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Formation and utilisation of alfalfa sward under the soil and climatic conditions of the Right-Bank Forest-Steppe

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Abstract. The aim of the study was to determine the optimal combination of sowing rate and complex mineral fertilisers for the formation of a productive alfalfa (*Medicago sativa* L.) sward of the 'Radoslava' variety under the soil and climatic conditions of the Right-Bank Forest-Steppe. The experiment was conducted on grey forest soils during 2024-2025 using a three-factor design: sowing rates of 6.0 and 8.0 million viable seeds per hectare, two harvesting periods, and three levels of mineral nutrition. It was established that in the year of sowing (2024), the crop reached the beginning of flowering stage (BBCH code 61-62) after 69-70 days, with a daylight duration of 14:53-16:12 hours, and provided three cuts with a total green matter yield of up to 33.13 t/ha. The greatest plant height in the first cut was 66.1-66.3 cm at a sowing rate of 6.0 million/ha and maximum fertilisation (Background + $K_{60}S_{20}Ca_{30}Mg_{20}$), whereas in the third cut it decreased to 21.2-30.3 cm due to reduced daylight duration and increased temperature. On average across the treatments, plant height ranged from 36.00 to 42.93 cm, while leafiness ranged from 33.74 to 40.77%. In the second year (2025), across three cuts at the beginning of flowering stage (BBCH code 64), the average plant height was 61.4-61.8 cm, leafiness was 53.0-54.3%,

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and green matter yield reached 75.8 t/ha. The statistical significance of factor effects was confirmed by $LSD_{0.05}$. It was determined that the optimal combination was a sowing rate of 6.0 million/ha with increased fertilisation (Background + $K_{60}S_{20}Ca_{30}Mg_{20}$), which ensured the highest total green matter yield with minimal risks of moisture deficiency under the unstable hydrothermal conditions of the Right-Bank Forest-Steppe

Keywords: sowing rate; mineral fertilisers; plant height; leafiness; green matter yield; mowing time

Introduction

Alfalfa is regarded as one of the principal perennial legume crops from which forage production systems are expected to obtain simultaneously high yields, stable quality of leaf-stem biomass, and long-term productive utilisation of the sward (Antoniv *et al.*, 2023). Under the conditions of the Right-Bank Forest-Steppe, this crop was of particular importance due to the combination of summer temperature stress, unstable moisture supply, and increased requirements for the economic efficiency of each technological component. In contemporary scientific literature, leading attention has been devoted to studies of the role of potassium nutrition. Consequently, it became relevant to clarify the technological combination of sowing rate, level of complex mineral nutrition, and mowing time for the alfalfa variety 'Radoslava' under the conditions of grey forest soils of the Right-Bank Forest-Steppe, taking into account not only yield but also biometric indicators, sward quality, and economic and energy efficiency. Data from E.A. Appiah *et al.* (2024) showed that optimising potassium nutrition was one of the key factors in realising the production potential of alfalfa. Scientists D.J. Heuschele *et al.* (2023) established that potassium fertilisation influenced not only the yield of leaves and stems, but also forage quality, nutrient uptake and the phytosanitary condition of the sward. M.M. Baidoo & M.A. Islam (2024) demonstrated that the effect of potassium must be assessed in relation to the harvest date, as it is the combination of these factors that determines the productivity and profitability of alfalfa cultivation. At the same time, H. Ren *et al.* (2025) concluded that the most stable increase in alfalfa yield was not achieved by an isolated increase in a single nutrient dose, but by a balanced ratio of N, P and K, adapted to the specific soil and climatic conditions. Phosphorus nutrition was also considered one of the determining factors for early crop development, winter survival and yield stabilisation. The results of studies by Y. Wang *et al.* (2024) showed that phosphorus fertilisation enhanced the overwintering of late-sown alfalfa, stimulated root system development and increased forage yield on saline soils. Based on a review of scientific studies, researchers L. Zhang *et al.* (2025) noted that optimising phosphorus nutrition improved not only yield but also forage quality. H. Ma *et al.* (2024) confirmed that, over a multi-year cycle, the combination of irrigation and phosphorus fertilisation resulted in a more stable level of productivity. Researchers J. Zhao *et al.* (2023) found that the combined application of nitrogen and phosphorus significantly altered the protein fractions and the content of non-structural carbohydrates in alfalfa, and thus directly influenced the quality of the plant material.

