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ORIGINAL ARTICLE

Fodder productivity of meadow clover varieties depending on the growing technology

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The research results for 2018–2020 on the formation of fodder productivity of the yield of the dry mass of different varieties of meadow clover from 1 ha depending on the sowing methods on different backgrounds of fertilizer on typical low-humus chernozems of the Forest-Steppe of Ukraine were presented. On average, for the first three years of growth and use, meadow clover provided productivity of yield of the dry mass of 8.22–9.88 tons from 1 ha, which depended little on sowing methods. Productivity increased by 8–12 % when inoculating seed with nodule bacteria combined with the application of N60P60K90 compared with the variant without fertilizers and only by 4–6 % under separate application of fertilizers (P60K90 or N60P60K90) or seeds inoculation on the background without fertilizers. The application of N60 on the background of P60K90 provided the highest payback of 1 kg of fertilizer (6–7 kg of dry mass) among fertilizers. In the first year, sowing under cover of spring barley provided higher productivity by 22–25 %, and in the second and third years, coverless sowing was provided by 7–10 %. The most productive variety was Taifun, which was 0.10–0.66 t/ha of dry mass superior to Lybid and Tina varieties. The factor of fertilization was the most influential in yield of dry mass from 1 ha and the sowing method with a share proportion of 55 % in the first year. Meadow clover annually provided three mowings of fodder biomass with the share of the first mowing of 44–50 %, the second – 32–34 %, and the third – 18–24 %, and the uneven distribution of the yield by mowing by 30–47 %.
Keywords: seed inoculation; meadow clover; productivity; distribution of yield by mowing; variety; sowing method; dry mass; fertilizer

Introduction

Solving the problem of increasing the production of highly nutritious grass fodders for ruminants and improving soil fertility belongs to meadow clover, which can reliably provide productivity of 8–12 t/ha and more of dry mass for two years in Polissia region of Ukraine (Stotska, 2011, 2017).

An essential role in forming fodder productivity and improving fodders' quality belongs to the meadow clover varieties (Demydas, Halushko, 2020). Varietal diversity of the main species of perennial legumes and cereals, including meadow clover, is higher in the countries with developed meadow cultivation, in particular in the countries of the European Union than in Ukraine, according to literature sources (Wiersma et al., 1998; Hannaway et al., 2018). The basic requirements for varieties of different types of perennial legumes allow now and in the future better using of their genetic potential based on generalizations of literary sources (Kurhak, 2010; Petrychenko et al., 2012; Petrychenko, Kurhak, 2013) were formulated. Varieties must be characterized by: high productivity and good fodder quality; ability to grow well after frequent mowing; sufficient coenotic activity even with the introduction of nitrogen, which makes it possible to effectively combine its use with biological and mineral sources of income; different, in a significant range, rhythm of regrowth during the season, which makes it possible to create different types of early-maturing grass stands for different target purposes; high productive longevity up to five years or more; extended geographical area and ecological range of the optimum, which allows cultivating of legume-and-cereal grass stands in more severe climatic and soil conditions, including the connection with climate change because of the global warming; ability to intensive vegetative regrowth from the first year of grasses life; high winter hardiness, resistance to lodging and other adverse phenomena; resistance to diseases, pests and weeds; ability to use abiotic environmental factors more effectively, in particular moisture, CO_2, light, temperature, nutrients, etc.

The creation of clover and clover-and-cereal agrophytocenoses on forage lands with the participation of meadow clover makes it possible to increase their productivity, protein content significantly, and energy saturation of fodders, significantly reduce the cost of technical nitrogen not only for fodder production but also in general in crop rotation, drastically reduce the costs of energy and money, as well as to reduce the negative impact of nitrogen fertilizers on the environment, which crisis becomes extremely important for agricultural production in the current conditions of ecological and energy (Kurhak, Karbivska, 2020; Karbivska, 2020).

The creation of sown single-species legumes and legume-and-cereal grass stands with high legume content is one of the most promising areas of intensification of fodder production in the world (Gayraund, 1986; Wiersma et al., 1998; Hamacher et al., 2016; Hannaway et al., 2018; Hynes et al., 2018). Replacement of mineral nitrogen with symbiotic is an essential reserve for reducing energy consumption, which often accounts for half of its total costs on cereal grass stands (Kurhak, 2010; Kurhak et al., 2016). Increasing the use of legumes in meadow cultivation is essential for the introduction of energy-saving technologies abroad, including organic meadow cultivation (Laidlaw, 1982; Larson, 1982; Damborg, Stødkilde, 2016; Peyraud, Peeters, 2016; Wallenhammar et al., 2018).

