PRODUCTIVITY OF CEREAL GRASSES WITH DIFFERENT RIPENING TIME DEPENDING ON FERTILIZERS

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Aim. To determine productivity indicators of perennial cereal grasses with different ripening time depending on fertilizer.


Results. The results of studies on the productivity of perennial cereal grasses with different ripening time depending on fertilization on the sod-podzolic soil of the Carpathian region conducted during 2011–2013 are shown.

Conclusions. Productivity of various types of perennial grasses on nitrogen-free backgrounds varied between 2.53–3.71 t/ha of dry weight, 1.81–2.67 t/ha of feed units, 0.27–0.42 t/ha of crude protein and 20.4–30.4 GJ/ha of exchangeable energy. The most productive were perennial fenugreek, festuca orientalis, awnless brome and reed canary grass. Nitrogen is the most effective nutrient element for the productivity of cereal grass stands. With the introduction of P₆₀K₆₀, compared to the option without fertilizers, productivity increases by 3–23%, N₉₀ against the background of phosphorus and potassium – by 1.8–2.1 times. The difference in harvest ripeness between early- and medium-ripening grass stands in the 1st mowing was 12 days, and between early- and late-ripening – 22 days.

Key words: gross and exchangeable energy, fodder units, grass stands with different ripening time, dry mass, raw protein.

Introduction. In increasing the production of cheap grass fodder, an important role is played by the intensification of meadow fodder production through the creation of sown cereal meadow grass stands of an intensive type with the introduction of nitrogen mineral fertilizers, which are a reliable measure to increase the productivity of meadow lands by 1.5–2 times and significantly improve the quality of fodder compared to traditional single- and double-edged use [1].

Analysis of recent research and publications. It is known that nitrogen fertilizers are one of the factors that increase the productivity of perennial agrophytocenoses. Its supply comes from two sources: application with mineral fertilizers and symbiotic nitrogen fixation by perennial leguminous grasses [2–5]. In the countries of Western Europe, until recently, preference was given to nitrogen mineral fertilizers with its introduction in doses of up to 300 kg/ha, when its use was effective. However, these countries have recently used both of these sources of nitrogen supply [6].

Numerous studies both in Ukraine and in the countries of Eastern Europe have also established the possibility of using increased doses of nitrogen fertilizers (60-300 kg/ha) on different types of land to increase the productivity of cereal meadow agrophytocenoses [7–9].

The effectiveness of nitrogen fertilizers largely depends on the composition of the meadow grass. Perennial grasses respond best to it, the productivity of which can increase by 1.5–2 or more times depending on the dose from nitrogen application. However, it should be borne in mind that each type of grass reacts differently to nitrogen fertilizers and has its own ecological optimum. These species characteristics of grasses are especially clearly manifested when studying the effectiveness of increasing nitrogen doses, which is confirmed by the results of research in Ukraine [1]. It has been proven that there is a greater return from nitrogen fertilizers in grasslands dominated by upper grasses than lower and low-value weed species. Among the high-elevation grasses, the best response to nitrogen is the festuca orientalis, perennial and multi-flowered fenugreek, awnless brome and reed canary grass, and the worst – meadow sedge, meadow timothy, and marsh sedge [1].

It has also been proven that the species with high sensitivity to nitrogen fertilizers, in the vast majority, are also characterized by high coenotic activity when grown
in compatible crops. These species are violent, which is significantly due to a larger area of the absorbing surface or the capacity of cationic and anionic exchange of roots [1; 10; 11]. It is also noted that perennial grasses also respond better to the application of mineral fertilizers, ensuring their higher efficiency than their use in field crops [12].

The generalization of the results of many experiments showed that in terms of the efficiency of fertilizer application, which is expressed by the payback of 1 kg of fertilizers by the increase in dry weight yield, nitrogen fertilizer provides the greatest return on cereal grass stands, followed by nitrogen-potassium, nitrogen-phosphorus, nitrogen-potassium, phosphorus, potassium and phosphorus [9].

However, despite a significant amount of research on the fertilization of cereal grass stands, the reaction of various types of perennial cereal grasses to the nitrogen of mineral fertilizers has not yet been sufficiently studied in the dry lowlands of the Carpathian region. Our research, which is presented in this article, is aimed at this.

