Revisited the matter of the fodder galega new feed crop cultivation on the irrigated lands of the Lower Volga region

N I Burtseva¹, T N Dronova¹ and O V Golovatyuk¹

¹All-Russian Research Institute of Irrigated Agriculture, 9, Timirjaseva St., Volgograd, 400002, Russia

E-mail: burczeva.58@yandex.ru

Abstract. The research results carried out on light-chestnut soils in 2011-2017 are presented, in order to determine the rational parameters of the water, nutritional regimes of the soil and various varieties of fodder galega to create highly productive herbage with their long-term use. The study of the fertilizers calculated doses influence and various pre-irrigation soil moisture thresholds on the herbage density showed that the maximum number of shoots was formed in the Magistr variety crops while maintaining an 80% moisture threshold due to an improved nutritional background. Under the same growing conditions, the highest symbiotic activity and photosynthetic activity of plants were noted. The yield of the fodder galega was significantly influenced by the moisture supply and the nutritional medium. The pre-irrigation soil moisture threshold maintaining at 80% minimum water capacity and the fertilizers application contributed to the formation of 47-83 t / ha of green mass, which meets the high requirements for the feed quality assessment. The accumulation of the root mass contributed to the enrichment of the soil with organic matter and nitrogen, most of which was obtained through the work of nodule-forming bacteria.

1. Introduction

In recent years, in the field fodder-grass cultivation of the Russian Federation, there has been a negative trend towards a reduction in planted acreage and a decrease in the productivity of perennial grasses. Due to the insignificant share of leguminous grasses in the structure of planted acreage, the problem of fodder protein production remains unresolved, and the environment-forming role does not correspond to their biological potential [1, 2].

Irrigation in the Lower Volga region is a powerful factor in the field fodder-grass cultivation intensifying, its productivity increasing, obtaining of energy fodder with high protein nutritional value, preserving and increasing soil fertility.

Agro ecological testing of a whole set of perennial leguminous grasses in experiments and production trials of the All-Russian Research Institute of Irrigated Agriculture has convincingly shown the highly effective use of other perennial grasses along with alfalfa, and first of all, the fodder galega. This crop is highly valued due to such properties as high crop yield, productive longevity, adaptability, excellent fodder qualities, manufacturability when used for hay [3-7]. The fodder galega can grow in one place for more than ten years. Its biomass is rich in nutrients, depending on natural zones and
developmental phases, the dry matter contains 18.0 - 32.0% of protein, 1.5 - 3.0% of fat, 24.4 - 31.6% of fiber, and 33.5 - 42.0% of nitrogen-free extractive substances [8-10].

The scientific and practical interest in the fodder galega is also due to its ability to fix atmospheric nitrogen by means of the nodule-forming bacteria activity. This ability makes it possible to reduce the use of nitrogen fertilizers, which leads to a decrease in the risk of a large amount of nitrates entering the environment and to a reduction in feed production costs. [1,8].

Long-term use of the fodder galega contributes to the accumulation of organic matter in the soil in a significant amount, which has a positive effect on the soil structure and the nutrients content in it [1].

In this regard, the Institute conducts research in field multifactorial experiments, the purpose of which is to determine the rational parameters of the water and nutritional regimes of the soil and the varietal composition of the fodder galega in order to obtain the given levels of agrophytocenoses productivity of long-term use (5-7 years).

2. Materials and methods

The field experiments were carried out in 2011 - 2017 on light-chestnut low-humus soil, with a humus content of 1.54 - 1.70%. The soil density in the root layer (0.7 m) is 1.34 t / m³, the pore space is 48.5, the lowest moisture capacity is 22.2%. The experimental plot soil contains 21 - 26 mg of mobile phosphorus, 222 - 286 mg / kg of exchangeable potassium.

The influence of the water regime (maintaining the pre-irrigation threshold of soil moisture of 70 and 80% minimum water capacity), the soil nutrient regime (applying fertilizers with doses calculated to obtain different yield levels by years of herbage life from 10-18 to 70-80 t / ha of green mass) were studied in the experiment. The research was carried out on the fodder galega crops of three varieties: Gale, Magistr and Krivich.

