# Influence Of Mineral Substances On Potato Growth And Development In Moderate Salinity (On The Example Of Syrdarya Region)

**Sultonova Nigorakhon Mukhamadkodirovna** — Associate Professor of Gulistan State University, (PhD)
**Almamatov Baxromjon O'ktamovich** — Associate Professor of Gulistan State University, (PhD)

ABSTRACT

The influence of mineral elements on the growth and development of potatoes, yield, quality of the crop and efficiency indicators of the combination of various minerals to Piskom and Sante potato varieties were determined. For this purpose, researches were carried out in experimental fields and farms located in the "Experimental Biology" laboratory of Gulistan State University, the Navbahor farm of the university in Sirdarya region, and Khojamushkent massif of Yangiabad district of Jizzakh region. The optimal nutrient medium was determined under the influence of different proportions of NPKZnMg. When potato plants were exposed to $N_{90}P_{60}K_{40}Zn_5Mg_3$kg/ha nutrient options, photosynthesis productivity, chlorophyll content, and mineral content in tubers were high. In all other concentrated nutrient variants, compared to this variant, the reduction of photosynthesis productivity and number of leaves, leaf surface area was observed. It was found that the nutrient option with the concentration of $N_{90}P_{60}K_{40}Zn_5Mg_3$ kg/ha had a positive effect on the productivity of photosynthesis, the number of leaves, and the surface area of the leaf.

**Keywords:** photosynthesis, chlorophyll, vitamins, productivity, leaf surface area, minerals, potato varieties

**In charge.**

The effect of nutrition elements in potato cultivation, in particular the effect of relative coefficients of phosphorus utilization with other elements on crop productivity and quality, has been studied by many foreign researchers. The reasons for the decrease in the formation of root hairs of plants with a deficiency of the phosphorus element were studied by B. G. Hopkins, taking into account the physico-chemical properties of the soil and the level of absorption of the phosphorus element in it, on the part of Major et al. and B. G. Hopkins, the recommended norms of phosphorus fertilizers from 100 kg to 400 kg per hectare. appropriate fertilizer application rates, based on the fact that differences were noted between different soil types, the phosphorus content showed a higher yield response on sandy soils and a lower yield response on sandy soils. Fardeau (1996) showed in his studies that the concentration of phosphorus in the soil is very low, ranging from about 0.002 to 2 mg/l in agricultural soils. Elke Pavelzik, Miriam Koch, Marcel Naumann, Andreas Gransee, and Heike Tiellar studied the effect of micro-and macronutrients on potato growth. Rosen S. J., Kelling K. A., Stark J. K., Porter G. A. (2014) showed how to optimize the management of phosphorous fertilizers in potato cultivation, Lingu Srun Chea in his study showed that some potato varieties can respond positively to phosphorus deficiency conditions.

**Analysis of literature on the topic.** Potato (Solanum tuberosum L.) is a highly demanded crop in the agricultural production system due to its high yield potential and high nutritional value [11]. In high-income countries such as the United States, France, and Germany, the average potato yield may exceed 45 t / ha, but in many other countries, the average yield is much lower, and the average global potato yield is 20 t / ha. Potatoes are a good source of energy and are rich in minerals, protein, fat, and vitamins [9]. In addition, potatoes are not only an important source of food, but also serve as raw materials for industrial production. These reasons, unlike other plants, increase the need for growing potatoes.

Potatoes belong to the rhizomatous group and by their nature are a perennial plant, and are grown as an annual. Because, as a cultivated plant, its entire life cycle is completed in one year. Potatoes are usually propagated vegetatively. In breeding practice, botanical seeds are used to create new varieties.

Potatoes belong to the tomato family (Solanium Solanaciae) and form a genus. According to Professor L. E. Gorbatenko, this genus includes more than 211 wild, semi-wild and cultivated species, of which only one is widely cultivated — Solanium tuberosum L. Many other species are biologically valuable, have characteristic features and are widely used as a source material in breeding work. These include S. Andigenum, S. Demissum, S. Leptostigma, S. Byasence, and S. Phurja [10].

To grow high yields in potato farming, it is necessary to provide plants with the vital factors of light, heat, air, water and nutrients at an optimal level and introduce advanced technologies for good crop growth. For the development of potato growing in our republic, many scientific works have been carried out. Professors D. T. Abdukarimov, T. E. Ostonokulov, B. I. Zuev, B. Azimov, I. Ergashev showed in detail the problems of creating new varieties and improving seed production. V. V. Berezhnova, Kh. T. Karakhodzhayeva studied the effect of mineral fertilizers on the growth and development of potatoes. The selection of plants from beds planted in the spring period, rather than from plants planted in the previous two-row sowing of potato varieties, increases the efficiency of seed production [2].

