in the year of sowing and in the second year of vegetation, which is 33–36% higher than in the next crop in terms of yield, that causes its severe depletion and complete extinction;

- leguminous perennial grasses that reach the beginning of flowering stage most quickly - sand sainfoin (*Onobrychis arenaria Kit*.), eastern goatweed (*Galega orientalis Lam*.) and bird's-foot trefoil (*Lotus corniculatus L*.) - also have a high yield of green mass in the first ear. In the conditions of climate change, dry spring, they make good use of the stock of winter-spring moisture and form a yield of green mass of 28.4–34.7 t / ha;

- late-ripening leguminous perennial grasses - alfalfa (*Medicago sativa L*.) and meadow clover (*Trifolium pratense L*.) form a mediocre level of green mass yield - 22.5–22.7 t / ha in the first cut.

Comparing the biological productivity of the green mass of the first cut of leguminous perennial grasses in the year of sowing and the following year of vegetation, it is established:

- white clover (*Melilotus albus L.*) and all early-ripening perennial grasses of the second year of vegetation form a higher yield of green mass in the first cut than in the year of sowing. In particular, white clover (*Melilotus albus L.*) - by 28.7%, eastern goatweed (*Galega orientalis Lam*.) - by 57.0%, sand sainfoin (*Onobrychis arenaria Kit*.) and bird's-foot trefoil (*Lotus corniculatus L*.) - respectively. by 13.5 and 35.2%;

- late-ripening perennial grasses - alfalfa (*Medicago sativa* L.) and meadow clover (*Trifolium pratense L*.) in the second year of vegetation formed a lower yield of green mass than in the year of sowing, respectively 12.7 and 9.3%.

The yield of green mass of leguminous perennial grasses in the second cut was uniform and amounted to 11.1–17.0 t / ha. It was highest in crops of meadow clover (*Trifolium pratense L*.) and sand sainfoin (*Onobrychis arenaria Kit*.), And lowest - in crops of bird's-foot trefoil (*Lotus corniculatus L*.) and eastern goatweed (*Galega orientalis Lam*.). The yield of green mass decreased the most significantly compared to the first mowing, the grass of sandy sainfoin (*Onobrychis arenaria Kit*.) - 2 times, bird's-foot trefoil (*Lotus corniculatus L*.) - 2.6 times, eastern goatweed (*Galega orientalis Lam.*) - in 2.7 times.

Early-ripening perennial grasses, which form a large yield of green mass in the first cut due to the use of winter-spring moisture, significantly reduce it in the second cut, while meadow clover (*Trifolium pratense L*.) reduced the yield of green mass in the second cut in 1.3 times.

All leguminous perennial grasses in the second cut prevailed in terms of green mass yields in the first year of vegetation by 14.4–20.6%, except for meadow clover (*Trifolium pratense L.*), which formed a green mass yield of 47.0% in the second year of vegetation. higher than in the year of sowing.

The third cut of the green mass is formed by alfalfa (*Medicago sativa L*.), meadow clover (*Trifolium pratense L*.), sand sainfoin (*Onobrychis arenaria Kit*.) and bird's-foot trefoil (*Lotus corniculatus L*.). Yield of green mass of leguminous perennial grasses in the third cut was 4.3–12.8 t / ha. The highest yields of green mass were formed by crops of alfalfa (*Medicago sativa L*.), and the lowest - meadow clover (*Trifolium pratense L*.). Crops of alfalfa (*Medicago sativa L*.) and bird's-foot trefoil (*Lotus corniculatus L*.) reduced their productivity compared to the second cut by 16.3–15.3%, while sainfoin (*Onobrychis arenaria Kit*.) and meadow clover (*Trifolium pratense L*.) - by 74.7–54.7%. This indicates that perennial leguminous grasses - meadow clover (*Trifolium pratense L*.) and sainfoin (*Onobrychis arenaria Kit.*), in the third cut of the second year of vegetation are severely depleted and in the third year of vegetation will not form a full crop of green mass.