Studies conducted in different soil-and-climatic conditions with different types of legumes showed that inclusion of legumes in the composition of legume-and-cereal cenosis without the introduction of mineral nitrogen increases the productivity of forage lands in

1.5–2.5, and in 2–3 times by gathering of crude protein compared with cereal grass stands on the same background of SC (Brauer et al., 2002; Nilsdotter-Linde, Halling, 2016; Kurhak, 2010; Kurhak, Voloshyn, 2017; Voloshyn, 2017; Hynes et al., 2018; Kovtun et al., 2020). Simultaneously, the use of legumes in the composition of legume-and-cereal grass stands replaces the application of 100–300 kg/ha of mineral nitrogen on the cereal grass stand.

The compliance of the components of the complex of physical conditions of the environment (humidity level, climate, and soil) and the corresponding regimes of use, a system of fertilization and care, and coenotic properties of the components under growing of perennial legumes in the mixtures with cereals in the selection of species and varieties of legumes to fodder phytocenoses is the main principle (Kutuzova, 1986; Mirkin, 1986; Bogovin et al., 1990; Kurhak, 2010; Petrychenko, Kurhak, 2013).

The most critical perennial legumes using in fodder production or under irrigation include meadow, white, and alsike clover in the Forest-Steppe and Polissia of Ukraine; alfalfa and yellow hybrid alfalfa – on carbonate and well-cultivated soils; common bird's-foot trefoil – on low-fertile soils under newly developed hayfields, and Hungarian sainfoin – in the southern Forest-Steppe (Bogovin et al., 1990; Kurhak, Tovstoshkur, 2010; Weib, Kalzendorf, 2016). Meadow, white, and alsike clover under hay use are kept in the composition of legume-and-cereal grass stands, as well as in single-species sowings for two-three years. Alfalfa and common bird's-foot trefoil are characterized by greater productive longevity (four-five years) (Bogovin et al., 1990; Kurhak, 2010).

It is essential to know the distribution of total yield by cycles of use on pastures and by mowing – under haymaking regime of grass, stands used in joining of grass fodder when planning green or raw conveyors or for continuous feeding of cattle in the summer and rhythmic operation of forage harvesters (Kurhak, 2010).

The evenness of the yield distribution by mowing depends on many factors. The species composition and fertilizer, including nitrogen application in portions, as well as the time of grass cutting, supply the soil with moisture are among the factors that most influence the distribution of the yield by mowing or cycles of grass stands used (Kurhak, 1995; Kurhak, Lukianets, 2004; Kutuzova, Akhlamova, 1978; Karbivska et al., 2002). It is known that the distribution of yield by cycles of use will usually be more even than under the haymaking regime in the early stages of the first grass cutting and following the increase in its frequency that is under pasture use. As a rule, 4–5 cycles are carried out, when the 4th and 5th are exclusively for grazing under pasture use, 2–3 cycles under haymaking use, where the 3rd mowing is used, in most cases, for cattle grazing. The yield by use cycles significantly increases, but the evenness of its distribution by the use cycles significantly improves under the application of nitrogen fertilizers, particularly in portions. According to O.P. Lukianets (2004), alfalfa-cereal grass stand with a share under haymaking use of the first mowing 61–62 %, the second – 36–37 %, the third – 2–3 % among the types of grass stands was characterized by the evenest distribution of yield by mowing.

Despite the significant amount of research on the study of technological measures for growing meadow clover, the issues on selecting the best varieties in single-species sowings under different technologies of its growth for fodder purposes in the Right-Bank Forest-Steppe of Ukraine remain insufficiently studied. This has become the subject of our research, which is undoubtedly relevant.

Materials and methods

The study was performed at the Department of Fodder Production, Land Reclamation and Meteorology in the field crop rotation of the Separate Division of the National University of Life and Environmental Sciences of Ukraine "Agronomic Research Station", which is located in the Right-Bank Forest-Steppe of Ukraine.