In the northern regions of Russia, it is recommended to germinate seed tubers before planting in the light for 30-35 days at a temperature of 15-17$^{0}$C [2]. In Jadwizin (Poland), seed germination for 4-10 weeks increased the yield, but in the dark, uprooting and transplanting sprouted plants reduced the yield [3].

In the Kashkadarya region, during the sowing period on March 18-23, the yield per hectare of the ZarafShan variety was 214.7-269.1; It was 221.0-283.5 for the Nevsky variety and 163.3-207.9 c / ha for the Detskoselsky variety. In all the studied potato varieties, the highest additional yield (42.6-55.6 c / ha) was obtained by cutting seed tubers and planting them in a solution of growth stimulators [3].

The most favorable time for planting spring potatoes is March 16, and summer potatoes are planted on July 10 in Bulungur district of Samarkand region. The duration of the growing season of plants was shorter by 6-9 days when grown in the spring period in all varieties compared to the summer period. Productivity in the spring period was 231.6 s for the Diamant variety, 180.5 s for the Cardinal variety, and 268.3 s for the Nevsky variety.In the summer period, this indicator was 189.6, 216.7, and 256.0 c ha, respectively, for varieties [1].

The effect of potato cultivation technology on yield was studied in the conditions of the Moscow region, when the Nevsky variety gave a yield of 29.6 t / ha, and the Golubizna variety 26.9 t/ha with a bush thickness between rows of 90 cm, 55000/ha. fertilizer $N_{100}P_{150}K_{150}$ kg / ha was obtained [4].

When fertilizing the soil with organic fertilizers, the moisture content of the soil layer increases by 1.7-2.4 %, due to the fact that the soil density decreases by 0.04 g/cm3, and the yield increases [4]. The experiments covered the question of preparing the soil for planting potatoes. In the first variant, the land was plowed to a depth of 30-32 cm in autumn, 1 harrowing was carried out in spring, the yield was 160 kg / ha. In the second variant, the moles were plowed in autumn and in spring with a single holding, single harrowing and single sowing, the yield of 203 c/ha was obtained. Thus, fields plowed in autumn must be plowed in spring, making the soil soft and grainy, and favorable conditions are necessary for full germination of potatoes [4].

**Dependence of the content of mineral substances in potato leaves and tubers on the nutrient medium.** Potato (Solanum tuberosum L.) ranks fourth in the world after wheat, corn and rice, growing 314.1 million tons annually on 18.1 million hectares. Potatoes are an important food source. it contains a large amount of carbohydrates, protein, vitamins and minerals [8]. While potato consumption in developing countries is increasing at an average rate of 4.5% per year due to potato processing, Kirkman (2007) estimates that global consumption in processed form will increase from 13% of total food consumption in 2002 to almost 18% by 2020 [8].

Over the past 50 years, as a result of the widespread use of fungicides, fertilizers, and irrigation methods, potato yields have increased significantly. It was noted that the application of mineral fertilizers for potato crops accelerated the growth and development of plants and increased productivity [7]. These data show that nitrogen (N) fertilizers increased the concentration of nitrogen in tubers, phosphorous fertilizers increased the concentration of phosphorus in tubers [7], the concentration in tubers increased after applying potash fertilizers, and Ca or Mg fertilizers reduced the amount of Ca in tubers and the corresponding Mg concentration also increased [12].

Potato tubers contain 1-1. 2% of mineral compounds, the most important of which are potassium, magnesium, calcium and phosphorus [5]. Potassium and phosphorus perform important structural functions, are part of enzymes and play an important role as regulators of metabolic processes. About 300 g of potatoes provide the human body with 48.6% phosphorus and potassium. 25.1% of the recommended daily allowance of potassium and phosphorus [12]. 60% of Uzbekistan's soils are saline to some extent, and 16.0% of agricultural crops are grown in these conditions. Potato yield in Mirzachol does not exceed 11.0-12.0 t / ha. Although some technological elements of potato cultivation have been developed for the Mirzachel saline soil and hot climate, today there is a need to develop a new system of agrotechnical measures for zoned varieties.