The purpose of the work is to establish productivity indicators based on the output of 1 ha of dry mass, feed units, raw protein, and exchangeable energy of perennial cereal grasses with different ripening time depending on fertilizer.

Research materials and methods. Research on the reaction of cereal grasses to mineral fertilizers was carried out on sod-podzolic surface-glazed soil in 2010–2013 in the “Druzhba” Dendrological Park of the Pre-Carpathian National University (Tysmenetsk District, Ivano-Frankivsk Region).

A field experiment on the selection of perennial cereal grasses with different fertilizers was carried out according to the following scheme (grass species and seed sowing rates, kg/ha):

- Early-ripening grass stands: cock’s-foot, 16.
- Medium-ripening grass stands: festuca orientalis, 26; perennial fenugreek, 26; awnless brome, 26; red fescue, 18; reed canary grass, 14.
- Late-ripening grass stands: meadow timothy, 14.

The experiment was conducted on three fertilizer backgrounds:

1) without fertilizers, 2) \( P_{60}K_{60} \), 3) \( N_{90}P_{60}K_{60} \).

The size of sowing plots is 10 m\(^2\), accounting plots – 8 m\(^2\). The number of variants is 21, plots are 84. The experiment was laid in the summer of 2010, and the records and observations were carried out during 2011–2013.

The following regional varieties of cereal grasses were used in the experiment: cock’s-foot – Stanislavskas, festuca orientalis – Smerichka, perennial fenugreek – Kolomysyska, awnless brome – Mars, red fescue – Hovera, reed canary grass – Samenska 40, meadow timothy – Karpatska.

In all experiments, nitrogen mineral fertilizers were applied superficially in the form of ammonium nitrate, phosphorus – granular superphosphate, and potash – calimagnesia. Phosphorous and potash were applied in one time in early spring, nitrogen in a dose of \( N_{90} \) – in three times in equal parts under each mowing.

The use of grass stands was done with three time mowing by carrying out the 1st mowing in the phase of cereal earing, and then – as the growth progressed in 35–45 days after the previous mowing. Mowing was carried out differentially, as the desired phase of vegetation in the widespread component of the grass stand arrived. In each mowing, mowing and harvesting began on early-ripening grass stands, then – on medium-ripening ones, and finished – on late-ripening ones.

Harvest accounting was carried out by weighing method, by weighing followed by calculation of yield from 1 ha of green mass, dry mass, fodder units, crude protein, exchangeable and gross energy according to SSTU 8044:2015 [13]. The content of dry mass was determined by the thermostatic weight method at a temperature of 105 ºC [14].

The content of fodder units, gross and exchangeable energy in fodder, which were used to calculate general productivity indicators, was determined by the calculation method using the digestibility coefficients of the dry weight of the fodder and its content of crude protein, crude fat, crude fiber, and nitrogen-free extractive substances [15] according to the State Technical Standards 8066:2015 [16].

Results and their discussion. Cereal grass stands of an intensive type are created when full mineral fertilizer (nitrogen, phosphorus, potassium) is applied [1; 17]. These fertilizers on cereal grasslands are usually highly effective, increasing the productivity of land and the share of valuable forage species in natural grasslands dominated by valuable meadow grasses from the mesophyte group, as well as improving the economic and energy efficiency of their cultivation in modern conditions with the introduction of moderate doses of nitrogen [18–20].

The comparative productivity of various types of perennial grasses under different fertilization options,
based on the results of our research on sod-podzolic soils, is shown in Table 1.

It was established that, on average, over the three years of use (2011–2013), the most influential factor in terms of yield from 1 ha of dry mass was the fertilizer factor, which accounts for 63%. Meanwhile, 37% is accounted for by the herbage factor. In the first year of use, the fertilizer factor accounted for 61%. In the 2nd year, the influence of the fertilizer factor increased to 63%, and in the 3rd year – to 65%. On the contrary, the influence of the fertilizer factor has decreased by the same amount over the years.