The soil of the experimental plot is typical low-humus large-pulverous medium-loam chernozem, which contains 4.3–4.5 % of humus, 4.6–5.4 and 15.2–15.8 mg/100 g, respectively, of P2O5 and K2O, salt pH – 6.9 in a layer of 0–20 cm.

During the research years (2018–2020), on average, air temperature during the growing season exceeded by 1.6–2.4 °C the norm or the average long-term indicator, which is 14.8 °C and on average per year, at the norm of 8.2 oC – by 0.5–1.9 oC, which confirms the situation with air temperature that has developed in recent years. The precipitation during the growing season was less than the norm (385 mm) by 12–112 mm, and was annually less by 54–104 mm at the norm of 598 mm. However, exceeding the average temperature and reducing the amount of precipitation was not critical, which, in general, had a positive effect on the formation of meadow clover yield during the years of grass stand use.

Field three-factor experiment "Productivity and quality of green mass of agrophytocenoses of different meadow clover varieties depending on the technology of cultivation in the Right-Bank Forest-Steppe of Ukraine" was laid in spring of 2018 according to the following scheme: gradation of factor A (fertilization) – 1. Without fertilizers (control); 2. Inoculation of seeds with nodule bacteria (background); 3. Background + P60K90; 4. Background + N60P60K90; factor B (variety) – 1. Lybid; 2. Taifun; 3. Tina; factor C (sowing method) – 1. Coverless; 2. Undersowing under spring barley.

The area of the sown plot was 30 m2, recording area was 25 m2. The experiment was repeated four times. The technology of meadow clover growing except the studied factors was generally accepted for the Right-Bank Forest-Steppe of Ukraine.

Nitrogen fertilizers in the form of ammonium nitrate with an active substance content of 34 %, phosphorus – as simple superphosphate (18.7 %), and potassium – in the form of potassium magnesia (26 %) according to the experimental scheme were applied annually in early spring.

According to the technological instruction, inoculation of seed with clover strains of nodule bacteria was performed immediately before meadow clover sowing. The sowing rate of meadow clover is 18 kg/ha of first-class seed, and spring barley – 160 kg/ha, which is reduced by 20 % of the generally accepted.

The dry matter content (dry mass) was determined by the thermostatic-and-weight method at a temperature of 105 °C. Yield recording of green mass was carried out by the weight method, by weighing followed by recalculation of the dry mass yield from 1 ha (Dospekhov, 1985).

The purpose of the research is to establish the patterns of formation of forage productivity of agrophytocenoses of different meadow clover varieties depending on the technologies of cultivation on typical low-humus chernozems of the Right-Bank Forest-Steppe of Ukraine.

Results and discussion

Analysis of the results of our research showed that on average for the first three years of life and use of grass stands, namely for 2018–2020, more influential factors by the yield of dry matter from 1 ha were factors of fertilization and varieties with a share proportion of 40–45 % (Table 1). The share of the factor of the sowing method was 15 %. It should be noted that the influence share of the factor of sowing method was the largest (55 %), the variety factor – the smallest (10 %) in the first year. Factors of fertilization and variety with a share proportion of 36–37 % influence were higher in the second year. In the second year, the difference between the factors in their influence on productivity was small. However, the factors of fertilization and variety with a share of influence of 36 and 34 % were somewhat more influential, and the variety factor (27 %) was less influential. In the third year, the factor of fertilization with a share proportion of 47 % was the most influential, and the variety factor (10 %) was the least influential.

On average, over three years of research, the productivity of biomass of different varieties of meadow clover under different technologies of cultivation based on the yield of dry mass from 1 ha ranged from 8.22 to 9.88 tons. It was the least in Lybid variety in the variant without fertilizers and coverless sowing, and the largest – in Taifun variety under seeds inoculation with nodule bacteria in combination with the introduction of N60P60K90.

Among the meadow clover varieties, Taifun variety provided the highest productivity and dominated Lybid variety by 0.60–0.66 t/ha, and Tina variety – by 0.10–0.23 t/ha at LSD05 – 0.46 t/ha under different backgrounds of fertilization and various sowing methods.