**Object of research, conditions of the place where it was conducted.** The varieties Sante, Pskem included in the State Register of Potatoes, and promising varieties Solanum tuberosum L., as well as samples of the biotechnological collection of the Experimental Biology laboratory, were used as research objects. The research was conducted in the Laboratory of Experimental Biology of Gulistan State University, Navbakhor farm of the University of Syrdarya region and Khojamushket massif of Yangiabad district of Jizzakh region.

**Research methodology.** In order to determine the value of phosphorus and potassium in the physiological and biochemical properties of potatoes and the quality indicators of their tubers, biotechnological and physiological and biochemical methods were used. Growing conditions: temperature 18-200C, light level 1500-2000 Lux, photoperiod 16/8 (day / night). Micro-and macronutrients in potato leaves and tubers were determined by the AVIO 200 optical emission spectrometric method (ICP-OES). The level of leaves was determined by the method of N. N. Tretyakov [1990] and weighing, and the net productivity of photosynthesis was determined by the method of A. A. Nichiporovich et al[1963]. [6]

Chlorophyll and carotenoids were evaluated using the Wettstein (1957) method for calculating chlorophylls and carotenoids.

**Analysis and results.** Fertilizer options with different ratios of phosphorus and potassium in four revolutions were selected and applied in practice.

Submission options are marked with the letter "T", Treatment-which means treatment. Table 1 shows the application rates of mineral fertilizers in various combinations of nitrogen, phosphorus, and potassium (kg / ha) [6].

**Table 1**
**Amount of mineral fertilizers applied in various combinations of nitrogen, phosphorus, and potassium (kg / ha)**

| № | Fertilizer No. kg / ha | | | | |
|---|---|---|---|---|---|
| | $NH_4NO_3$ | $NH_4H_2PO_4$ | $K_2SO_4$ | $ZnSO_4$*$_2$O | H2o $Mg(NO_3)_2$*$5H_2O$ |
| **T0** | 0 | 0 | 0 | 0 | 0 |
| **T4** | 263 | 308 | 89 | 15 | 30 |
| **T5** | 350 | 410 | 133 | 15 | 30 |
| **T6** | 350 | 410 | 133 | 0 | 0 |

Physiological indicators of potato varieties fed through the root+leaf. Leaf feeding is a complex and multi-stage process. Through the leaves, plants absorb not only solar energy, carbon (C), oxygen (O), but also nitrogen (N), sulfur (S) and other chemical elements present in the air. The main mineral elements of nutrition enter plants through the roots.

Mineral elements are quickly absorbed through the leaves, so foliar top dressing on green leaves is an emergency in extreme cases, but can not replace root dressing.

Scientists of the Far Eastern Research Institutea introduced foliar fertilization of fruit and berry crops in the 70s and 80s. The doses of mineral fertilizers and the time of spraying on green leaves were determined. The feeding period of the aboveground part of plants was defined as 10-15 days. Spraying should be carried out mainly in spring, when the main part of the leaves appears, after flowering and during the period of intensive growth of buds and fruits. Plants need all the elements for three periods of nutrition. Spraying with solutions is carried out in the evening, in calm and windless weather, trying to apply a thin layer on the upper and lower surfaces of the leaves.

In conclusion, when feeding potato varieties through root + leaf, an increase in the height of plants and the level of the leaf surface was noted compared to root feeding. First of all, there was an increase in the level of the leaf surface (Table 2).

**Table 2**
**Productivity of photosynthesis of potato plants fed through root+leaf (2020-2022)**

| № | Options and their statistics | Plant height, cm | Number of leaves on one plant, pcs. | Leaf level per plant,$^{m2}$ | Photosynthetic productivity, g/$^{m2}$ | Leaf level per hectare thousand/$^{m2}$ |
|---|---|---|---|---|---|---|
| **1** | T0 ($N_0P_0K_0$) | 42,50 | 65,00 | 0,17,17 | 4,53 | 21,06 |
| **5** | T4($N_{90}P_{60}K_{40}Zn_5Mg_3$) | 67.80 | 88.00 | 0.89,89 | 7.29 | 89.38 |
| **6** | T5($N_{120}P_{80}K_{60}Zn_5Mg_3$) | 65.40,40 | 86.00 | 0.77,77 | 6.31 | 77.51 |
| **7** | T6($N_{120}P_{80}K_{60}Zn_0Mg_0$) | 56,9,90 | 82,00 | 0,58,58 | 5,48 | 53,82,82 |
| 8 | **Average value** | **58,15,15 ±2.26** | **80,25 ±0.57** | **0,60,60 ±0,10** | **5.90 ±0.32** | **60,44,44 ±7.33** |
| 9 | Minimum | 42.50 | 65.00 | 0.17,17 | 4.53 | 21.06 |
| 10 | Maximum | 67.80 | 88.00 | 0.89,89 | 7.29 | 89.38 |

