The effect of mineral fertilizer on the harmfulness of phyllophages in the cultivation of Epilobium angustifolium

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Abstract. In the experiments, the effect of mineral fertilizers in a dose of N₁₂₀ P₁₂₀K₁₂₀ on phyllophages harmfulness on plants while cultivating Epilobium angustifolium has been studied. The research was carried out on 3 summer Epilobium angustifolium plantings in the conditions of the North-Western region of Russia in the Vologda region. The article notes the positive effect of mineral fertilizers on the productivity of Epilobium angustifolium plants. It has been revealed that the use of fertilizers reduces the damage to plants caused by phyllophages by 13%, and this agrotechnical technique effectiveness is expressed in the yield increase of 3.9%.

1. Introduction

Many factors affect the growth and development of plants: temperature, illumination, availability of nutrients, soil pH, and others. Pests are one of the significant factors influencing plant productivity. The negative impact of pests is manifested directly and indirectly, because they are also carriers of pathogens of viral plant diseases. The losses from the effects of pests on the plant are very significant. There are many ways of controlling pests, one of them is the use of fertilizers.

Fertilization is known to have a positive impact on increasing crops productivity [1-8]. It increases the regenerative function of cells and thereby reduce the negative impact of pests [9]. Fertilization is a good agrotechnical technique in pest control.

Thus, the effective impact of fertilizers can be seen in:

1. Using fertilizers to destroy a harmful organism. For example, liming of soils and applying ammonia fertilizers prevent the development of the larvae of nutcracker beetle, black beetle, harmful weevil, and beet weevil in the soil [10].

2. Reducing the food activity of pests. Research works have shown that using phosphorus fertilizers changes the chemistry of plants. So, in the experiments on cabbage, the effect of fertilizers decreased the damage to the leaf surface caused by caterpillars. The fertility of pests also decreases and, as a result, their number and harmfulness are reduced.

3. Influencing the processes of plant growth and development. Applying fertilizers accelerates the growth and development of plants under favorable temperature conditions. This leads to a faster passage of the most vulnerable phenological phases for the plant during the period of the maximum activity of pests or to their mismatch, which also reduces the pests harmfulness indicators. For example, the Swedish fly inhabits only the youngest shoots of cereals. In the tillering phase, the pest lays eggs only on the side shoots. Applying the calculated doses of fertilizers stimulates growth processes in plants,
and by the time the eggs are laid by a fly, most of the plants will pass the tillering phase, and in the whole the percentage of damage to the crop by the pest will decrease [11].

4. Increasing the resistance of plants to the effect of harmful organisms. All types of fertilizers contribute to the growth and development of plants, increasing their immunity and the ability to restore damaged organs and tissues. It is known that the introduction of fertilizers for cabbage, followed by hoeing, contributes to the formation of an additional layer of roots in the plant. Owing to this, the plant root system, previously damaged by cabbage fly larvae, quickly regenerates. Many changes taking place in plants are enhanced by fertilizers, which ultimately leads to increasing their resistance to unfavourable environmental factors [10].

Currently, researchers are actively studying Epilobium angustifolium: its fodder, medicinal and nutritional qualities [12-14].

Epilobium angustifolium grows well only when it has a dominant position in the cenosis [15, 16]. Monocultures are known to be the most susceptible to pests in comparison with crops grown in mixed crops [17, 18].

The purpose of our research was to study the effect of fertilizers on the harmfulness of phytophages on Epilobium angustifolium plants.

The task of the research included:
- conducting a comparative assessment of the harmfulness of phytophages in areas with the application of mineral fertilizers (N120 P120K120) and in areas without the application of fertilizers in conditions of cultivated plantings of Epilobium angustifolium;
- based on the data obtained in the experiment giving an objective assessment of applying mineral fertilizer while cultivating Epilobium angustifolium to reduce the harmfulness of phylophages.

2. Materials and methods
The experiment was carried out at the experimental field of the Vologda State Dairy Farming Academy. The age of crop planting is 3 years. A comparative assessment of the harmfulness of phytophages was carried out against the background with using mineral fertilizers N120 P120K120 (Zhukova, 2008) [19] and without them. The repetition in the experiment is fourfold. The control was the option with Epilobium angustifolium plants having gauze insulators preventing their occupation by pests.