In general, for all cuts, perennial legumes for the second year of the growing season formed a yield of green mass of 41.3–59.4 t / ha. The highest yield of green mass was observed in plants of sand sainfoin (*Onobrychis arenaria Kit.*), 8.6% lower - in white clover (*Melilotus albus L.*), 14.5% - in alfalfa (*Medicago sativa L.*), on 17.7% - in the bird's-foot trefoil (*Lotus corniculatus L.*), 26.3% - in clover (*Trifolium pratense L.*) and 30.5% less - in the eastern goatweed (*Galega orientalis Lam.*).

All leguminous perennial grasses for the second year of vegetation formed a yield of green mass higher than in the year of sowing, by 22.8-31.3%, except for the eastern goatweed (*Galega orientalis Lam.*), which increased its productivity for the second year of vegetation by 68, 5%. This is due to the extremely low yield of green mass of the eastern goatweed (*Galega orientalis Lam*.) In the sowing year. Crops of white clover (*Melilotus albus L*.) reduced the yield of green mass in the second year of vegetation by 8.6% compared to the first year, which was due to the formation of only one cut of the second year of vegetation.

In the third year of vegetation of leguminous perennial grasses in the first cut, the level of their green mass yield was 27.0–36.0 t / ha. The highest yield of green mass was formed by crops of sand sainfoin (*Onobrychis arenaria Kit*.), And the lowest - alfalfa (*Medicago sativa L*.). Compared to the second year of vegetation, alfalfa (*Medicago sativa L*.) increased its yield of green mass by 15.9%, sand sainfoin (*Onobrychis arenaria Kit*.) - by 3.6%, bird's-foot trefoil (*Lotus corniculatus L*.) formed the harvest of the first cut at the level of the second year of vegetation, and the eastern goatweed (*Galega orientalis Lam*.) - decreased by 7.3%.

The second cut of the green mass of leguminous perennial grasses yielded 5.0–8.0 t / ha. The highest productivity was provided by alfalfa grass (*Medicago sativa* L.), and the lowest - bird's-foot trefoil larch (*Lotus corniculatus L*.). All leguminous perennial grasses

in the second cut of the third year of the growing season significantly reduced their green mass yield, compared to the second year of the growing season, by 47.7–69.4%. The yield of green mass of sand sainfoin (*Onobrychis arenaria Kit.*) fell the most, and the yield of alfalfa (*Medicago sativa L.*) fell the least.

The third cut of the green mass was formed only by alfalfa (*Medicago sativa L.*) and bird's-foot trefoil (*Lotus corniculatus L.*) with a yield of 7.5–8.0 t / ha. Compared to the second year of the growing season, these perennial leguminous grasses reduced their productivity: *Lotus corniculatus L.* - by 20.2%, alfalfa (*Medicago sativa L.*) - by 37.5%.

In general, during the third year of vegetation, perennial legumes formed a green mass yield of 33.5–43.0 t / ha. The highest yield of green mass was provided by sowing alfalfa (*Medicago sativa L.*), 4.2% less - sand sainfoin (*Onobrychis arenaria Kit.*), 4.7% less than alfalfa (*Medicago sativa L.*) - bird's-foot trefoil (*Lotus corniculatus L.*) and 22.1% smaller - Eastern goatweed (*Galega orientalis Lam.*).

Compared with the yield of green mass of leguminous perennial grasses in the second year of the growing season, in the third year it was 15.4–30.6% lower. The most significantly reduced productivity of crops of sand sainfoin (*Onobrychis arenaria Kit.*), and the least - bird's-foot trefoil (*Lotus corniculatus L.*).

Meadow clover (*Trifolium pratense L.*) and white clover (*Melilotus albus L.*) have been growing for only two years.

In the fourth year of vegetation of leguminous perennial grasses, their yield of green mass decreases significantly and is 18.0–34.0 t / ha. The highest yields of green mass were formed by crops of sand sainfoin (*Onobrychis arenaria Kit.*), 6% lower - 3.2 t / ha - alfalfa (*Medicago sativa L.*), and the lowest - eastern goatweed (*Galega orientalis Lam.*) and bird's-foot trefoil. (*Lotus corniculatus L.*).