When fed through root + leaf, the surface level of one leaf was 0.17$^{m2}$ in the non-fertilized version and 0.89 in T4; T5 was 0.77 and T6 was 0.58$^{m2}$. From these data, it can be seen that the leaf surface area during the flowering phase was higher in the T-4 variant compared to other variants.

In general, it is noted that the daily photosynthetic productivity of potato varieties strongly correlates with such factors as plant height, the number of leaves and the surface area of the leaf formed in one plant. The fact that the daily productivity of photosynthesis is relatively high in the T4 and T5 variants of the experiment can be explained by the increase in the leaf surface area in these variants.

Influence of the amount of feed and the method of feeding on the amount of pigments. The amount of pigments that affect photosynthesis depends on the quality of light. Changes in the amount of pigments were revealed when potatoes of the varieties "Grasshopper", "Red Scarlett", and "Adretta" were exposed to light with different wavelengths. As a result, it was noted that the amount of pigments in potato leaves depends on the wavelength of light and the biological characteristics of the varieties. It was noted that the amount of "a" and "b" chlorophylls and carotenoids under the influence of blue light was higher in the "Adretta" variety than in other varieties [116]. It is natural to record such a situation. Because the process of photosynthesis mainly occurs in the leaves of plants. In this study, it is recommended to determine the amount of pigments in plants in order to determine or select them as productive for a particular area.

Another important aspect of determining the amount of pigments is that it can be used for long-term storage of plant products. It is known that the amount of carotenoids in the leaf is considered one of the important criteria for preliminary monitoring of the condition of stored fruits. The results obtained showed that under unfavorable conditions, carotenoids prevent stress oxidation and ensure long-term high-quality storage of fruits. At the same time, it is noted that the amount of carotenoids can determine the resistance of plants to stressful conditions (for example, drought) [125].

From the literature analysis above, it can be noted that the amount of pigments is one of the important criteria that determine the productivity and adaptability of plants to the external environment. The results of studies showed that the amount of chlorophyll " a " in potato varieties in the control was 8.38, in the T1 variant – 11.09, in the T2 variant – 11.74 g, in the T4 variant – 12.42 mg/g. From these data, it can be seen that chlorophyll a was produced by 4.04 g / mg more than in the control. You can see that it has formed. The same situation is noted for chlorophyll "b". In the control, this indicator was 1.38 g / mg, and in the T4 variant-3.60 g / mg. According to scientific sources, carotenoids are additional pigments that absorb light energy. An analysis of the relevant literature shows that the carotenoid content in plants varies greatly and ranges from 0.2 to 5.1 mg / g [128].

The amount of chlorophyll " a "was 11.21 mg / g, chlorophyll "b" - 3.02 mg/g, and the amount of carotenoids - 4.33 mg/g when feeding potato varieties through root + leaf. Among the studied variants, a positive result was recorded in the T4 variant in terms of chlorophyll content. It is noted that the amount of chlorophylls and carotenoids depends more on the level of the leaf surface. From these data, it can be seen that the amount of feed and its composition affected the pigments. A relatively good result was recorded in the T4 variant and is equal to 13.53 mg/g. This is 5.15 mg / g more than in the control group. The average amount of carotenoids was 4.63 mg/g. This indicator was equal to 3.75 mg/g in the control, 5.0 in the T4 variant, and 4.63 mg / g in the T6 variant.

