THE EFFECT OF MICROBIOLOGICAL PREPARATIONS AND MINERAL FERTILIZER DOSES ON THE STEM HEIGHT OF GREEN PEA (PISUM SATIVUM L.) PLANTS

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Abstract. This scientific article investigates the effect of microbiological preparations on the stem growth of pea plants (Pisum sativum L.). The preparations Fitovak, Teria-S, Yer Malhami, as well as their combinations, were applied against three different mineral fertilizer backgrounds: $P_{90}K_{60}$, $N_{30}P_{90}K_{60}$ and $N_{60}P_{90}K_{60}$. Plant stem height was measured at the stages of budding, flowering, and pod formation. The highest results were observed in the variant where Teria-S was applied on the $P_{90}K_{60}$ background. Specifically, the stem height reached 54.9 cm at the budding stage, 70.7 cm during flowering, and 76.2 cm at the pod formation stage. Furthermore, high effectiveness was also recorded with the $N_{30}P_{90}K_{60}$ background when Teria-S was applied, with stem height reaching 72.8 cm during the pod formation stage. On the $N_{60}P_{90}K_{60}$ background, the application of Teria-S led to an increase in stem height up to 73.8 cm. In some cases, the combined use of the biostimulant Fitovak and the biological preparation Yer Malhami resulted in comparatively lower values.

Keywords. Pea (Pisum sativum L.), stem height, Microbiological preparations, Fitovak, Teria-S, Yer Malhami, Mineral fertilizers.

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Аннотация. В данной научной статье изучено влияние микробиологических препаратов на рост стебля растения гороха (Pisum sativum L.). Препараты Фитовак, Терия-S, Ер малхами, а также их комбинации применялись на фоне трёх норм минеральных удобрений: $P_{90}K_{60}$, $N_{30}P_{90}K_{60}$ va $N_{60}P_{90}K_{60}$. Высота стебля растений измерялась в фазах

бутонизации, цветения и образования бобов. На фоне $P_{90}K_{60}$ наивысшие результаты были получены при применении препарата Терия-S. В частности, высота стебля в фазу бутонизации составила 54,9 см, в фазу цветения 70,7 см, а в фазу образования бобов 76,2 см. Кроме того, высокая эффективность наблюдалась и при норме $N_{30}P_{90}K_{60}$ с использованием препарата Терия-S, где в фазе образования бобов высота стебля достигала 72,8 см. На фоне $N_{60}P_{90}K_{60}$ при применении Терия-S высота стебля увеличивалась до 73,8 см. Варианты, в которых биостимулятор Фитовак и биопрепарат Ер малхами применялись совместно, в некоторых случаях демонстрировали более низкие результаты.

Ключевые слова. Горох, высота стебля, микробиологические препараты, Фитовак, Терия-S, Ер малхами, минеральные удобрения.

Introduction. Currently, pea (Pisum sativum L.) is cultivated on approximately 30.0 million hectares worldwide, with an average grain yield of 2.52 tons per hectare. The leading pea-producing countries include China, with 12.96 million tons; India, 5.43 million tons; France, 0.25 million tons; the United States, 0.23 million tons; and Egypt, 0.20 million tons. In these countries, high and high-quality yields are achieved by sowing peas within optimal timeframes and at appropriate seeding rates, determining fertilization norms based on the soil and climatic conditions of each region, and applying recommended agronomic practices. These measures have a positive effect on the growth, development, and productivity of pea plants, while also improving the quality indicators of the harvested crop.

Literature Review. According to X. Atabaeva, O. Qodirkhojaev, X. Atabaeva, Umarov, and X. Bo‘riev, peas are mainly grown for food purposes. The seeds are used in the preparation of various culinary dishes, including the flour and groats of peas, which are also used in food production. Pea flour is added to pasta, bread, pies, and baked flatbreads, as well as to the flour of cereal crops to increase their protein content. In addition, it is used in the production of certain types of sausages, coffee, cocoa, and confectionery products [2].

According to the data of Z. Islamova, the combined application of nitragin with mineral fertilizers, namely in the variants P_{90} K_{60} + nitragin and **$N_{30}P_{90}K_{60}$** + nitragin, ensured the highest formation of nodule bacteria and an increase in yield by 3.3-5.4 t/ha. Increasing the amount of nitrogen led to a decrease in nodule formation or even a complete absence of nodules. In this case, the yield increase was observed to be due solely to the nitrogen fertilizer [1].