The calculations were done at the end of the budding phase and the beginning of the flowering phase of plants. In the options, the coefficient of harmfulness was calculated using the formula (Karavyanskiy, 1971) [20] and the average damage score was determined (Polyakov, 1958) [21].

The yield of the green mass of Epilobium angustifolium was evaluated at 10 points diagonally. 10 plants with different degrees of damage were selected. In all cases, the plants and their parts (leaves, inflorescences) were weighed, the number of leaves was counted. The number of plants damaged and untouched by pests was counted.

3. Research results
It has been reliably established that pests significantly reduce the yield of the green mass of Epilobium angustifolium (Table 1).

| Number of repetition | Yield of the green mass, c/ha (experiment) | Yield of the green mass, c/ha (control) | Difference with control |
|----------------------|------------------------------------------|----------------------------------------|------------------------|
| 1                    | 219,7                                    | 254,8                                  | 36,1                   | 14,2       |
| 2                    | 223,9                                    | 251,7                                  | 27,8                   | 11,0       |
| 3                    | 219,9                                    | 258,9                                  | 39,0                   | 15,1       |
The difference on average in the experiment was 13.7% or 35.1 c/ha. The percentage of leaves damaged by phyllophages is 87.5, which is estimated as 3 points.

The mathematical processing of the obtained data by NCP05 confirms this.

According to our research data, in the experiment with applying mineral fertilizers at a dose of N120 P120K120, the yield of green mass due to pests was 42.3 c/ha less than the control option, which in percentage terms was 9.8% (Table 2).

**Table 2.** Comparative yield of the green mass of Epilobium angustifolium depending on the effect of the complex of the main types of phyllophages with applying mineral fertilizers (N120 P120K120), in the conditions of crop plantings, c/ha.

| Number of repetition | Yield of the green mass, c/ha (experiment) | Yield of the green mass, c/ha (control) | Difference with control, c | % |
|----------------------|---------------------------------------------|----------------------------------------|---------------------------|---|
| 1                    | 380,9                                       | 428,6                                  | 47,7                      | 11,1 |
| 2                    | 389,7                                       | 432,5                                  | 42,8                      | 9,9  |
| 3                    | 385,1                                       | 429,5                                  | 44,4                      | 10,3 |
| 4                    | 395,5                                       | 429,9                                  | 34,4                      | 8,0  |
| Average value        | 387,8                                       | 430,1                                  | 42,3                      | 9,8  |
| HCP05                | -                                           | -                                      | 9,0                       | 2,2  |

The percentage of damaged leaves is 74.5, and in terms of points it is 2.2. The reliability of the result of HCP05 is 9.0 c/ha.

The effectiveness of mineral fertilizers is presented in (Table 3).

**Table 3.** Efficiency of mineral fertilizers on Epilobium angustifolium plantings.

| Experiment option          | Yield of the green mass, c/ha (experiment) | Yield of the green mass, c/ha (control) | Reduction in the yield of green mass compared to control, % |
|----------------------------|---------------------------------------------|----------------------------------------|----------------------------------------------------------|
| Plots without fertilizers  | 221,2                                       | 256,3                                  | 13,7                                                     |
| HCP05                      | -                                           | -                                      | 3,4                                                      |
| Plots with applying fertilizer (N120 P120K120) | 387,8                                       | 430,1                                  | 9,8                                                      |
| HCP05                      | -                                           | -                                      | 2,2                                                      |

Calculating the yield of green mass in the phase of the beginning of flowering of Epilobium angustifolium showed a significant difference between the option with the use of fertilizers and the option without fertilizers.

It can be seen that in experiments without applying fertilizers, the percentage of damaged leaves was 87.5%, which is 13% more than in the option with fertilizers. The difference in the yield of green mass is 3.9% in favor of the option with fertilizers.
4. Conclusions
The conducted research has shown that the application of mineral fertilizers at a dose of N_{120} P_{120} K_{120}
when cultivating Epilobium angustifolium reduces the negative impact of phyllophages on the plant by
13% and increases the yield of Epilobium angustifolium by 38.7 c/ha on average. Thus, the application
of mineral fertilizers in Epilobium angustifolium plantings is an effective agrotechnical technique.

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