Cultivation of fireweed (*Epilobium ngustifolium*) together with nettle dioecious (*Urtica dioica*)

Boris Starkovskiy^{1*}, Gennadiy Simonov², Yulia Malinovskaya¹

¹Federal State Budgetary Educational Institution of Higher Education "The Vereshchagin Vologda State Dairy Farming Academy" 160555, Molochnoye, Schmidt St., 2, Vologda, Russia

²Federal State Budgetary Institution of Science "The Vologda Scientific Center of the Russian Academy of Sciences", North-Western Research Institute of Dairy and Grassland Farming, a separate division of the Federal State Budgetary Institution of Science "The Vologda Scientific Center of the Russian Academy of Sciences", 160555, Molochnoye, Lenin St., 14, Vologda, Russia

Abstract. The authors studied the possibility of cultivating fireweed in a grass mixture with nettle dioecious in the conditions of the North-Western region of the Russian Federation. It has been stated that both plants begin to grow immediately after snowmelt. The blooming phase of nettle begins simultaneously with that of fireweed. As the plants grow and develop in a grass mixture, the suppression of fireweed is noted. In the third year of life, nettle stalks were higher than those of fireweed. During the period of research, the productivity of the grass mixture was lower than that of pure fireweed plantings by 1.3 t/ha. In the single-species option, the amount of protein and the amount of metabolizable energy were 348 kg/ha and 19.5 GJ/ha respectively, which is 42 kg/ha and 2.5 GJ/ha higher than in the grass mixture. Nettle dioecious forms dense bushes in the third year of growing. Fireweed turns out to be in unfavorable conditions: its growing energy decreases, it comes into the blooming phase earlier and its suppression from the coenosis by nettle becomes evident.

1 Introduction

An increase in fodder production is impossible without improving the fodder production system based on the structure of fodder crops, knowledge of their peculiarities, and agro-climatic conditions of the region. The requirements for such crops are low unit costs and satisfying the need for nutrients in highly productive animals [1, 2].

Perennial grasses are the main fodder crops used in fodder production in the conditions of the European North of the Russian Federation [3].

The key factors in choosing grasses are their nutritive value, high adaptability to growing conditions, productivity and technological adaptability.

Grass selection is based on studying their agrobiological properties.

Knowing the peculiarities of plant growth and development allows to design the technology of their cultivation properly.

Keeping highly productive animals requires an appropriate ration that is balanced not only in protein, sugar and fat, but also enriched with biologically active and mineral substances, amino acids. Traditional kinds of perennial forage grasses do not have such a variety of

* Corresponding author: bor.2076@yandex.ru

nutrients. Therefore, in recent years, there has been an increased interest in wild plants to overcome the shortage of the above-listed substances in animal diets.

In the conditions of Non-Black Soil Zone, fireweed (*Chamaenerion angustifolium*) and nettle dioecious (*Urtica dioica* L.) are widely distributed in nature.

These plants have high growing energy, grow fast in spring, are very productive in using the moisture accumulated in the soil during autumn and winter, have high winter hardiness, and tolerate a temperature drop to -20-25°C.

Many investigators note the useful properties and unique chemical composition of these plants, which have been of interest to a greater or lesser extent for many years [4, 5]. Among the first researchers of fireweed biology was M. D. Danilov (1938), who studied the conditions of the plant's growth and reproduction, as well as his foreign counterparts P. J. Myerscongh, F. H. Whitehead (1966). Scientists J. Van. Andel, W. Bos, W. Ernst (1978) proved that fireweed grows equally well on alkaline and acidic soils. Phytocenoses with fireweed were studied in different years by P. E. Reynolds, A.M. Obarymskyj (1994), N. A. Zabelkin, N. G. Ulanova (1995), L. E. Astragalova (2000). The negative impact of parasitic fungi on fireweed was studied by M. J. Daft and T. A. Nicolson (1974). In the UK phytophages on fireweed were studied by H. L. Stroyan (1957), P. Lauterer (1968), M. MacGarvin (1982), in Russia they were studied by D. S. Shapiro (1965), B. N. Starkovskiy, D. P. Zorin (2010). Domestic and foreign scientists have studied the chemical composition of fireweed plant raw material in detail. Researchers identified mineral substances and more than 40 acids (A. T. Glen, W. Lawrie, I. McLean (1967), A. Hiermann, F. Bucar (1997), L. Velasco, F. D. Goffman (1999), I.V. Polezhayeva (2005), T. P. Kukina, T. S. Frolova, O. I. Salnikova (2014). A. M. Rabinovich, T. N. Zagumennikova (1995), B. N. Starkovskiy, N. I. Kapustin (2000) studied the question of cultivating fireweed and using its green mass in different periods.