A separate group of contemporary studies concerned plant density, sowing rate, and the adaptation of alfalfa to environmental stress conditions. J. Liu *et al.* (2024) demonstrated that on saline soils, the interaction between plant density and nitrogen nutrition altered the growth and quality of the forage. P. Álvarez-Vázquez *et al.* (2020) demonstrated that optimising row spacing and sowing rates allowed yield to be maintained without excessive crop density. A group of researchers led by A. Liatukienė *et al.* (2025)

established that it was the combination of soil and climatic conditions that determined the growth pattern and yield of alfalfa. A synthesis of these studies provided grounds for concluding that, for the conditions of the Right-Bank Forest-Steppe, it is insufficient to assess either the fertiliser rate or the sowing rate in isolation – an integrated determination of their combination is required, one that ensures high green matter yield, sufficient foliage, rational use of moisture, and an energy-efficient technology. The aim of the study was to investigate the influence of sowing rates and various combinations of macro- and microelements on the formation of the alfalfa sown variety 'Radoslava', as well as on the components of green matter yield and the quality indicators of plant raw material during the first two years of vegetation (2024-2025). To achieve this aim, the following objectives were set: 1) to determine the effect of sowing rates and complex mineral fertilisers on the formation of the sward, plant height, leafiness and green matter yield of alfalfa during the first two years of growth; 2) to determine the characteristics of yield distribution across swaths and mowing times in the second year of sward utilisation.

Materials and Methods

Alfalfa (*Medicago sativa* L.) is a perennial legume forage crop of the 'Fabaceae' family that develops a deep root system, is characterised by a high regenerative capacity after mowing, a substantial proportion of leaf mass in the yield, and the ability for symbiotic fixation of atmospheric nitrogen. The combination of these characteristics determined its high forage value and suitability for repeated utilisation throughout the growing season. The study was conducted during 2024-2025 at the experimental field of Vinnytsia National Agrarian University on grey forest soils according to a staged experimental scheme. At the first stage, visual observations of the growth and development of alfalfa plants were carried out throughout the growing season, with recording of the timing of the main developmental stages and the formation of cuts depending on weather conditions. At the second stage, before each cut at the budding and beginning of flowering stages, plant height was measured on 20 typical plants in each treatment. Leafiness was determined by the gravimetric method as the ratio of leaf mass to the total mass of the plant sample. At the third stage, green matter yield was calculated by complete weighing of the accounting plot area and converted into t/ha. Yield calculation was performed using the following formula:

$$Y = \frac{m}{S} \times 10, \quad (1)$$

where Y – yield, t/ha; m – mass of green matter from the sample plot, kg; S – sample plot area, m^2. Leafiness index was determined using the formula:

$$L = \frac{m_1}{m_2} \times 100, \quad (2)$$

where L – leafiness index, %; m_1 – leaf mass, kg; m_2 – total mass of the plant sample, kg. To assess the compliance of the forage mass with the requirements for legume hay, the provisions of DSTU 4674:2006 (2007) were used.

Field germination was determined by counting the number of plants within the accounting area after the emergence of full seedlings, while shoot density was determined by counting the number of shoots per 1 m^2 before mowing. According to the results of the agrochemical analysis of the arable soil layer (0-30 cm), the humus content was 2.69%, alkaline hydrolysable nitrogen – 81 mg/kg, available phosphorus – 218 mg/kg, exchangeable potassium – 72 mg/kg, available sulphur – 5.3 mg/kg, available copper – 0.29 mg/kg, available zinc – 0.45 mg/kg, available manganese – 14.6 mg/kg, and pH of the salt extract – 6.1. The experiment was conducted with three replications, systematic arrangement of treatments, a total plot area of 30 m^2, and yield accounting after excluding border rows. The weather conditions of 2024 and 2025 were characterised by elevated temperatures and uneven distribution of precipitation during the active growing season. Spring regrowth began earlier than the long-term average dates, which accelerated the initial stages of organogenesis; however, during summer this intensified the risk of moisture deficiency and shortened the intervals between the stages of cut formation. The alfalfa variety 'Radoslava' was sown on 8 April 2024 using a HEGE 80 (Hege Maschinenbau) precision seed drill in combination with a MITSUBISHI GX 50 tractor (Mitsubishi Agricultural Machinery) with row spacing of 12.5 cm. The experimental design included two sowing rates – 6.0 and 8.0 million viable seeds/ha – and three mineral nutrition treatments: Background $N_{35}P_{90}K_{90}S_{3.5}$, Background + $K_{30}S_{10.5}Ca_{15}Mg_{10}$ and Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$. Mineral fertilisers were applied before sowing, full emergence was obtained 10 days after sowing, and mowing dates were determined according to the crop reaching the budding or beginning of flowering stages. The study was conducted in accordance with the requirements of the Convention on Biological Diversity (1992).