The highest productivity (9.20–9.88 t/ha) was obtained under seeds inoculation with nodule bacteria combined with N60P60K90 application, when the yield of dry mass from 1 ha increased by 0.93–1.05 t/ha or by 8–11 % compared to the variant without fertilizers. The productivity of meadow clover increased much less and did not exceed 0.71 t/ha under separate application of fertilizers or seed inoculation. Productivity increased by 0.36–0.56 t/ha under coverless sowing and by 0.29–0.32 t/ha at sowing under the covering of spring barley at LSD05 of 0.41 t/ha under seeds inoculation by nodule bacteria. Productivity increased by 0.27–0.30 t/ha and by 0.23–0.71 t/ha, respectively, under the application of P60K90 or N60P60K90. Productivity increased by 0.33–0.62 t/ha by adding N60 to P60K90.

On average, there was no significant difference in productivity between sowing methods for three years of research, which did not change evenly.

It should be noted that over the years of life and use of meadow clover, the patterns of influence of the studied factors on biomass productivity were different. The yield was formed only from meadow clover biomass under coverless sowing in the first year, while it was from spring barley grain as a cover crop and meadow clover biomass as an undercover crop sowing under cover of spring barley.

The total productivity in the range of 7.45–8.52 t/ha of dry mass at sowing under cover of spring barley with different varieties of meadow clover and various fertilizers was obtained. In particular, it was received 3.61–3.98 t/ha of spring barley grain in terms of dry matter and 3.84–4.59 t/ha of dry biomass of meadow clover. Varieties of meadow clover both on the yield productivity of barley grain from 1 ha and the yield of meadow clover biomass from 1 ha or in total did not significantly affect. Tendentiously, productivity was slightly higher, especially the meadow clover biomass, with the Taifun variety's participation.

The highest productivity was at seed treatment with nodule bacteria in combination with the application of N60P60K90, when the yield of dry matter from 1 ha compared to the variant without fertilizers increased by 0.34–0.35 tons and 0.61–0.66 t at LSD05 of 0.17 and 0.19 t at sowing under cover of spring barley. The total productivity of barley grain and meadow clover biomass at seed inoculation with nodule bacteria in combination with the application of N60P60K90 at growing of different varieties of clover ranged from 8.40–8.57 t/ha of dry mass, which was 0.95–1.03 t/ha of dry mass more than the variant without fertilizers or by 13–14 %.

The total or separate productivity of barley grain and meadow clover biomass increased only by 2–10 % under separate application of fertilizers (N60P60K90, P60K90, or N60 on the background of inoculation) or only seed inoculation. The largest increase in productivity was after the introduction of N60P60K90 on the background of seed inoculation.

Table 1. The productivity of agrophytocenoses of different meadow clover varieties under different cultivation technologies (2018–2020), t/ha of dry mass.

Fertilization (factor A)	Variety (factor B)	Year of use			Average
		First	Second	Third	
Coverless sowing (factor C)					
Without fertilizers (control)	Lybid	5.96	11.30	7.41	8.22
	Taifun	6.06	13.01	7.52	8.86
	Tina	5.98	12.51	7.45	8.65
Inoculation of seeds with nodule bacteria (background)	Lybid	6.25	11.87	7.57	8.56
	Taifun	6.31	13.60	7.75	9.22
	Tina	6.28	13.41	7.68	9.12
Background + P60K90	Lybid	6.59	12.21	7.70	8.83
	Taifun	6.62	13.90	8.05	9.52
	Tina	6.61	13.68	7.94	9.41
Background + N60P60K90	Lybid	6.82	12.65	8.35	9.27
	Taifun	6.87	14.26	8.52	9.88
	Tina	6.84	13.95	8.47	9.75
Sowing under cover of spring barley (factor C)					
Without fertilizers (control)	Lybid	(3.61; 3.84) 7.45	10.56	6.77	8.26
	Taifun	(3.63; 3.93) 7.56	12.16	6.86	8.86

