Influence of the nutritional background on the yield and sowing qualities of narrow-leaved lupin seeds in the conditions of Krasnoyarsk forest-steppe

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Abstract. The article discusses the cultivation of narrow-leaved lupine (Lupinus angustifolius L.) on various food backgrounds (without fertilizers; ammophos + potassium sulphate + ammonium nitrate; ammophos + potassium sulphate + ammonium sulfate; ammophos). The results of the study of the influence of the background of nutrition on the yield and sowing qualities of the seeds of lupine narrow-leaved: germination energy, germination. The highest yield of lupine grain was obtained on plots without the use of mineral fertilizers – 19.49 c/ha. On fertile soils, narrow-leaved lupine does not respond to the use of mineral fertilizers, while the use in the experience of mixtures of mineral fertilizers ammophos + potassium sulphate + ammonium nitrate and ammophos + potassium sulphate + ammonium sulfate contributed to an increase in the size of lupine seeds. The largest seeds were obtained in plots with the application of a mixture of fertilizers ammophos + potassium sulfate + ammonium sulfate - the weight of 1000 grains was 125.0 g, which is 11.9% higher than the reference values. In all variants of the experiment, the high seed germination energy is 93.3% (ammophos) – 99.0% (ammophos + potassium sulfate + ammonium sulfate). High seed germination rates were obtained from 96.5% (without fertilizers) to 99.5% (ammophos). This indicates that the agroecological conditions of the region meet the requirements of culture.

1. Introduction

The average annual production of leguminous crops in Russia does not exceed 1.5 million tons, which is completely insufficient, since the need for poultry farming alone is 2 million tons. In the conditions of commissioning the capacities of modern livestock and poultry complexes and the development of feeding rations for highly productive animals and birds, protein components with a protein content of at least 35% are required [1]. One of the crops that can meet the needs of modern intensive animal husbandry is lupin (Lupinus angustifolius L.).

Lupine is characterized by valuable economically useful features: a high content of protein in seeds and leaves, a full-fledged amino acid composition, non-cracking of beans during mowing, stable yield of green mass and seeds [2, 3, 4]. Currently, there are varieties with a growing season of 85-95 days, which contributes to the promotion of the growing border to the north. The low content of alkaloids in the grain and green mass of lupine allows it to be used for the production of various types of feed without restrictions [5].

For crop production in the Krasnoyarsk Territory, narrow-leaved lupin is a new crop. Employees of the Krasnoyarsk State Agrarian University are developing a technology for cultivating narrow-leaved...
lupine for the soil and climatic conditions of the Krasnoyarsk forest-steppe [6, 7, 8]. A key link in the intensive production of crop products is the use of mineral fertilizers. However, at present, the question of the effectiveness of the use of mineral fertilizers for lupin remains open.

According to[5], narrow-leaved lupine is poorly responsive to the application of mineral fertilizers, despite the high level of nutrient consumption. Due to the active nitrogen-fixing ability, lupine does not need nitrogen fertilizers, and the need to apply phosphorus-potassium fertilizers depends on the content of mobile compounds of these elements in the soil. In studies [9] on sod-podzolic sandy loam soils, only phosphorus-potassium mineral fertilizers were applied to lupine, while it was recorded that the share of soil fertility in the formation of crop yield was 69 %, mineral fertilizers – 31 %. Mineral fertilizers (potassium chloride and simple superphosphate), both when applied separately and in combination with manure and pesticides, more significantly affected the yield of the green mass of feed lupine on sod-podzolic sandy soil than organic fertilizers (cattle manure) [10]. The yield of the green mass of lupine in relation to the control (without fertilizers) increased against the background of increasing doses of phosphorus-potassium fertilizers: P₀₀K₄₀ - by 23 %, P₃₀K₈₀ - 31.7 %, P₅₀K₁₂₀ - 49 %. On gray forest soil [11] in the lupine-wheat agroecosystem, the effectiveness of different levels of mineral nutrition was studied: N₈₀P₁₀₄K₁₀₄, N₃₀P₇₈K₇₈, N₂₀P₁₀₄K₁₀₄N₂₀P₃₂K₅₂, N₃₀K₅₀. On average, for 3 years of the experiment on the variant without the use of mineral fertilizers, the grain yield was 32 % less compared to the maximum dose of fertilizers. With an increase in the dose of applied diammonium phosphate, the productivity of crops increased.

In the conditions of the Krasnoyarsk forest-steppe, the question of the influence of the background of nutrition on the yield and sowing qualities of the seeds of narrow-leaved lupine is put to study for the first time.

2. Materials and methods

Field studies to assess the effectiveness of mineral fertilizers were carried out in 2020 on the basis of the educational and scientific complex (ESC) "Borskiy" of the Krasnoyarsk State Agrarian University, located in the Krasnoyarsk forest-steppe. This area receives 350-450 mm of precipitation per year. The average annual air temperature varies from 0.5 to 1.3 ° C, sometimes dropping to -2 ° C. The duration of the period of biological activity varies from 90 to 115 days. The sum of the active temperatures is 1550-1800 ° C, the soil freezes to a depth of 1.5-3 m. The soil of the experimental field is leached black soil of medium-thick light-clay granulometric composition, formed on yellow-brown clay. The humus content is 6.9 %, the pH of water is 7.2 [12].