Results and Discussion

Observations showed that during the formation and utilisation of the first-cut sward, the most favourable weather conditions were created with an average monthly air temperature in May of 16.3°C and total atmospheric precipitation of 205.4 mm. Under such conditions, the height of alfalfa plants reached 66.3 cm under the high mineral nutrition background (Background + K_{60} $S_{20,5}Ca_{30}Mg_{20}$) and a sowing rate of 6.0 million seeds/ha, with leafiness of 53.53% and field germination of 87%. On average across the three cuts, the treatments demonstrated a decrease in plant height and leafiness with increasing sowing rate (Table 1).

Table 1. *Biometric indicators of alfalfa at the beginning of the flowering stage (first cut, 2024), M ± m*

Fertilisation	Sowing rate, million seeds/ha	Field germination, %	Height, cm		Leafiness, %	
			first cut	average over 3 cuts	first cut	average over 3 cuts
Background $N_{35}P_{90}K_{90}+S_{3.5}$	6.0	84 ± 3.6	64.4 ± 6.60	37.03 ± 5.07	48.24	35.55 ± 12.36
	8.0	80 ± 6.4	63.4 ± 6.16	36.00 ± 4.78	46.62	33.74 ± 21.44
Background + $+K_{30}S_{10}Ca_{15}Mg_{10}$	6.0	84 ± 2.6	65.3 ± 4.89	39.23 ± 4.19	50.45	37.66 ± 11.53
	8.0	82 ± 2.6	64.4 ± 4.44	38.37 ± 3.92	48.05	35.50 ± 10.91
Background + $+K_{60}$ $S_{20.5}Ca_{30}Mg_{20}$	6.0	87 ± 2.6	66.3 ± 5.24	42.93 ± 4.27	53.53	40.77 ± 11.32
	8.0	84 ± 4.2	66.1 ± 3.54	41.67 ± 2.94	51.29	39.04 ± 11.15

Note: M ± m – confidence interval of the arithmetic mean at the 5% significance level
Source: developed by the authors

At a sowing rate of 6.0 million seeds per hectare, the best values for plant height (42.93 cm) and leafiness (40.77%) were obtained when the maximum dose of mineral fertilisers was applied, resulting in an increase in these parameters of 5.9 cm (15.9%) and 5.22%, respectively, compared with the Background + $N_{35}P_{90}$ + $K_{90}S_{3.5}$. The formation of subsequent cuttings took place in summer with an increase in the average monthly air temperature to 24.6°C and above, accompanied by an uneven distribution of precipitation and a reduction in the length of daylight hours in autumn to 12:48 hours. Changes in temperature and moisture supply influenced the growth processes of alfalfa and green matter yield indicators. The average height of alfalfa plants in the year of sowing varied depending on the fertilisation level within the range of 36.00-42.93 cm. The lowest values were recorded in the background treatment (36.00-37.03 cm), whereas with the application of increased doses of mineral fertilisers (Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$) plant height increased to 41.67-42.93 cm. The increase in plant height compared with the background treatment averaged 4.7-5.9 cm. The sowing rate had only a minor influence on plant height, since the difference between the 6.0 and 8.0 million seeds/ha treatments did not exceed 1.0-1.5 cm. Analysis of the dynamics of plant height formation by cuts showed that the maximum values were formed in the first cut (66.1-66.3 cm), whereas in the second cut they decreased to 23.4-32.2 cm and in the third cut to 22.3-30.3 cm. The reduction in height in the later cuts was explained by the physiological characteristics of the crop and the influence of weather conditions in the year of sowing, particularly the elevated temperature regime and unstable moisture supply. At the same time, the application of increased fertiliser doses contributed to an increase in plant height in the second and third cuts by 6.7-7.6 cm compared with the background treatment. Variations in biometric indicators between the first and third cuts across the experimental treatments resulted in a yield reduction ranging from 5.2 to 25.3%. Despite the difficult hydrothermal conditions, the crop formed a vigorous sward and entered the winter period in satisfactory condition. In the second year of growth (2025), utilisation of the alfalfa sward was planned at the budding stage (BBCH code 49) and the beginning of flowering stage (BBCH code 62). According to the data presented in Table 2, plant height at the budding stage ranged from 52.7 to 55.7 cm at a sowing rate of 6.0 million seeds/ha and from 54.1 to 55.0 cm at a sowing rate of 8.0 million seeds/ha.