	Tina	(3.62; 3.87) 7.49	11.69	6.80	8.66
Inoculation of seeds with nodule bacteria (background)	Lybid	(3.63; 3.98) 7.61	10.99	7.06	8.55
	Taifun	(3.65; 4.16) 7.81	12.59	7.15	9.18
	Tina	(3.64; 4.09) 7.73	12.05	7.09	8.96
Background + P60K90	Lybid	(3.70; 4.24) 7.74	11.31	7.40	8.82
	Taifun	(3.72; 4.39) 8.11	12.87	7.43	9.47
	Tina	(3.71; 4.28) 7.99	12.30	7.42	9.24
Background + N60P60K90	Lybid	(3.95; 4.45) 8.40	11.58	7.63	9.20
	Taifun	(3.98; 4.59) 8.57	13.15	7.68	9.80
	Tina	(3.96; 4.56) 8.52	12.59	7.65	9.59
LSD05, t/ha by factors					
Fertilization (factor A)		(0.17; 0.19) 0.33	0.75	0.30	0.46
Variety (factor B)		(0.15; 0.17) 0.27	0.70	0.26	0.41
Sowing method (factor C)		(–; –) 0.34	0.67	0.31	0.44
		The share of factors influence, %			
Fertilization (factor A)		(98; 88)35	33	47	55
Variety (factor B)		(2; 12)10	34	10	35
Sowing method (factor C)		(–; –)55	33	33	10

Note: in parentheses, the first number is the productivity by the yield of the dry mass of spring barley grain as a cover crop from 1 ha, the second – dry mass of undersowing meadow clover.

In the first year of life and use of grass stands, the total productivity of barley grain and clover biomass at undercover sowing was 1.36–1.68 t/ha of dry mass or 22–25 % higher than under coverless sowing, when three mowings were obtained. However, when comparing the productivity only by meadow clover biomass, it turned out that the yield of dry mass from 1 ha was, on the contrary, 2.12–2.28 t/ha or 36–55 % higher under coverless sowing than at undercover sowing.
Productivity was the highest in the second year of life, ranging from 10.56 to 14.26 t at the yield of dry mass from 1 ha, which was 0.74–1.11 t or 7–9 % higher coverless sowing than sowing under cover of spring barley. In the third year, the productivity at a dry mass yield from 1 ha ranged from 6.77 to 8.52 t. It was 8–10 % higher at coverless sowing than at sowing under cover of spring barley as in the second year of use (Table 2).

Table 2. Distribution of dry mass yield of meadow clover varieties under different cultivation technologies, 2018–2020.

Fertilization (factor A)	Variety (factor B)	T/ha			%			V, %*
		Mowing						
		First	Second	Third	First	Second	Third	
Coverless sowing (factor C)								
Without fertilizers (control)	Lybid	3.70	2.88	1.64	45	35	20	38
	Typhoon	3.83	3.19	1.84	44	36	20	36
	Tina	3.79	2.94	2.02	45	34	21	36
Inoculation of seeds with nodule bacteria (background)	Lybid	3.85	3.00	1.71	45	35	20	38
	Typhoon	4.08	3.32	1.82	44	36	20	36
	Tina	4.00	3.10	2.02	44	34	22	33
Background + P60K90	Lybid	4.15	2.91	1.77	47	33	20	39
	Typhoon	4.39	3.05	2.08	46	32	22	36
	Tina	4.32	3.01	2.08	46	32	22	36
Background + N60P60K90	Lybid	4.26	3.06	1.95	46	33	21	38
	Typhoon	4.65	3.16	2.07	44	32	24	30
	Tina	4.58	3.22	1.95	47	33	20	39

Sowing under cover of spring barley (factor C)								
Without fertilizers (control)	Lybid	3.96	2.81	1.49	48	34	18	45
	Typhoon	4.26	3.02	1.58	48	34	18	45
	Tina	4.16	2.94	1.56	48	34	18	45
Inoculation of seeds with nodule bacteria (background)	Lybid	4.10	2.90	1.54	48	34	18	45
	Typhoon	4.42	3.12	1.64	48	34	18	45
	Tina	4.30	3.05	1.61	48	34	18	45
Background + P60K90	Lybid	4.32	2.74	1.76	49	31	20	44
	Typhoon	4.55	3.03	1.89	48	32	20	42
	Тіна	4.53	2.86	1.85	49	31	20	44
Background + N60P60K90	Tina	4.60	2.85	1.75	50	31	19	47
	Typhoon	4.80	3.14	1.86	47	32	21	39
	Tina	4.80	2.97	1.82	50	31	19	47
LSD05, t/ha by factors								
Fertilization (factor A)		0.17	0.14	0.07	–	–	–	–
Variety (factor B)		0.18	0.13	0.07	–	–	–	–
Sowing method (factor C)		0.19	0.15	0.07	–	–	–	–
The share of factors influence, %								
Fertilization (factor A)		45	43	37	–	–	–	–
Variety (factor B)		25	29	40	–	–	–	–
Sowing method (factor C)		30	28	23	–	–	–	–

Note: * – unevenness of yield distribution by mowing, expressed by the coefficient of variation.