The decrease in the yield of green mass of leguminous perennial grasses is due to the formation of only two cuts instead of three in the previous years of vegetation in the previous year of vegetation and a significant decrease in the yield of green mass in the first cut.

The yield of green mass of leguminous perennial grasses in the first cut was 12.0–26.0 t / ha. It was highest in crops of sand sainfoin (*Onobrychis arenaria Kit.*), and lowest - in bird's-foot trefoil (*Lotus corniculatus L.*). Compared to the third year of the growing season, in the first mowing, perennial grasses reduced the yield of green mass by 58.0–15.0%, the largest number of bird's-foot trefoil (*Lotus corniculatus L.*), and the smallest - alfalfa (*Medicago sativa L.*).

The yield of green mass of the second cut of leguminous perennial grasses was 3.0–9.0 t / ha. It was highest in alfalfa (*Medicago sativa L.*) and sainfoin (*Onobrychis arenaria Kit.*), And lowest in eastern goatweed (*Galega orientalis Lam.*). The yield of green mass of leguminous perennial grasses in the second cut of the fourth year of vegetation corresponded to the indicators of the third year. However, the yield of green mass of legumes of perennial grasses of the fourth year of the growing season is the lowest in all years of research, including and compared with the yield of green mass in the year of sowing of perennial legumes.

On average, during the 2–4 years of vegetation of leguminous perennial grasses, when they formed full-fledged cuts, the highest yield of green mass was provided by crops of sand sainfoin (*Onobrychis arenaria Kit.*) - 44.9 t / ha, 6.7% lower yield of green mass of alfalfa (*Medicago sativa L.*) - 41.9 t / ha. The yield of green mass of bird's-foot trefoil (*Lotus corniculatus L.*) was 36.0 t / ha, which is 19.8% less than sand sainfoin (*Onobrychis arenaria Kit.*), And eastern goatweed (*Galega orientalis Lam.*) - 30.9 t / ha, which is 31.2% less than sand sainfoin (*Onobrychis arenaria Kit.*).

A fairly high yield of green mass is formed by white clover (*Melilotus albus L.*) and meadow clover (*Trifolium pratense L.*) - 54.3 and 43.8 t / ha, respectively. However, these are perennial leguminous grasses that die two years after their creation by the herbage, so they grow fully only one (second) year. The yield of green mass of white clover (*Melilotus albus L.*) was 17.3% higher, and meadow clover (*Trifolium pratense L.*) - 2.5% lower than sand sainfoin (*Onobrychis arenaria Kit.*).

The average yield of green mass of leguminous perennial grasses in the first cut was the highest on the sowing of white clover (*Melilotus albus L.*) - 54.3 t / ha, which is 40.7% more than sand sainfoin (*Onobrychis arenaria Kit.*). The lowest yield of green mass in the first cut was characteristic for sowing meadow clover (*Trifolium pratense L.*) - 22.5 t / ha, which is 58.6% less than white clover (*Melilotus albus L.*).

In the second cut, the yield of green mass of leguminous perennial grasses was 6.5–17.0 t / ha. The highest yield of green mass was observed on crops of meadow clover (*Trifolium pratense L.*), and among leguminous perennial grasses that grew for 4 years - alfalfa (*Medicago sativa L.*) - 10.8 t / ha. The lowest yield of green mass was on crops of eastern goatweed (*Galega orientalis Lam.*). At the same time, white clover (*Melilotus albus L.*) does not form a second cut at all.

The value of the green mass yield of the third cut of leguminous perennial grasses was 6.9–2.6 t / ha. The highest yield of green mass was provided by crops of alfalfa (*Medicago sativa L.*), and the lowest - sand sainfoin (*Onobrychis arenaria Kit.*). At the same time, crops of eastern goatweed (*Galega orientalis Lam.*) Did not form a third cut at all, sand sainfoin (*Onobrychis arenaria Kit.*) Formed a third cut only in the second year of vegetation, and alfalfa (*Medicago sativa L.*) and *Lotus corniculatus L.*) - in the second and third years of the growing season.