Table 2. *Plant height and leafiness of alfalfa in the second year of growth (2025) depending on fertilisation and the timing of green matter harvesting (average over three cuts), M ± m*

Fertilisation	Sowing rate, million seeds/ha	Height, cm		Leafiness, %	
		BBCH code 49	BBCH code 62	BBCH code 49	BBCH code 62
Background $N_{35}P_{90}+K_{90}S_{3.5}$	6.0	52.7 ± 7.36	59.7 ± 5.22	56.1 ± 10.66	51.5 ± 11.30
	8.0	54.1 ± 5.87	61.2 ± 4.95	54.3 ± 8.66	51.4 ± 15.30
Background + $+K_{30}S_{10}Ca_{15}Mg_{10}$	6.0	54.4 ± 5.48	61.8 ± 4.72	55.4 ± 2.47	54.0 ± 16.60
	8.0	54.3 ± 5.95	61.4 ± 5.26	52.3 ± 3.75	54.6 ± 14.35
Background + $+K_{60}S_{20.5}Ca_{30}Mg_{20}$	6.0	55.7 ± 4.93	62.7 ± 4.87	51.9 ± 6.21	53.6 ± 18.17
	8.0	55.0 ± 4.06	62.7 ± 5.18	53.2 ± 7.79	56.9 ± 12.41
Average	6.0	54.3 ± 5.92	61.4 ± 4.94	54.5 ± 5.43	53.0 ± 5.18
	8.0	54.5 ± 5.29	61.8 ± 5.13	53.3 ± 5.21	54.3 ± 5.17

Note: M ± m – confidence interval of the arithmetic mean at the 5% significance level
Source: developed by the authors

At the beginning of the flowering stage, plant height increased to 59.7-62.7 cm and reached its maximum in the treatments with enhanced mineral nutrition (Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$), where it attained 62.7 cm regardless of sowing rate. On average across the experimental treatments, plant height was 54.3-54.5 cm at the budding stage and 61.4-61.8 cm at the beginning of flowering, indicating a stable tendency towards increased growth during the transition to the generative phase of development. Plant leafiness at the budding stage ranged from 51.9 to 56.1%, while at the beginning of flowering it ranged from 51.4 to 56.9%. On average, this indicator amounted to 54.5-53.3% (BBCH code 49) and 53.0-54.3% (BBCH code 62), indicating a slight reduction in leafiness during the transition to the flowering stage. The highest leafiness (56.9%) was recorded at a sowing rate of 8.0 million seeds/ha under the maximum fertilisation treatment (Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$), which was accompanied by the formation of tall plants (62.7 cm). In the year of sowing, the total seasonal green matter yield reached 33.13 t/ha at a sowing rate of 6.0 million viable alfalfa seeds/ha under mineral fertilisation at the dose of Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$, which was 29.7% higher than the background. It is worth noting that, owing to the uniform stem density and plant height within the established sward, green matter yield maintained a tendency to increase according to the studied factors (Table 3).

Table 3. *Green matter yield of alfalfa at the beginning of flowering by cuts, t/ha, 2024*

Fertilisation (factor A)	Sowing rate, million/ha (factor B)	Cuts			Total
		1st	2nd	3rd	
Background $N_{35}P_{90}+K_{90}S_{3.5}$	6.0	8.80	8.76	8.34	25.90
	8.0	10.94	8.70	8.17	27.81
Background + $K_{30}S_{10.5}Ca_{15}Mg_{10}$	6.0	10.86	10.55	9.87	31.28
	8.0	11.44	9.88	9.63	30.95
Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$	6.0	11.58	11.21	10.34	33.13
	8.0	11.78	10.70	10.07	32.55
$LSD_{0.05}$	*A*	0.69	0.63	0.59	1.90
	B	0.56	0.51	0.48	1.55
	AB	0.97	0.89	0.84	2.69