The highest productivity (9.20–9.88 t/ha) was obtained by seed inoculation with nodule bacteria combined with N60P60K90 application when the yield of dry mass from 1 ha increased by 0.93–1.05 t/ha compared to the variant without fertilizers or by 8–11 %. The productivity of meadow clover increased much less and did not exceed 0.71 t/ha under separate application of fertilizers or seed inoculation. Productivity increased by 0.36–0.56 t/ha under coverless sowing and by 0.29–0.32 t/ha at sowing under cover of spring barley at LSD05 of 0.41 t/ha under seed inoculation with nodule bacteria. Productivity increased by 0.27–0.30 t/ha and by 0.23–0.71 t/ha under application of P60K90 or N60P60K90 against the background of inoculation. Productivity increased by 0.33–0.62 t/ha by adding N60 to P60K90.

It is essential to know the distribution of total yield by cycles of use on pastures and mowing – under haymaking regime of grass stands use in joining of grass fodder when planning green or raw conveyors or for continuous feeding of cattle in the summer and rhythmic operation of forage harvesters. On average, for the first three years of use, namely for 2018–2020, in all mowing, factors of fertilization and varieties with a share proportion of 25–45 % were the most influential factors in terms of yield of dry mass from 1 ha. The share of the factor of the sowing method was 23–30 %. It should be noted that the share of factors of fertilization and sowing method decreased slightly, the share of the variety factor increased from the first to the third mowing. On average, over three years of research, the productivity of biomass of different varieties of meadow clover under different cultivation technologies based on the yield of dry matter from 1 ha in the 1st mowing ranged from 3.70 to 4.80 t, in the 2nd – 2.81–3.16 and in the 3rd – 1.49–2.08 t.

Taifun variety provided the highest productivity in the 1st and 2nd mowing. In most cases, in the 3rd mowing among the meadow clover varieties, which prevailed over Lybid and Tina varieties by 1–5 % by different fertilization backgrounds and various sowing methods.

The highest productivity was obtained by seed inoculation with nodule bacteria combined with the application of N60P60K90, when the yield of dry mass from 1 ha increased by 8–11 % compared to the variant without fertilizers during all mowings. The productivity of meadow clover in all mowings increased only by 0–5 %. Moreover, this increase was insignificant under the separate application of P60K90 or N60P60K90 on the background of inoculation. This was also true for N60 on the background of P60K90 or seed inoculation on the background without fertilizers.

Between sowing methods, on average, over three years of research, no significant difference in productivity in all mowing was observed, which did not change irregularly.

Analysis of the yield distribution of different meadow clover varieties by mowing under different fertilizers and sowing methods showed that the share of the first mowing was the largest and the third was the smallest. The first mowing share ranged from 44 to 50 %, the second – 32–34 %, and the third – 18–24 %. The unevenness of yield distribution by mowing which was expressed by the coefficient of variation, ranged from 30 to 47 %.

We found that, regardless of the variety and fertilizer, the evenness of yield distribution by mowing was slightly better under coverless sowing than at sowing under the spring barley cover. In the first case, the first mowing share was higher, and the third mowing was lower by 2–4 %. The unevenness of yield distribution by mowing at coverless sowing was also less by 6–8 %. Among the varieties, Taifun variety was characterized by a slightly better evenness of yield distribution by mowing in the variant with combined application of inoculation and fertilizer in the dose of N60P60K90 regardless of the sowing methods. In this case, the first mowing share was the smallest, and the third – the largest. The unevenness of yield distribution by mowing was the lowest with a coefficient of variation 30 % and 39 % – at sowing under cover of spring barley with a coefficient of variation on other variants of 33–39 % and 44–47 %, respectively.