Summarizing the results of research on the yield of green mass of leguminous perennial grasses in the second and subsequent years of the growing season, it should be noted:

- with uncovered sowing of perennial legumes, all species form the highest yield of green mass for the second year of the growing season due to the higher yield in the second and third cuts;

- the highest yield of green mass in the first cut is formed by crops of sand sainfoin (*Onobrychis arenaria Kit.*), and the lowest - meadow clover (*Trifolium*

pratense L.), in the second cut, respectively - meadow clover (*Trifolium pratense L.*) and lovage *Lotus corniculatus L.*.), and in the third - alfalfa (*Medicago sativa L.*) and sainfoin (*Onobrychis arenaria Kit*.);

- in crops of alfalfa (*Medicago sativa L.*), sainfoin (*Onobrychis arenaria Kit*.) and bird's-foot trefoil (*Lotus corniculatus L.*), the first mowing provided the highest yield of green mass in the third year of growing perennial legumes, while in the second sloping - in the second year of life of leguminous perennial grasses;

- the yield of green mass was most evenly formed in the first mowing of perennial legumes during all years of research in crops of alfalfa (*Medicago sativa L.*), while in other leguminous perennial grasses - only in the second and third years of the growing season.

Analysis of the average yield of green mass of leguminous perennial grasses for all years, taking into account the year of creation of grass showed that the highest yield of green mass provides grass cranberry white (*Melilotus albus L.*) - 56.9 t / ha, 21.6% lower - 44 , 6 t / ha - sand sainfoin (*Onobrychis arenaria Kit*.), 26.2% lower - 42.0 t / ha - alfalfa (*Medicago sativa L.*). The yield of green mass of meadow clover (*Trifolium pratense L.*) was 38.9 t / ha, which is 31.6% less than that of white clover (*Melilotus albus L.*); bird's-foot trefoil (*Lotus corniculatus L.*) - 36.1 t / ha, and eastern goatweed (*Galega orientalis Lam.*) - 26.5 t / ha, which is, respectively, 36.6 and 54.3% less than clover white (*Melilotus albus L.*).

Alfalfa (*Medicago sativa L.*), sand sainfoin (*Onobrychis arenaria Kit.*) and bird's-foot trefoil (*Lotus corniculatus L.*) on average for all years of research formed a yield of green mass similar to the value of green mass formed during the full development of perennial legumes. 2–4 years of vegetation and only eastern goatweed (*Galega orientalis Lam.*) In the period of full development, on 2–4 years of vegetation, formed a yield of green mass by 14.2% higher than in general for all years of vegetation. Under the conditions of uncovered grass cover, in the year of sowing all types of perennial legumes, except for the eastern goatweed (*Galega orientalis Lam.*), form a full crop of green mass, which is equivalent to the crop formed in subsequent years of perennial legume vegetation.

Conclusions and suggestions

In conditions of moderate soil contamination with heavy metals lead, cadmium, copper and zinc, the highest field germination of seeds at sowing is observed in alfalfa (*Medicago sativa L.*) - 58.9%. The lowest liquefaction of grasses of the second-fourth years of the growing season is found in the crops of Eastern goatweed (*Galega orientalis Lam.*) and bird's-foot trefoil (*Lotus corniculatus L.*). The highest average yield of green mass for all years of vegetation is provided by sowing of white clover (*Melilotus albus L.*) - 56.9 t / ha, but it grows only for two years. Among leguminous perennial grasses that develop over four years, the highest yield of green mass is provided by sowing of sand sainfoin (*Onobrychis arenaria Kit.*) - 44.6 t / ha.

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№58/2021

Norwegian Journal of development of the International Science

ISSN 3453-9875

VOL.2

It was established in November 2016 with support from the Norwegian Academy of Science.

DESCRIPTION

The Scientific journal "Norwegian Journal of development of the International Science" is issued 24 times a year and is a scientific publication on topical problems of science.

1000 copies

Norwegian Journal of development of the International Science

Iduns gate 4A, 0178, Oslo, Norway

email: publish@njd-iscience.com

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