Note: A – factor A (fertilisation), B – factor B (sowing rate), AB – interaction of factors A and B
Source: developed by the authors

The data obtained led to the conclusion that, regardless of changes in hydrothermal conditions throughout the growing season, during the formation of the sward, the studied variety of alfalfa 'Radoslava' was adapted to stressful environmental conditions and yielded three cuts by the time the crop reached the early flowering stage. In the second year of growth, the hydrothermal conditions during the growing season enabled the plants to reach the early flowering stage throughout the season and produce three full cuts, starting with the first cut in the first ten days of June and the third in the first ten days of September. The highest green matter yield was observed with maximum fertilisation, amounting to 83.8 t/ha with a sowing rate of 8.0 million seeds/ha and a shoot density of 2,096 shoots/m^2. In total, across the three cuts, the gross green matter yield varied between treatments, with an average of 45.5 t/ha over the years, due to tillering and plant growth against a background of sufficient nutrients and moisture. The increase attributable to sowing rates was 2.1 t/ha. Increasing the application rates of mineral fertilisers ensured an increase in green matter yield compared to the background treatment. In particular, when applying additional $K_{30}S_{10.5}Ca_{15}Mg_{10}$ the average yield increased by 10.1%, and with the application of $K_{60}S_{20.5}Ca_{30}Mg_{20}$ – by 18.8% compared with the background (48.4 t/ha), amounting to 53.3 and 57.5 t/ha respectively (Table 4).

Table 4. *Green matter yield of alfalfa at the beginning of flowering over two years (2024-2025) of vegetation, t/ha*

Fertilisation (factor A)	Sowing rate, million/ha (factor B)	Years			Average by	
		2024	2025	Mean	Factor B	Factor A
Background $N_{35}P_{90}+K_{90}S_{3.5}$	6.0	25.9	67.3	46.6	52.0	48.4
	8.0	27.8	72.4	50.1	54.1	
Background + $K_{30}S_{10.5}Ca_{15}Mg_{10}$	6.0	31.3	73.8	52.6		53.3
	8.0	31.0	77.0	54.0		
Background + $K_{60}S_{20.5}Ca_{30}Mg_{20}$	6.0	33.1	80.4	56.8		57.5
	8.0	32.6	83.8	58.2		
Average over the years		30.3	75.8	+45.5	2.1	
$LSD_{0.05}$	*A*	1.90	2.11			
	B	1.55	1.34			
	AB	2.69	2.86			

Source: developed by the authors

The method of sowing alfalfa with a row spacing of 12.5 cm, combined with the provision of nutrients to the plants, created favourable conditions for the formation of a dense sward across the area. Under these conditions, the alfalfa, with its upright bush type, plant height of 44-86 cm (1^{st}-3^{rd} cuts) and leafiness of 53.0-54.5%, ensured consistent green matter yield figures during the formation of the second and third cuts. The data obtained indicated the adaptability of this variety to changing weather conditions during the growing season and its ability to maintain consistent plant height and leafiness within standard sowing rates and mineral fertiliser application rates. With a leaf content of over 50%, the forage mass obtained during the budding to early flowering stages met the requirements for high-quality legume hay as per DSTU 4674:2006 (2007).

It is advisable to consider the research results not in isolation, but within the broader context of contemporary research into resource-saving alfalfa cultivation technologies. In contrast to the introduction, where the main focus was on the role of mineral nutrition, the Discussion section analysed studies that investigated the combined effects of water regime, fertilisation levels, harvest timing, varietal characteristics and environmental constraints. This approach made it possible to better explain why, specifically under the conditions of the Right-Bank Forest-Steppe, a moderate sowing rate of 6.0 million seeds/ha combined with more intensive mineral nutrition was preferred, and why the greatest effect was observed not so much in the formal increase in crop density as in the stabilisation of the yield structure, foliation and green matter yield. L. Liu *et al.* (2025) found that a moderately managed water deficit in alfalfa crops can reduce water consumption without significantly compromising forage quality and may even enhance the economic return of the technology. The data obtained were consistent with these findings: under conditions of an unstable hydrothermal regime, the advantage lay not with maximum plant density, but with the option that best balanced the plants' water requirements with the actual resource capacity of the agrocenosis. This is precisely why a sowing rate of 6.0 million seeds/ha proved more productive in terms of overall economic efficiency, as it did not intensify competition for water but allowed the benefits of increased mineral nutrition to be maximised. The results were further supported by studies on water management systems for alfalfa crops. Z. Jia *et al.* (2024) demonstrated that optimising the drip irrigation regime in semi-arid conditions improved the crop's seed yield through better regulation of water supply during critical growth stages. U. Cholula *et al.* (2026) demonstrated that under water-deficient irrigation, not only yield but also the nutritional value of various alfalfa varieties changes significantly. Although the experiment in this study was conducted without artificial irrigation, the general pattern was consistent: under limited water availability, the most effective approach was one that did not cause excessive grass stand density but created conditions for stable leaf mass formation. This explained why the advantage of maximum fertilisation was most clearly evident precisely in combination with a lower sowing rate.