Conclusions

On average, for the first three years of life and use, meadow clover provides the productivity of yield of dry mass from 1 ha of 8.22–9.88 t, which depends little on sowing methods. Productivity increases by 8–12 % when inoculating seed with nodule bacteria combined with the application of N60P60K90 compared to the variant without fertilizers, and only by 4–6 % under separate application of P60K90 or N60P60K90 or seed inoculation on the background without fertilizers. Application of N60 on the background of P60K90 provides the highest payback of 1 kg of fertilizer (6–7 kg of dry mass) among fertilizers.

In the first year, sowing under cover of spring barley provided higher productivity by 22–25 % and coverless sowing – by 7–10 % in the second and third years. Taifun variety was the most productive one, which prevailed over Lybid and Tina varieties by 0.10–0.66 t/ha of dry mass. The factor of fertilization was the most influential in yield of dry mass from 1 ha and the sowing method with a share proportion of 55 % in the first year.

Meadow clover annually provides three mowings of fodder biomass with a share of the first mowing of 44–50 %, the second – 32–34 %, and the third – 18–24 %, and the unevenness of yield distribution by mowing of 30–47 %.

References

Bogovin, A. V., Makarenko, P. S., Kurgak, V. G. et al. (1990). Handbook of hayfields and pastures. Kyiv.

Brauer, D., Ritchey, D., & Belesky, D. (2002). Effects of lime and calcium on root development and nodulation of clovers. Crop Science, Iss. 42, p. 1640–1646.

Damborg, V., Stødkilde L., Jensen S. and Weisbjerg M. (2016). Characterisation of protein and fibre in pulp after biorefining of red clover and perennial ryegrass. The multiple roles of grassland in the European bioeconomy: Proceedings of the 26th General Meeting of the European Grassland Federation. Trondheim, Norway. September, 4–8, p. 366–371.

Demidas, G. I., Galushko, I. V. (2020). Mineral composition of fodder mass of different varieties of meadow clover depending on the elements of cultivation technology. Feed and feed production, 89, 151–160.

Gayraund, P. (1986). Perennie de la Luzerne. Cultivar, 196, 22–23.

Hamacher, M., Loges, R. and Taube, F. (2016). Evaluation of fifteen leguminous and non-leguminous forage species to improve forage quality of temporary grasslands in northern Germany. The multiple roles of grassland in the European bioeconomy: Proceedings of the 26th General Meeting of the European Grassland Federation. Trondheim, Norway, September, 4–8, 263–265.

Hannaway, D. B., Brewer, L. J., Ates, S. et al. (2018). Match clover: optimal selection of clover species. Sustainable meat and milk production from grasslands: Proceedings of the 27th General meeting of the European Grassland Federation. Cork, Ireland. June, 17–21, 218–220.

Hynes, D., Laidlaw, S. and Ferris, C. (2018). Effect of management strategy on wilting of monocultures and mixture of red clover and perennial ryegrass. Sustainable meat and milk production from grasslands: Proceedings of the 27th General Meeting of the European Grassland Federation. Cork, Ireland. June, 17–21, 249–251.

Karbivska, U., Kurhak, V., Gamayunova, V., Butenko, A. et al. (2020). Productivity and quality of diverse ripe cereal grass fodder depending on the methods of soil cultivation. Acta Agrobotanica, 73(3), 1–11.

Karbivska, V. M. (2020). Accumulation of root mass of legumes and its influence on the nutrient regime of sod-podzolic soil. Foothill and mountain agriculture and animal husbandry, 67 (I). 84–97.

Kovtun, K. P., Veklenko, Yu. A., Yashchuk, V. A. (2020). Formation of phytocenosis and productivity of sainfoin-cereal grass mixtures depends on the sowing and spatial distribution of species in the Forest-Steppe right bank. Feed and feed production, 89, 112–120. https://doi.org/10.31073/kormovyrobnytstvo202089-11.

Kurgak, V. G. (1995). Legumes for sown meadow grasses. Livestock of Ukraine, 10, 27–29.

Kurgak, V. G. (2010). Meadow agrophytocenoses. Kyiv: ACTION.

Kurgak, V. G., Karbivska, U. M. (2020). Features of formation of leguminous-cereal agrophytocenoses on sod-podzolic soils of Prykarpattia of Ukraine. Feed and feed production, 89, 121–133. https://doi.org/10.31073/kormovyrobnytstvo202089-12.