Before sowing, the seeds were scarified and treated with a special strain of Rizotorfin (250 g of the preparation per hectare of seeds). Mineral fertilizers (P and K) were applied once for the main tillage, nitrogen fertilizers - differentially, depending on the hay harvest and the year of herbage life. The seeding rate of seeds is 5 million per 1 hectare, the row spacing used in the experiments is 0.3 m.

The water regime of the soil in the fodder galega crops was maintained by irrigation with a Bauer "Rainstar" sprinkler. Irrigation rates were 450 - 550 m³ / ha. Measurements and observations on experimental crops were carried out in accordance with generally accepted methods.

3. Results and discussion

The fodder galega sowing during the years of research was carried out in the 3rd decade of April - the first decade of May. The completeness of the seedlings depended on the weather conditions, which developed in the spring, during the sowing period - the seedlings. In different years of research, it fluctuated within 32-45%. By the end of the growing season, there were 85-120 plants per 1 m² in the herbage of the first year of life. From the second year to the fourth year, there was a herbage density increase due to the offspring development of the fodder galega roots: there were already up to 258-350 plants per square meter. After the fifth year of life, there was a slight decrease in the herbage density (Figure 1).
In the variants with the lowest pre-irrigation threshold of soil moisture (70% minimum water capacity), the herbage density was 5-18% less.

The density of the herbage was also influenced by fertilization: on the sowing of Magistr's fodder galega, while maintaining the 80% moisture threshold, the herbage density in the control was 315 shoots in the fourth year of life, and when fertilizing was applied - 348-386 pcs / m² (Figure 1). The same trend persisted in the variant with 70% pre-irrigation moisture threshold.

In experiments the fodder galega herbage consumed different amounts of moisture, depending on the year of life, the nutrition background, and the water regime. The total water consumption on average over the years, starting from the second year of life, did not change significantly and amounted to 5200 - 5700 m³ / ha in the control variant (without fertilizers). On variants with an improved nutritional background due to fertilization, the total water consumption increased to 5360 - 6070 m³ / ha. The maximum indicators of total water consumption in all the years of research were noted in the options for which the highest yields were obtained. The share of irrigation water was 61-64 and 69-72%, while maintaining the 70 and 80% soil moisture threshold, respectively. During the years of research, the share of atmospheric precipitation accounted for only 16-19% of the soil moisture reserves, the fodder galega plants used from 10 to 21%.

Starting from the second year of life the fodder galega formed a symbiotic apparatus in the rhizosphere of plants: from 10-43 to 22-65 nodules per plant. Their maximum number was noted in the flowering beginning phase in the first hay harvest - 43-65 pcs. From the first to the subsequent hay harvest, the nodules number decreased to 10-22 pcs / plant. The number of active nodules was 35-58% of their total number.

The maximum leaf area on the fodder galega crops was noted during the second - fifth years of life in the first hay harvest. The assimilation surface on crops of 2-4 years was equal to 48-54 thousand m² / ha, in subsequent years its indicators decreased slightly, but insignificantly.

High rates of fodder galega photosynthesis determined their maximum productivity, this crop yield was 70-78 tons of green mass per hectare.

The fodder galega productivity was significantly influenced by the conditions of moisture supply and the nutrient medium. With an increase in the pre-irrigation moisture threshold from 70 to 80% minimum water capacity, the fodder galega crops productivity increased by 2-13 t / ha starting from the second year of life. The green mass harvesting by irrigation options varied from 29.6 - 52.0 to 32.3 - 79.0 t / ha. Due to the fertilizers application the nutrient medium improvement increased the crop
productivity level in 1.5 - 1.9 times compared to the control (option without fertilizers). The fodder galega crop productivity against a natural background of fertility was 29.6 - 36.0 in the second and 31.4 - 48.5 t / ha in the third year of life. Fertilization contributed to an increase in crop productivity to 36.9 - 56.4 and 50.2 - 83.8 t / ha in the second and the third years, respectively.