According to V.G. Vasin and A.V. Vasin, peas are also used as a forage crop. The grain, straw, by-products, chaff, or haulm are utilized as feed. The grain serves as an excellent feed for various animals, especially pigs. Darker-colored pea seeds are typically used for fodder purposes [7].

According to V.I. Zotikov and A.A. Borovlev, pea, like other leguminous grain crops, is considered a valuable agrotechnical crop, as it enriches the soil with nitrogen and serves as a good precursor. The wide use of peas in the national economy is undoubtedly related to the chemical composition of its grain, straw, and chaff [5].

According to R.U. Gusmanov, A.I. Terexov, G.F. Mukminova, U.G. Gusmanov, and A. Zorikova, pea flour is used in bread baking by adding 15-20% to wheat flour. Pea grain is considered a nutritious groat, and various dishes are prepared from its flour. Pea grain, straw, and husks are used in animal husbandry. Pea grain is also used in the production of sausages, canned goods, confectionery, and cookies. The grain and straw are used in feed preparation, with 1 ton of grain being equivalent to 0.5 feed units [8].

Materials and Methods. Field experiments were conducted at the educational and research experimental farm of Tashkent State Agrarian University. The experimental farm is located in Tashkent region, Qibray district, on the right bank of the Chirchiq River, at an altitude of 550-570 meters above sea level.

The soil of the experimental farm is a typical sierozem (gray soil) that has been irrigated since ancient times.

The experiment includes 15 variants, arranged in 3 replications, with the variants distributed across 4 tiers. The total area of each plot is 84 m^2, of which 60 m^2 is used for accounting purposes. The total area occupied by the experiment is 0.064 hectares. The experimental design is presented in Table 1. The pea variety “Osiyo-2001” was sown in the trial.

The research was carried out under field and laboratory conditions, following the methodology outlined in “Methods of Conducting Field Experiments” (UzPITI), [3], “Методика полевого опита” (B.Dospexov), [6], “Методика Государственного сортоиспитания селскохозяйственних култур” [4].

Results of the Rasearch. In the conducted field experiments, the effect of various microbiological preparations and their application in combination with different rates of mineral fertilizers on stem growth of pea plants (Pisum sativum L.) was studied. This research primarily focused on changes in stem length during three critical growth stages of the vegetation period: budding, flowering, and pod formation. A scientific analysis was carried out based on the results obtained for each experimental variant.

The Effect of Microbiological Preparations on the Background of Phosphorus and Potassium Fertilizers ($P_{90}K_{60}$).

In this group, no nitrogen fertilizer was applied. In the control variant, where neither nitragin nor immunostimulants were used, stem length was

recorded as 48.5 cm during the budding stage, 66.4 cm during the flowering stage, and 70.4 cm during the pod formation stage. This result was established as the main reference criterion for the experiment.

In the variant where the Fitovak biostimulant was applied, stem length was observed to be 44.6 cm during the budding stage, 64.1 cm during the flowering stage, and 68.5 cm during the pod formation stage. These indicators were lower compared to the control variant, indicating that the preparation was not sufficiently effective under these conditions.

In contrast, the Teria-S preparation produced the highest results according to the research findings. In this variant, stem length reached 54.9 cm during the budding stage, 70.7 cm during the flowering stage, and 76.2 cm during the pod formation stage. This indicates that the microbiological preparation had a positive effect on plant physiology, particularly on vegetative development.

In plants treated with the Yer Malhami biopreparation, stem lengths were recorded as 52.8 cm during the budding stage, 70.4 cm during the flowering stage, and 75.1 cm during the pod formation stage. Although these results were close to those obtained with the Teria-S treatment, they were found to be slightly lower.

In the variant where the Fitovak biostimulant and Yer Malhami biopreparation were applied in combination, stem length was recorded as 47.5 cm during the budding stage, 64.6 cm during the flowering stage, and 69.8 cm during the pod formation stage. As expected, these results did not show a synergistic effect and were, in some cases, even lower than the results observed when the preparations were used individually.

Effect of the preparations under the background of nitrogen, phosphorus, and potassium ($N_{30}P_{90}K_{60}$)

In this group, the addition of nitrogen fertilizer led to an overall increase in stem growth. In the control variant, stem lengths of 49.3 cm during the budding stage, 69.4 cm during the flowering stage, and 72.4 cm during the pod formation stage were recorded. When the Fitovak biostimulant was applied, stem lengths were observed to be 46.7 cm, 65.5 cm, and 70.3 cm, respectively.