A soil-agrochemical survey of the experimental site conducted before the sowing of lupine showed a low supply of nitrate nitrogen, very low - ammonium nitrogen, medium - mobile phosphorus and very high – exchange potassium.

The object of the study is the variety of narrow-leaved lupine Vityaz (figure 1), obtained at the All-Russian Research Institute of Lupine. Universal type of use, belongs to the usual branched morphotype, with good leafiness, is characterized by intensive growth in the initial stages of development, is resistant to a number of diseases, is also resistant to cracking of beans and shedding of seeds on the root, meets the requirements of the standard for feed grain [13].

During the study, weather conditions were different from the average long-term ones. The beginning of the growing season was accompanied by high indicators of average daily air temperature and rainfall. In general, the growing season of 2020 was characterized as warm and excessively moisture-rich.

To study the effect of the nutrition background on the yield and sowing qualities of lupine seeds, the following experimental scheme was used:

- Control (without fertilizers);
- Ammophos + potassium sulphate + ammonium nitrate;
- Ammophos + potassium sulphate + ammonium sulfate;
- Ammophos.
The repetition of the experiment is three times, the placement of dividers is systematic, the area of each experimental divider is 240 m².

Agrotechnics of the experiment: the predecessor-pea-oat mixture; autumn finch processing was carried out to a depth of 22 cm, early spring harrowing to a depth of 3 cm, pre-sowing cultivation to a depth of 6-8 cm. Sowing with a pneumatic planter SSPN-1.6 on 20.05.2020 to a depth of 6 cm, the seeding rate is 1.3 million germinating seeds per hectare. The yield was recorded on 04.10.2020 by the direct threshing method with the SampoTerrion 130 (figure 2) combine.

![Figure 1. Narrow-leaved lupine, variety Vityaz.](image1)
![Figure 2. Harvesting lupine harvester Sampo Terrion 130.](image2)

The data obtained are given to 100 % purity and standard humidity. Mathematical processing of the research results was carried out using the MS Excel computer program by the method of variance analysis [14]. Germination rate and germination energy were determined according to State Standart 12038-84 [15]. Weight of 1000 seeds - according to State Standart 12042-80 [16].

3. Results and discussion

Seeds of agricultural crops are carriers of biological and economic properties, so the size and quality of the future crop depends on their sowing qualities [17]. To create the most favorable conditions for the growth and development of plants, strict compliance with the agricultural technology of cultivation of the crop with the use of seeds with high sowing qualities is required [18].

For all variants of the experiment, including the control, seeds with high indicators of germination energy and germination were obtained (table 1). The indicators of seed germination energy, determined on the 4th day after their laying for germination, for all variants of the experiment exceeded 93 % and were close to the indicators of germination, which indicates favorable conditions for the formation of seed sowing qualities in the conditions of 2020.

According to [19], the germination of narrow-leaved lupin seeds should be at least 87 % for the category of original and elite seeds, and at least 80 % for the category of reproductive seeds. The germination rate of seeds from control plots was 96.5 %, in areas using mineral fertilizers (tuks), the
germination rate of seeds ranged from 97.0 % (ammophos + potassium sulphate + ammonium nitrate) to 99.5 % (ammophos).

According to the author of the Vityaz variety [10], the weight of 1000 seeds is 130-160 g. At the same time, the initial material obtained from the Bryansk region was used for sowing, the weight of 1000 seeds was 118.2 g. In the conditions of 2020 in the Krasnoyarsk forest-steppe, the weight of 1000 seeds on the control plots was 112 g. The introduction of ammophos did not affect the studied indicator. The use of mixtures of mineral fertilizers (tuks) ammophos + potassium sulphate + ammonium nitrate and ammophos + potassium sulphate + ammonium sulfate contributed to an increase in the grain size of lupine seeds, the weight of 1000 grains was 118 and 125 g, respectively, "table 1".

Table 1. The influence of fertilizers on the sowing quality of seeds and grain yield of lupine of the narrow-leaved Vityaz variety.

| Variant                             | Weight of 1000 seeds, g | Germination energy, % | Germination rate, % | Yield, c/ha |
|-------------------------------------|-------------------------|-----------------------|---------------------|-------------|
| Control (without fertilizers)       | 111.7                   | 95.0                  | 96.5                | 19.49       |
| Ammophos + potassium sulphate + ammonium nitrate | 118.4                   | 95.8                  | 97.0                | 16.58       |
| Ammophos + potassium sulphate + ammonium sulfate | 125.0                   | 99.0                  | 99.3                | 17.20       |
| Ammophos                             | 112.6                   | 93.3                  | 99.5                | 13.20       |

The highest yield of lupine grain was obtained in the control variant on the plots without fertilizers. The use of mineral fertilizers on the soil, with a low supply of nitrogen, medium-phosphorus, with a very high supply of potassium, did not contribute to increasing the productivity of the crop. Due to the symbiotic activity of nodule bacteria that develop on the roots of lupine, fixing nitrogen from the air, the culture provides itself with this element of nutrition.

4. Conclusion

Thus, studies on the influence of mineral fertilizers in the cultivation of narrow-leaved lupine on the sowing qualities of seeds in the conditions of Krasnoyarsk forest-steppe showed the effectiveness of the use of physiologically acidic fertilizers on the studied culture. Lupine is not responsive to mineral fertilizers when cultivated in fertile soil.

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