Nettle leaves contain glucose, urticin, sitosterol, histamine, violaxanthin, flavonoids, carotene, and vitamins. All this complex of active substances supports the immune system and improves the work of the circulatory system [26].

Fireweed, as well as legumes such as red clover and goat's rue (*Galega orientalis*), is rich in protein (17-18 % of dry matter); and in sugar content (10% of dry matter) it exceeds them by 1.3-1.9-fold. As for the amount and composition of amino acids, it is as good as the studied species of perennial legumes, and it exceeds them in terms of the amount of essential amino acids [27].

Some elements of fireweed growing technology were studied, pests and pest control measures, as well as the green mass feed value were identified [17, 27, 28, 29].

Fireweed and nettle dioecious have a complex of economically useful properties, which determined the choice of the object of our research.

The purpose of the research was to determine the effectiveness of growing fireweed together with nettle dioecious, and to give an objective assessment of the feasibility of cultivating these forage crops together using the obtained data.

2 Materials and methods

The research was carried out in the Vereshchagin Vologda State Dairy Farming Academy. The experimental plot was previously used for growing potatoes. The tillage system was autumn plowing and spring pre-sowing cultivation.

Planting material consisting of fireweed root segments was gathered in the places of its natural growth. Nettle seeds were sown to the depth of 1.5-2.0 cm with a special hand-pushed seeder. The quality of nettle seeds used in the experiment was the following: purity - 76.3%, germination capacity - 75%, economic viability - 57.2%. With a seeding rate of 0.3 kg/ha at 100% economic viability, the actual seeding rate was 0.52 kg/ha.

The experiment was carried out according to the scheme:

1. fireweed – in pure form (control)
2. fireweed + nettle dioecious

In the beginning of the experiment, in the option with fireweed and nettle dioecious, fireweed was the first to be planted, using 15 cm long pre-prepared root segments. The root segments were planted to the depth of 8-10 cm. The distance between the rows of fireweed was 70 cm, and nettle seeds were sown between the rows. Fireweed green mass yield was counted in the blooming phase; in mixed plantings it was counted in the blooming phase of the dominant plant. The method of yield counting is a continuous one with determining the botanical composition. Protective strips and unrecorded sections were excluded before counting. Starting from the initial moment of plant growing every 10 days the growing energy and phase of plant development were measured.

In plant communities, the fireweed root system was distributed in different soil horizons in depth. This ensured the uniform and rational use of soil nutrients. Being a part of a grass mixture, plant species use moisture and heat more effectively.

Nettle dioecious (*Urtica dioica* L.) is a perennial grass with a long, thin, creeping rhizome [30].

Both plants are known to have the same requirements for vegetation conditions and to respond positively to the presence of nitrogen in the soil. This factor along with the others was the reason to study them growing together. The results of studying the components of grass mixtures at different phases of their development are presented in Table 1.

Table. 1. The influence of the agrophytocenoses composition on passing the development phases by the grass mixture components

Years of the research	Option	The date of the beginning of vegetation	Budding	Blooming	
				beginning	full phase
1 st year	1 Fireweed	10.06.	10.07.	22.07.	27.07.
	2 Fireweed	11.06.	10.07.	22.07.	27.07.
	Nettle dioecious	20.06.	—	—	—
2 nd year	1 Fireweed	27.04.	15.06.	02.07.	07.07.
	2 Fireweed	27.04.	16.06.	29.06.	08.07.
	Nettle dioecious	30.04.	25.06.	30.06.	03.07.
3 rd year	1 Fireweed	29.04.	15.06.	23.06.	27.06.
	2 Fireweed	28.04.	14.06.	21.06.	26.06.
	Nettle dioecious	04.05.	18.06.	25.06.	27.06.

3 Research results

The data given in Table 1 indicate that during the first year of the experiment, the vegetation period began in the first half of June. In the subsequent years of the research fireweed plants began their vegetation period immediately after the snowmelt together with nettle. Depending on the prevailing weather conditions, fireweed plants in single-species plantings came into the blooming phase in the period from the 23rd of June to the 2nd of July, which is 2 to 3 days later than being in the grass mixture. The earlier beginning of the blooming phase of fireweed in the grass mixture is probably due to competition for the basic life support factors.

During the first year of the experiment, nettle plants developed slowly and were lower than fireweed plants (figure 1). As a part of the coenosis, fireweed was prevailing (98.4%), and since its yielding capacity was low, its yield in the year of planting was not recorded.

The diagram (figure 1) shows that in the first year the growth and development of plants was slow. So in our studies the plants of nettle dioecious reached a height of 15–18 cm by the end of vegetation. The fireweed plants on average were 54 cm in height.