As evidenced by our research, nitrogen in the dose of N90 on the background of P60K60 turned out to be a more influential nutrient element than the combined application of P60K60. The productivity of various types of perennial grasses in the version without fertilizers was 3.20–3.71 t/ha of dry weight, 2.21–2.67 t/ha of fodder units, 0.33–0.42 t/ha of crude protein and 25.9–30.4 GJ/ha of exchangeable energy. Against the background of the introduction of P60K60, the productivity varied between 3.35–3.88 t/ha, 2.35–2.79 t/ha, 0.36–0.45 t/ha, and 27.5–31.8 GJ/ha, respectively /ha, which is only 0.14–0.20 t of dry weight more than the option without fertilizers, the yield increase was insignificant. Meanwhile, when applying N90P60K60, productivity increased to 5.44–6.69 t/ha of dry weight, 3.86–4.82 t/ha of feed units, 0.79–1.04 t/ha of raw protein and 44, 6–55.5 GJ/ha of exchangeable energy, which is 1.6–2.2 times more compared to background P60K60. In this case, productivity at the output of 1 ha of dry mass increased by 1.97–2.81 t at LSD0.05, 0.25 t.

Among the studied species of perennial cereal grasses in these environmental conditions, perennial fenugreek provided the highest productivity in the first three years of use in all agrophones. Only within the margin of error of the experiment (0.25 t/ha of dry mass), it was inferior to the festuca orientalis, the awnless brome and the reed canary grass. By 0.38–1.10 t/ha of dry mass, or by 11–20%, perennial fenugreek, early-ripening cock’s-foot, and late-ripening meadow timothy, which were characterized by an average level of productivity, yielded. The least productive was red fescue, which by 0.40–1.25 t/ha of dry mass, or 15–23%, was inferior to perennial fenugreek, festuca orientalis, awnless brome and reed canary grass. However, in terms of productivity, it was not significantly inferior to the cock’s-foot and the meadow timothy. The analysis of the research results revealed that the productivity of the researched types of grasses according to the years of their use in terms of yield from 1 ha of dry mass was stable. On nitrogen-free backgrounds (options without fertilizers and P60K60), it fluctuated between 3.11–4.00 t/ha of dry mass over the years, and with the annual application of N90P60K60 5.20–7.12 t/ha with an uneven distribution of the harvest over the years 4-7%.

It is known that the perennial grasses introduced into the culture differ in terms of the onset of optimal agrotechnical periods for the use of grass stands for the production of certain grass fodder (mowing for hay, haylage, artificially dried grass fodder or for green fodder, or livestock grazing on green feed). Research by V.H. Kurhak and the generalization of the results of his research [1] established that the early-ripening varieties include the early-ripening varieties of cock’s-foot and the meadow foxtail. The mid-ripening varieties include the festuca orientalis, perennial fenugreek, awnless brome, red fescue, reed canary grass and the late-ripening – meadow timothy, red top, intermediate wheatgrass.

In the presence of several grass stands in the agricultural enterprise, which are characterized by different periods of onset of fodder maturity, it is possible, on their basis, to extend the optimal agrotechnical period of harvesting herbs in each cycle of use and to organize a green (raw material or pasture) conveyor of continuous and uniform supply of green mass for the production of various types of herbs feed for 140-150 days.

According to our data, the timing of grass mowing for hay, hay or green fodder, especially in the first mowing, depended on the cycles of seasonal development of the dominant components (Table 2). In early-ripening grasses, the 1st mowing occurred on average on 25.05 with fluctuations in the years 20.05–29.05, in medium-ripening in 6.06 with deviations in the years 26.05–11.06, and in late-ripening in 16.06 with fluctuations in 10.06–22.06. According to the averaged data, the 2nd mowing of early-ripening grasses occurred on 9.07, mid-ripening – 22.07 and late-ripening – 5.08, and the 3rd on 20.08, 6.09 and 23.09, respectively. The difference in harvest ripeness between early- and medium-ripe grass stands in the 1st mowing was equal to 12 days, and between early- and late-ripening – 22 days, in the 2nd mowing 13 and 27 days, and in the 3rd – 17 and 34 days, respectively. Since the optimal agrotechnical term for harvesting grasses of the same type in terms of precocity is about 10 days on average, the presence of different types of precocity in the grass conveyor made it possible to extend the optimal period of grass collection in the 1st mowing to an average
of 32 days, in the 2nd – up to 37 and in the 3rd – up to 44 days. This created favorable conditions not only for improving the quality of fodder and reducing crop losses, but also for a more rational use of harvesting equipment in the system of conveyor production of fodder.