Starting from the fourth year of life, the fodder galega crop productivity decreased, reaching by the seventh year the level of 14.0 - 47.0 t / ha in the variant with the maintenance of the 70% moisture threshold and 18.0 - 51.0 t / ha in the variant with the 80% pre-irrigation moisture threshold.

The highest green mass crop productivity in all the years of research was formed by the fodder galega Magistr variety. In comparison with the Gale variety, its crop productivity was 11.2 - 22.1% higher. The Krivich variety was inferior to the Magister variety by 2.8 - 10.0% (Figure 2).

![Figure 2. The fodder galega productivity depending on the water and nutritional soil regimes.](image)

The fodder galega, like other perennial legumes, is highly valued for its ability to improve soil fertility during long-term cultivation. The maximum accumulation of root mass in the experiments was noted at the end of the herbage vegetation development in the fifth or sixth year of life. According to the variants of the experiment, up to 6.82 - 16.1 t / ha of easily mineralized organic matter rich in nutrients was accumulated in a half-meter soil layer. The accumulation of organic matter was influenced by fertilizers and improved conditions for water consumption. An increase in the pre-irrigation moisture content level from 70 to 80% minimum water capacity and an improvement due to the fertilizers introduction in the nutrition background contributed to an increase in the stocks of root and crop residues by 7.3 - 13.9 and 14.4 - 23.5%, respectively; Magistr variety was noted to be slightly more accumulated in root mass.

Up to 200 - 320 kg of nitrogen, 55 - 98 - phosphorus and 135 - 205 kg / ha of potassium entered the soil with organic matter after seven years of the fodder galega cultivation.

According to the chemical analysis results, it was revealed that in the fodder galega biomass, according to the variants of the experiment and varieties, the amount of nitrogen ranges from 3.5 - 4.0%, protein - 21.2 - 25.3, fiber - 20.8 - 22.2, fat - 2.88 - 3.06%. It should be noted that the improvement of the nutritional and water regimes of the soil had a positive effect on the nutritional value of the biomass. Indicators of protein, fat, feed units increased and fiber - decreased.

In terms of the content of feed units (0.65 - 0.72) and metabolic energy (10.12 - 10.54 MJ), the fodder galega was superior to the traditional culture of alfalfa, which confirms its high nutritional value and usefulness.
4. Conclusions
Field experiments have confirmed the ability of the fodder galega to grow under the Lower Volga region conditions for 5 - 7 years, maintaining high productivity. According to the years of life and the variants of the experiment, this crop formed from 17 - 22 to 54 - 79 t/ha of green mass.

The soil moisture pre-irrigation threshold maintaining within 80% minimum water capacity ensured obtaining 32.3 - 48.5 t / ha of green mass on crops of the second and third years of life without the use of fertilizers, the introduction of calculated doses of fertilizers contributed to an increase in crop productivity to 47.3 - 83.8 t / ha. The highest productivity for all variants of the experiment and years of life was noted for the selection of the Penza Research Institute of Agriculture Magister: 11.0 - 20.2 in the first, 36.7 - 79.0 - in the third, and 21.5 - 51.0 t / ha in the seventh year of life of crops.

The resulting biomass met the high requirements for the quality assessment of feed. The content of feed units was 0.65 - 0.72, digestible protein 148 - 178, metabolizable energy - 10.12 - 10.54 MJ.

After a seven-year use of the fodder galega herbage, by the end of the vegetation development, from 6.8 to 16.1 t / ha of organic matter was accumulated in the half-meter layer. During the decomposition of the organic matter the soil was replenished with nutrients readily available for subsequent crops.

The fodder galega cultivation on the irrigated lands of the Lower Volga region will offer an opportunity to provide the region's animal agriculture with high-grade, highly nutritious fodder, as well as to enrich the soil with organic matter, thus to maintain soil fertility.

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