**Table 3**
**Effect of nutrient content on pigment content (root+foliar top dressing)**

| Variants | Chlorophylll" a " | Chlorophyll" b " | TotalInformation Chlorophylls | Carotenoids | Chlorophyll Carotenoid ratio |
|---|---|---|---|---|---|
| T0($N_0P_0K_0$) | 8.38 | 1.38 | 9.76 | 3.75 | 1.16 |
| T4($N_{90}P_{60}K_{40}Zn_5Mg_3$) | 13.53 | 4.03 | 17.56 | 5.00 | 1.30 |
| T5($N_{120}P_{80}K_{60}Zn_5Mg_3$) | 11.70 | 3.77 | 15.47 | 4.48 | 1.32 |
| T6($N_{120}P_{80}K_{60}Zn_0Mg_0$) | 11.65 | 2.97 | 14.62 | 4.63 | 1.25 |
| **Average** | **11,3131 ±0,58** | **3,03 ±0,32** | **14,35,35± 0,90** | **4,4646 ±0,14** | **1,25±0,01** |

**Effect of different levels of nutrients on the mineral content of potato leaves and tubers.** The concentration of mineral elements in potato tubers is influenced by both environmental and genetic factors. But one of the most important environmental factors is the presence of mineral elements in the soil.

Information on the effect of mineral elements on potato yield is presented in the table below. According to the table, the amount of Mn from the studied mineral elements averaged 0.01 mg/l, while Mg-2.05, Na-1.81, K-44.47, Ca-1.85, Fe-0.20, Zn - 0.03, R-14.1, Al-0.19 and S-0.48 mg/l. These data show that the studied mineral elements contain more potassium (44.76) and phosphorus (14.1) than other mineral elements (Figure 4.12). The T4 variant($N_{90}P_{60}K_{40}Zn_5Mg_3$) had more trace elements in the variant. For example, the amount of potassium was 38.71 mg / l in the control(T0-$N_0P_0K_0$), 55.46 mg/L in the T4 variant ($N_{90}P_{60}K_{40}Zn_5Mg_3$) and 46.01 mg/L in the production variant (T6-$N_{120}P_{80}K_{60}Zn_0Mg_0$). Thus, it was found that in the leaves of potato varieties in the T4 variant, potassium was 16.75 mg/l more than in the control, and 9.45 mg/l more than in the production variant (T-6) (Fig. 1). A similar result was recorded in the amount of other mineral elements. A similar result was recorded for the number of other mineral elements. Based on these data, there is a sharp difference in the amount of minerals in the leaves of potato varieties. It was found to have the lowest amount of magnesium (0.01) and the highest amount of potassium (44.47). The amount of nutrients affected the mineral composition of the leaves. A relatively high speed is recorded in the T4 variant($N_{90}P_{60}K_{40}Zn_5Mg_3$). The mineral content of potato tubers is shown in Table 4. According to the table, the amount of Mn was 0.009 mg/l in the average cross-section of the variants, while Mg-1.87 mg/l, Na-0.75; K-33.33; Ca-1.71; Fe-0.15; zinc-0.023; P-13.26; Al-0.13 and S-0.37 mg/l. It was found that the amount of minerals in the stems is the smallest amount of magnesium and the largest amount of potassium, as in the leaf. The influence of variants on the number of buds is noted. In the T0 variant ($N_0P_0K_0$) without iron-containing fertilizers, it was 0.098 mg/l, and in the T4 variant($N_{90}P_{60}K_{40}Zn_5Mg_3$) - 0.270 mg/l. In this variant, compared to the control, iron was accumulated by 0.172 mg/l and 0.158 mg/l more than in the production variant T6($N_{120}P_{80}K_{60}Zn_0Mg_0$).

**Table 4**
**Amount of minerals in potato tubers**

| **Fertilizer options** | **Mn,** mg / L | **Mg,** mg/ L | **Na,** mg / L | **K,** mg/ L | **Ca,** mg / L | **Fe,** mg/ L | **Zn,** mg/L | **P,** mg/ L | **Al,** mg / L | **S,** mg / L |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **T0($N_0P_0K_0$)** | 0,003 | 1,448 | 0,052 | 30,23 | 1,498 | 0,098 | 0,021 | 12,76 | 0,066 | 0,312 |
| **T4($N_{90}P_{60}K_{40}Zn_5$ $Mg_3$)** | 0,014 | 2,003 | 0,942 | 36,73 | 2,633 | 0,270 | 0,026 | 14,77 | 0,174 | 0,396 |
| **T5($N_{120}P_{80}K_{60}$ $Zn_5Mg_3$)** | 0,010 | 2,301 | 1,082 | 34,85 | 1,592 | 0,103 | 0,023 | 13,08 | 0,209 | 0,415 |
| **T6($N_{120}P_{80}K_{60}$ $Zn_0Mg_0$)** | 0,009 | 2,149 | 0,862 | 34,06 | 1,683 | 0,112 | 0,018 | 13,04 | 0,188 | 0,303 |
| **Average value** | **0,009 ±0,001** | **1,87 ±0,11** | **0,75 ±0,12** | **33,33±0,82** | **1,71 ±0,17** | **0,15 ±0,02** | **0,023 ±0,002** | **13,26±0,25** | **0,13 ±0,02** | **0,37 ±0,01** |

The amount of minerals also differed in the composition of leaves and buds (Figure 1). The main difference was observed in the amount of potassium. The average amount of potassium in a potato leaf was 44.76 mg/l, and in tubers – 33.33 mg/l.