Kurgak, V. G., Lukyanets, O. P. (2004). Influence of grassland type, fertilization systems and use on the productivity of dry meadow lands of the northern Forest-Steppe of Ukraine. Coll. Science. works of Vinnytsia State Agrarian University. Vinnytsia, 17, 9–15.

Kurgak, V. G., Tovstoshkur, V. M., (2010). Productivity of different types of grass stands under different fertilizer systems on the land of the Left-Bank Forest-Steppe. Interdepartmental. topic. "Feed and feed production". Vinnytsia, 66, 247–252.

Kurgak, V. G., Voloshin, V. M. (2016). Influence of fertilizers and modes of use on the productivity of different types of meadow grasses. Collection of scientific works of the National Center "Institute of Agriculture NAAS", 3–4, 166–178.

Kurgak, V. G., Voloshin, V. M. (2017). Improving the efficiency of perennial legumes in the meadows of Ukraine. Handbook of Ukrainian farmers "Biologization of agriculture": Scientific and practical collection, 1, 288–291.

Kutuzova, A. A. (1986). Scientific basis for the use of biological nitrogen in meadow farming. Bull. agricultural science, 4(355), 106–112.

Kutuzova, A. A., Akhlamova, N. M. (1978). Recommendations for the creation and use of legume-cereal pastures and hayfields in the central regions of the forest zone of the European part of the USSR. Moscow.

Laidlaw, A. S. (1982). Production and management of red clover swards. Legumes in Grassland. Ed. R. B. Murray, pp. 47–50.

Larson, W. M. (1982). Spreader alfalfa, a new pasture Iegume. Forage and Grassland Conference. Minnesota. February, 21–24, 58–60.

Mirkin B. M. (1986). What are plant communities. Moscow: Nauka.

Nilsdotter-Linde, N., Halling, M. and Jansson J. (2016). Widening the harvest window with contrasting grass-clover mixtures. The multiple roles of grassland in the European bioeconomy: Proceed. XXVI General Meeting of the European Grassland Federation. Trondheim, Norway. September, 4–8, 191–193.

Petrichenko VF, Kurgak VG (2013). Cultural hayfields and pastures of Ukraine. Kyiv: Agrarnaya Nauka.

Petrychenko, V., Bohovin, A. and Kurhak, V. (2012). More efficient use of grassland under climate warming. Grassland – a European Resource: Proceedings of the 24th General Meeting of the European Grassland Federation. Lublin, Poland, June, 3–7, 151–153.

Peyraud, J. and Peeters A. (2016). The role of grassland based production system in the protein security. The multiple roles of grassland in the European bioeconomy: Proceedings of the 26th General Meeting of the European Grassland Federation. Trondheim, Norway. September, 4–8, 29–43.

Stotska, S. V. (2011). Formation of forage productivity of meadow clover depending on elements of technology of cultivation in Polissya central conditions. Thesis of Doctoral Dissertation. Vinnytsia.

Stotska, S. V. (2017). The concentration of chlorophyll in the leaves of meadow clover plants depends on agronomic cultivation techniques. Bulletin of Zhytomyr National Agroecological University, 2(1), 72–77.

Voloshin, V. N. (2017). Botanical composition and productivity of meadow herbage on gray forest soils. Bulletin of the Belarusian State Agricultural Academy. Horky, 1, 62–66.
Wallenhammar, A., Stoltz E., Omer Z. and Granstedt A. (2018). Production capacity of forage legumes and persistence to root rot in organic mixed swards. Sustainable meat and milk production from grasslands: Proceedings of the 27th General meeting of the European Grassland Federation. Cork, Ireland. June, 17–21, 375–377.
Weib, K. and Kalzendorf, C. (2016). Effect of wilting and silage additives on silage quality of lucerne, red clover and legume-grass mixtures. The multiple roles of grassland in the European bioeconomy. Proceedings of the 26th General Meeting of the European Grassland Federation. Trondheim, Norway. September, 4–8, 170–172.
Wiersma, D. W., Smith, R. R., Mylnarek, M. J. et al. (1998). Harvest management effects on red clover forage yield, quality and persistence. J. Prod. Agric, 11, 309–313.

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