**Conclusions**

1. The productivity of various types of perennial cereal grasses on nitrogen-free backgrounds is 2.53–3.71 t/ha of dry weight, 1.81–2.67 t/ha of fodder units, 0.27–0.42 t/ha of raw protein and 20.4–30.4 GJ/ha of exchangeable energy. Perennial fenugreek, festuca orientalis, awnless brome and reed canary grass are the most productive, while red fescue is the least productive. Cock’s-foot and meadow timothy are characterized by an average level of productivity.

2. Nitrogen is the most important nutrient element in terms of its effect on the productivity of cereal grass stands. With the introduction of N$_{90}$ on different backgrounds of phosphorus and potassium, productivity increases by 1.8-2.1 times, while – P$_{60}$K$_{60}$ compared to the variant without fertilizers, is only 3-23%.
3. Between early- and medium-ripening grass stands, the difference in the onset of harvesting maturity in the 1st mowing is 12 days, and between early- and late-ripening stands – 22 days, and in the 2nd mowing – 13 and 27 days, respectively, and in the 3rd – 17 and 34 days, which makes it possible to organize a reliable green conveyor belt for the supply of biomass for livestock feeding on the basis of these different maturing grass stands and to save the need for harvesting machines for harvesting grass fodder for the winter period.

<table>
<thead>
<tr>
<th>Type of grass stand by precociousness</th>
<th>Mowing 1-st</th>
<th>Mowing 2-nd</th>
<th>Mowing 3-rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early-ripening (cock’s-foot)</td>
<td>25.05</td>
<td>9.07</td>
<td>20.08</td>
</tr>
<tr>
<td></td>
<td>20.05-29.05</td>
<td>2.07-15.07</td>
<td>18.08-30.08</td>
</tr>
<tr>
<td>Medium-ripening (festuca orientalis, perennial fenugreek, awnless brome, red fescue, reed canary grass)</td>
<td>6.06</td>
<td>22.07</td>
<td>6.09</td>
</tr>
<tr>
<td></td>
<td>26.05-11.06</td>
<td>12.07-1.08</td>
<td>27.08-20.09</td>
</tr>
<tr>
<td>Late-ripening (meadow timothy)</td>
<td>16.06</td>
<td>5.08</td>
<td>23.09</td>
</tr>
<tr>
<td></td>
<td>10.06-22.06</td>
<td>16.07-20.08</td>
<td>14.09-29.09</td>
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</tbody>
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Note. The numerator is the average, the denominator is the deviation by year.

References


ЛІТЕРАТУРА

Кургак В.Г., Карбівська У.М.

**Продуктивність різностіглих злакових трав залежно від застосування мінеральних добрив**

**Мета.** Встановити показники продуктивності різностіглих багаторічних злакових трав залежно від удобрения. **Методи.** Польовий, лабораторний, математико-статистичний, економіко-математичний. **Результати.** Представлено результати досліджень із вивчення продуктивності різностіглих багаторічних злакових трав залежно від удобрения надерново-підзолистому ґрунті Прикарпаття проведених упродовж 2011–2013 pp. **Висновки.** Продуктивність різних видів багаторічних злакових трав на безазотних фонах коливалась у межах 2,53-3,71 т/га сухої маси, 1,81–2,67 т/га кормових одиниць, 0,27–0,42 т/га сирого протеїну і 20,4–30,4 ГДж/га обмінної енергії. Найпродуктивнішими були пажитниця багаторічна, костриця східна, стоколос безостий та очеретянка звичайна. Найбільш діючим поживним елементом на продуктивність злакових травостоїв є азот. За внесення P₂O₅ K₂O продуктивність порівняно з варіантом без добрив збільшувалась на 3–23 %, N на фоні фосфору та калію – в 1,8–2,1 рази. Різниця в настанні збиральної стиглості між ранньо- і середньостиглими травостоями в 1-му укосі становила 12 діб, а між ранньо- і пізньостиглими – 22 доби.

**Ключові слова:** валова і обмінна енергія, кормові одиниці, різностіглі травостої, суха маса, сирій протеїн.

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