S. Tlahig *et al.* (2024) established that even under similar yield levels, varieties and growing seasons differed significantly in forage quality indicators, which were critical for adapting production to climate change. In the present study, the variety 'Radoslava' demonstrated relatively stable indicators of leafiness, while a leaf proportion exceeding 50% at the budding and beginning of flowering stages indicated the preservation of high forage value. Importantly, increasing the sowing rate did not provide an advantage in terms of quality; instead, it intensified competition among plants. This once again confirmed that, under practical production conditions, not every increase in crop density is technologically justified. When interpreting mowing dates, it is important to consider the phytosanitary aspect as well. J.S. Herreid *et al.* (2024) demonstrated that the timing of alfalfa harvest in commercial crops significantly influenced the population dynamics of the alfalfa weevil. Although this study did not set out to conduct a specific phytosanitary assessment, the very fact of a clear difference between the yield of the cuts and the timing of developmental stages indicated that the management of the grass stand has broader implications than simply a change in forage yield. The first cut, which accounted for more than half of the annual yield, proved critical not only for gross yield but also for the subsequent stability of the agro-phytocenosis (Bélanger *et al.*, 2020). A study by X. Li *et al.* (2023) found that sustained irrigation and the application of phosphorus fertilisers over a six-year period significantly increased alfalfa yield and the stability of green matter formation. The authors also noted that optimal phosphorus nutrition promoted better root system development and more efficient water use by plants. R.M. Sulc *et al.* (2021) investigated changes in the nutritional value of low-lignin alfalfa during regrowth after mowing. The researchers demonstrated that reducing lignin content improved feed digestibility and maintained high-quality green matter even at later stages of plant development.

Thus, optimising mowing times should be considered as part of integrated management of crop productivity, quality and sustainability. Z. Ben & H. Yang (2025) noted that alfalfa's response to fertilisation varied significantly depending on the combination of agrochemical and weather factors; consequently, universal recommendations not tailored to the specific site had limited practical value. The maximum dose of compound fertiliser yielded the best results not on its own, but in a specific combination with a moderate sowing rate, grey forest soils and unstable moisture supply. It was precisely this combination of conditions that allowed the Background + $K_{60}S_{20}Ca_{30}Mg_{20}$ treatment to demonstrate its superiority in terms of plant height, leafiness, gross green matter yield and energy efficiency. A.G. Desta (2026) summarised data on the role of alfalfa in improving soil condition and reducing greenhouse gas emissions in integrated crop-livestock systems. This approach was important for interpreting the results of this study, as the choice of cultivation technology must take into account not only the current year's profit but also the long-term stability of the agroecosystem. The advantage identified in the variant with a sowing rate of 6.0 million seeds/ha and increased complex fertilisation can be assessed as more rational not only from an economic but also from an agroecological perspective: it ensured high productivity without an excessive increase in plant density and the associated risks of resource depletion. In particular, it is important to note the crop's adaptability to changing weather conditions and the ability to produce a consistent green matter yield, which was adjusted by the timing of grass cutting and the level of mineral nutrition. Thus, the results of the study confirmed that for alfalfa in the conditions of the Right-Bank Forest-Steppe, the effectiveness of the technology was determined not by the maximum intensification of a single element, but by a balanced combination of sowing rate, mineral nutrition, the timing of grass stand utilisation, and a resource-saving yield formation regime. It was precisely this logic that explained why, in the experiment, the combination of 6.0 million/ha of germinating seeds with the Background + $K_{60}S_{20}Ca_{30}Mg_{20}$ treatment proved to be the best: it ensured a high gross yield of green matter, sufficient foliage, better economic indicators and technological stability under variable hydrothermal conditions. Thus, the data obtained were not only of local practical significance but also complemented current understanding of adaptive yield management in perennial leguminous grasses.