Fig. 1. The height of the coenosis components during the experiment

In the second and subsequent years of the life of plants in spring in all the options under study early regrowth was noted. Further, with the growth and development of agrocenosis, there was a gradual suppression of fireweed from the grass mixture. This can be seen by the strength of nettle growth, which in the second year of the co-growth had the same height of the stems with fireweed and in the third year it was already higher (figure 1.). In natural conditions by the 5th and 6th years of life nettle dioecious forms dense bushes and a powerful root system, thus creating unfavorable conditions for fireweed.

In mixtures of fireweed and nettle dioecious, in the 3rd year at harvesting time nettle plants were 6–8 cm higher than fireweed plants.

The productivity of fireweed and nettle dioecious agrophytocenosis varied by years of use and was connected with the biological characteristics of the crops.

The yielding capacity of the herbage under study in the experiment is shown in table 2.

The data in table 2 show that fireweed is more productive when grown as a single species than in a grass mixture. The yield during the second and third years in pure fireweed plantings was 5.9 and 16.3 t/ha of green mass, respectively. The productivity of fireweed + nettle dioecious coenosis during the period under study was 4.7 and 14.6 t/ha.

In a fireweed single-species option, the amount of nutrients per hectare is higher than in the coenosis of its co-growth with nettle. It should be noted that the yielding capacity of ‘fireweed + nettle’ agrocenoses was counted for two cuttings, and that of fireweed single-species plantings was counted for one cutting (table 3).

Table 3 demonstrates that from the second year of vegetation fireweed played an important role in the composition of grass mixtures, giving the main amount of sugar in the grass mixture (more than 95%). The same tendency was noted for protein.

While cutting the ‘fireweed + nettle’ grass mixture, on average for two years of experience, 306 kg/ha of crude protein and 17.0 GJ/ha of metabolizable energy were received, and when cultivating pure fireweed, these indices were higher and amounted to 348 kg/ha and 19.5 GJ/ha, respectively, compared to the grass mixture.

Table 2. The agrocenoses productivity

Years of research	Option	The date of the beginning of vegetation	The period from the beginning of vegetation to harvesting	The yield of green mass, t/ha	Component ratio in the grass mixture, %
1 st year	1 Fireweed	10.06.	-	-	100
	2 Fireweed Nettle dioecious	11.06. 20.06.	-	-	98,4 1,6
2 nd year	1 Willow herb	27.04.	72	5,9	100
	2 Fireweed Nettle dioecious	27.04. 30.04.	72	4,7	95,6 4,4

3 rd year	1 Fireweed	29.04.	60	16,3	100
	2 Fireweed	28.04.	59	14,6	96,1
	Nettle dioecious	04.05.			3,9

Table 3. The productivity of agrocenoses with single-species and mixed fireweed growing

Name of components	Green mass, t/ha	Dry matter yield, t/ha	Feed units units/ha	Metabolizable energy, GJ/ha	Crude protein, kg/ha	Sugar, kg/ha	Fat, kg/ha
1 st year							
Fireweed	5,9	1,0	886	10,2	183	100	49,3
Fireweed + Nettle dioecious	4,7	0,8	724	8,4	154 (147 + 7,6)	82,9 (80,3+ 2,6)	41,0
HCP ₀₅	3,3						
2 nd year							
Fireweed	16,3	2,8	2482	28,7	513	281	138
Fireweed + Nettle dioecious	14,6	2,5	2218	25,6	459 (440 + 19,0)	247 (241+ 6,45)	122
HCP ₀₅	5,1						
The average value for the research period							
Fireweed	11,0	1,9	1684	19,5	348	191	93,6
Fireweed + Nettle dioecious	9,7	1,6	1471	17,0	306 (293 + 13,3)	165 (161+ 4,5)	81,6
HCP ₀₅	3,3						

4 Conclusions

The research has shown that the green mass yield in the ‘fireweed + nettle’ option was lower than in fireweed single-species plantings with the index of 9.7 t/ha against 11.0 t/ha (on average for two years). The amount of crude protein and the amount of metabolizable energy in the single-species option were 42 kg/ha and 2.5 GJ/ha higher than in the grass mixture. In terms of sugar and fat, fireweed single-species plantings also showed better results in comparison with the grass mixture (191 and 93, 6 kg/ha against 165 and 81, 6 kg/ ha, respectively). The dry matter yield over the years of research has confirmed the advantage of the control option. Nettle dioecious during the third year of its growing in mixture had higher stems than fireweed and formed dense bushes. In the grass mixture unfavorable conditions for fireweed growth are created: the growing energy of fireweed decreases, it comes into the blooming phase earlier, and thus its suppression from the coenosis by nettle dioecious becomes obvious.

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