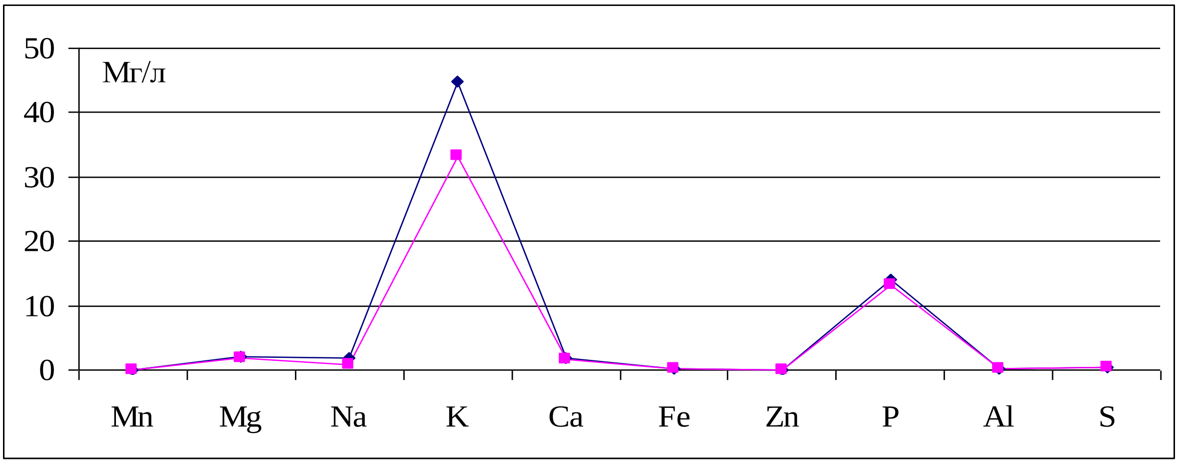


**Figure 1. Effect of nutrients on the mineral composition of potato leaves**
*Note: Blue is the amount of minerals in the leaves, while pink is the amount of minerals in the buds.*

In general, the amount of fertilizers affected the amount of minerals in potatoes. Among the minerals studied, the amount of Mn, Fe, Zn, Al, and S ranged from 0.009 to 0.37 mg / L, and the amount of Mg, Na, and Ca ranged from 1.87 to 1.85 mg/l. It is noted that the amount of potassium is higher than that of others. The amount of potassium in the potato leaf was 44.76, and in the tubers – 33.33 mg/l. A relatively high indicator was also recorded for phosphorus. The phosphorus content in the potato leaf was 14.11 mg/l, and in the tuber – 13.26 mg/l. In this study, studies were conducted to determine the optimal amount of nutrients for growing potatoes in medium salinity soil conditions due to a combination of various minerals, and according to the results of the studies, T4($N_{90}P_{60}K_{40}Zn_5Mg_3$) was recommended as the most optimal nutrient option.

**Conclusions and suggestions.**

1. When feeding through the root+leaf in different ways, the plant height T4 ($N_{90}P_{60}K_{40}Zn_5Mg_3$) was 25.3 cm, the leaf surface of one plant was 0.72 m2, and the photosynthetic productivity increased by 2.76 g/m2. In turn, this variant received 15.26 t / ha more control and 6.35 t / ha more than the variant used in production.

2. In potato variants T4($N_{90}P_{60}K_{40}Zn_5Mg_3$), the amount of chlorophyll "a" was 13.53, chlorophyll "b" - 4.03, the amount of carotenoids - 4.03.

3. In terms of the amount of vitamins, a high indicator was noted in the T4 variant. In

this case, the amount is $B_{1-14}$-, 4, $B_{2-0}$, 320, $B_{12-1}$, 610 and PP-0.002 mg / ml, compared with the control, respectively: 10.54; 0.284, 1.288 and 0.001 mg / ml were noted as high. In this variant, it was noted that the amount of protein is 1.5% compared to the control.

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