Conclusions

The alfalfa variety 'Radoslava' under the conditions of grey forest soils of the Right-Bank Forest-Steppe demonstrated stable productivity and adaptability to fluctuations in the hydrothermal regime, providing three full cuts during the growing season both in the year of sowing and in the second year of use. In the year of sowing (2024), the optimal combination was a sowing rate of 6.0 million/ha with the fertiliser dose Background + $K_{60}S_{20}Ca_{30}Mg_{20}$, which ensured the highest total green matter yield of 33.13 t/ha, exceeding the background treatment by 27.9% ($LSD_{0.05}$ for factor A = 1.90 t/ha). At the same time, the average plant height over three cuts was 42.93 cm, while leafiness reached 40.77%, representing the highest values among all studied fertilisation treatments. In the second year of vegetation (2025), mowing at the beginning of the flowering stage (BBCH code 62) provided a total yield of 75.8 t/ha, which was 2.5 times higher than in the year of sowing (30.3 t/ha). The average plant height was 61.4-61.8 cm, and leafiness ranged from 53.0 to 54.3%. In the total green matter yield during the vegetation period of alfalfa, the first cut accounted for 54.4-56.2%. Increasing the sowing rate from 6.0 to 8.0 million/ha had no significant effect on green matter yield (the difference remained within the $LSD_{0.05}$ limits), although it was accompanied by a reduction in plant height and leafiness. The decrease in leaf mass under the higher sowing rate was considered undesirable in terms of the qualitative characteristics of the plant material. Taking this into account, the sowing rate of 6.0 million viable seeds/ha proved to be the more rational choice for the conditions of the Right-Bank Forest-Steppe. Plant material harvested at the budding to early flowering stages was characterised by a leaf content exceeding 50%, corresponding to the high forage value of legume hay. Prospects for further research include studying the chemical composition and nutritional value of green matter depending on the investigated factors, assessing the impact of agronomic measures on soil fertility and sward structure, as well as determining the longevity of the use of the alfalfa variety 'Radoslava' during the third and subsequent years of vegetation under conditions of an unstable hydrothermal regime.

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None.

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Формування та використання травостою люцерни посівної за ґрунтово-кліматичних умов Лісостепу Правобережного

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Анотація. Метою дослідження було визначити оптимальне поєднання норми висіву та комплексних мінеральних добрив для формування продуктивного травостою люцерни посівної (*Medicago sativa* L.) сорту 'Радослава' в ґрунтово-кліматичних умовах Лісостепу Правобережного. Дослід було проведено на сірих лісових ґрунтах у 2024-2025 роках за трифакторною схемою: норми висіву 6,0 і 8,0 млн/га схожих насінин, двох строків збирання та трьох рівнів мінерального живлення. Встановлено, що у рік сівби (2024 рік) культура досягла фази початку цвітіння (код 61-62 BBCH) через 69-70 діб за тривалості світлової доби 14:53-16:12 години та забезпечила три укоси із валовим збором зеленої маси до 33,13 т/га. Найбільша висота рослин у першому укосі становила 66,1-66,3 см при нормі висіву 6,0 млн/га і максимальному удобренні (Фон + $K_{60}S_{20}Ca_{30}Mg_{20}$), тоді як у третьому укосі – знизилась до 21,2-30,3 см внаслідок скорочення тривалості світлової доби та підвищення температури. В середньому за варіантами висота рослин коливалась від 36,00 до 42,93 см, облиствленість – від 33,74 до 40,77 %. На другий рік (2025 рік) за трьома укосами у фазі початку цвітіння (код 64 BBCH) середня висота рослин становила 61,4-61,8 см, облиствленість – 53,0-54,3 % з урожайністю зеленої маси 75,8 т/га. Статистична значущість впливу факторів підтверджена $НІР_{05}$. Встановлено, що оптимальним поєднанням стала норма висіву 6,0 млн/га із підвищеним удобренням (Фон + $K_{60}S_{20}Ca_{30}Mg_{20}$), яке забезпечувало найбільший валовий збір зеленої маси за мінімальних ризиків дефіциту вологи в умовах нестійкого гідротермічного режиму Лісостепу Правобережного

Ключові слова: норма висіву; мінеральні добрива; висота рослин; облиствленість; урожайність зеленої маси; строк скошування