In the variant where the Teria-S preparation was applied, stem lengths of 47.2 cm during the budding stage, 65.6 cm during the flowering stage, and 72.8 cm during the pod formation stage were recorded. These results were lower than the control during the flowering stage but higher during the pod formation stage.

Table-1

The effect of microbiological preparations on the stem height of pea plants

№	Rates of mineral fertilizers, kg/ha	Names of nitragin and immunostimulant used for seed treatment before sowing of pea crop	Growth stages		
			Budding stage	Flowering	Pod formation
1	P_{90} K_{60}	Control (no nitragin or immunostimulant applied)	48.5	66.4	70.4
2		Fitovak	44.6	64.1	68.5
3		Teria-S	54.9	70.7	76..2
4		Yer malhami	52.8	70.4	75.1
5		Yer malhami + Fitovak	47.5	64.6	69.8
6	N_{30} P_{90} K_{60}	Control (without application of nitragin and immunostimulator)	49.3	69.4	72.4
7		Fitovak	46.7	65.5	70.3
8		Teria-S	47.2	65.6	72.8
9		Yer malhami	46.9	66.3	72.1
10		Yer malhami + Fitovak	46.5	67.6	70.7
11	N_{60} P_{90} K_{60}	Control (nitragin and immunostimulator are not applied)	47.3	68.2	71.8
12		Fitovak	48.5	68.8	71.9
13		Teria-S	50.1	69.7	73.8
14		Yer malhami	45.8	68.7	71.9
15		Yer malhami + Fitovak	47.3	70.1	72.4

In the variant where the Yer Malhami biopreparation was applied, the stem length reached 46.9 cm during the budding stage, 66.3 cm during the flowering

stage, and 72.1 cm during the pod formation stage. This indicates a moderate effectiveness of the biopreparation.

In the variant where the Fitovak biostimulant and Yer Malhami biopreparation were applied together, the plant stem length was recorded as 46.5 cm during the budding stage, 67.6 cm during the flowering stage, and 70.7 cm during the pod formation stage.

Effect of the preparations under the nitrogen, phosphorus, and potassium ($N_{60}P_{90}K_{60}$) application rate.

This group was conducted under the highest nitrogen background, and overall stem growth indicators were slightly higher across all variants. In the control variant, stem lengths were recorded as 47.3 cm during the budding stage, 68.2 cm during the flowering stage, and 71.8 cm during the pod formation stage.

The effect of the Fitovak biostimulant in this group was recorded as 48.5 cm during the budding stage, 68.8 cm during the flowering stage, and 71.9 cm during the pod formation stage. In other words, the results were very close to those observed in the control variant.

The Teria-S preparation also showed the best results in this group. The stem length was recorded as 50.1 cm during the budding stage, 69.7 cm during the flowering stage, and 73.8 cm during the pod formation stage. This indicates that Teria-S maintained its effectiveness even under high nitrogen conditions.

The effect of the “Yer malhami” biopreparation on plant stem growth under this background was relatively reduced. The stem length was measured at 45.8 cm during the budding stage, 68.7 cm during the flowering stage, and 71.9 cm during the pod formation stage.

In the variant where the Fitovak biostimulant and Yer malhami biopreparation were applied together, stable and favorable results were obtained: stem length reached 47.3 cm during the budding stage, 70.1 cm during the flowering stage, and 72.4 cm during the pod formation stage.

Conclusion. Based on the results of the conducted field experiments, it was found that the stem height of pea plants (Pisum sativum L.) is significantly influenced by the application of microbiological preparations in combination with various mineral fertilizer backgrounds. Under the phosphorus and potassium (P90K60) background, the highest stem growth was observed with the use of the Teria-S preparation, where stem lengths reached 54.9 cm during budding, 70.7 cm during flowering, and 76.2 cm during pod formation. Although the Yer malhami biopreparation also showed relatively high performance with 75.1 cm, the Fitovak biostimulant demonstrated lower effectiveness, with a maximum of 68.5 cm.

In the nitrogen-supplemented ($N_{30}P_{90}K_{60}$) background, overall stem growth increased, and the Teria-S preparation again yielded the highest result, with a stem height of 73.8 cm. The combined application of Fitovak and Yer malhami under this background resulted in plant heights of 71.9 cm each. In some cases, the combined use of both preparations did not produce a synergistic effect, and the results were even lower than those observed when the preparations were applied individually.

The analysis indicates that the Teria-S preparation consistently provided the most effective physiological response for enhancing stem height in pea plants, maintaining its efficacy even under high-nitrogen conditions.

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