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EFFECT OF MINERAL ELEMENTS ON POTATO PHOTOSYNTHETIC PRODUCTIVITY

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Abstract
In order to determine the effect of mineral elements on the growth and development, yield, crop quality of the Picasso variety, as well as performance indicators, studies were conducted to determine the optimal nutrient medium under the influence of various ratios of NPKZnMg in greenhouse conditions. Photosynthesis efficiency and yield were higher when potato plants were exposed to nutritional options in the ratio $N_{90}P_{60}K_{40}Zn_5Mg_3$kg/ga. In all other variants of concentrated nutrients, in comparison with this variant, a decrease in the productivity of photosynthesis and the number of leaves, leaf surface area was observed. It was found that the nutritional variant with a concentration of $N_{90}P_{60}K_{40}Zn_5Mg_3$ kg/ga had a positive effect on the productivity of photosynthesis, the number of leaves and leaf surface area.

Keywords: number of leaves, leaf surface area, potato, potassium, trace elements, nutrients, optimal conditions, phosphorus, photosynthetic productivity.

Влияние минеральных элементов на фотосинтетическую продуктивность картофеля

Аннотация
С целью определения влияния минеральных элементов на рост и развитие, урожайность, качество урожая сорта Пикассо, а также показатели эффективности были проведены исследования по определению оптимальной питательной среды под влиянием различных соотношений NPKZnMg в тепличные условия. Эффективность фотосинтеза и урожайность были выше при воздействии на растения картофеля вариантами питания в соотношении $N_{90}P_{60}K_{40}Zn_5Mg_3$кг/га. Во всех остальных вариантах концентрированных питательных веществ по сравнению с этим вариантом наблюдалось снижение продуктивности фотосинтеза и количества листьев, площади листовой поверхности. Установлено, что вариант питания с концентрацией $N_{90}P_{60}K_{40}Zn_5Mg_3$ кг/га оказал положительное влияние на продуктивность фотосинтеза, количество листьев и площадь поверхности листа.

Ключевые слова: количество листьев, площадь листовой поверхности, картофель, калий, микроэлементы, элементы питания, оптимальные условия, фосфор, продуктивность фотосинтеза.

MINERAL ELEMENTLARNING KARTOSHKANING FOTOSINTEZ MAHSULDORLIGIGA TA’SIRI

Annotatsiya
Pikasso navli kartoshkaning o’sishi va rivojlanishi, hosildorligi, hosili sifatiga mineral elementining ta’siri hamda samaradorlik ko’rsatkichlarini aniqlash maqsadida issiqxona sharoitida NPKZnMg turli xil nisbatlari ta’sirida optimal ozuqa muhitini aniqlash bo’yicha tadqiqotlar olib borildi. $N_{90}P_{60}K_{40}Zn_5Mg_3$kg/ga nisbatli ozuqa variantlari kartoshka o’simligiga ta’sir ettirilganda fotosintez mahsuldorligi va hosildorligi yuqori bo’ldi. Boshqa barcha kontsentratsiyali ozuqali variantlarida ushbu variantiga nisbatan fotosintez mahsuldorligi va barglar miqdori, bargning yuza sathining pasayishi kuzatildi. $N_{90}P_{60}K_{40}Zn_5Mg_3$ kg/ga kontsentratsiyali ozuqa varianti fotosintez mahsuldorligiga va barglar miqdori, bargning yuza sathiga ijobiy ta’sir ko’rsatganligi aniqlandi.

Kalit so'zlar: barglar miqdori, bargning yuza sathi, kartoshka, kaliy, mikroelement, ozuqa, optimal sharoit, fosfor, fotosintetik mahsuldorlik.

Introduction

Today it is important to meet the needs of the world's population in agricultural products. Therefore, in connection with the constant instability of the food supply in the world, attention is being paid to creating opportunities for supplying agriculture and the food industry with sufficient quality and assortment to meet the needs and demands of the population. One of the topical issues is the satisfaction of the need for food products in the required quantity, quality and assortment to ensure the livelihoods of the population and the availability of appropriate resources and guarantees for this. It is also important to preserve the available resources and increase them in the agricultural sector. One such food resource is the potato, and there is a growing focus today on growing carbohydrate- and protein-rich plants that can be grown in a short amount of time.

It is important to select suitable potato varieties in accordance with the soil and climatic conditions of the Syrdarya region, to obtain seedlings free from pathogens and to determine the optimal nutritional options necessary for their growth.

Literature Review

At the beginning of the 20th century, special attention was paid to the study of the relationship of factors such as the effect of plant nutrients on plant productivity. During this time, the most famous "Law of Profitability" was developed by Karl Sprengel, and the "Minimum Law" was later published by Justus von Liebig in the early 19th century. According to the law of the minimum, if all the necessary nutrients are at the optimal level, the yield can increase [4]. It states that plant growth is not determined by the total amount of nutrients available, but by the minimum amount of nutrients. This law shows the importance of a balanced diet for adequate plant growth. The law of diminishing productivity, developed by Eilhard Alfred Mitscherlich, is no less important here. According to this law, the more nutrients, the greater the yield, that is, the reaction in nutrition will go from the saturation line [4]. Another law is the law developed by Georg Liebscher. Liebscher stated that plants with a minimum margin will help increase yields while reaching optimal levels of fertilizer [2]. These patterns form the basis of modern approaches to the development of strategies for the efficient use of resources in crop production. De Wit (1992) proposed using the laws developed by Liebig, Mitscherlich and Liebscher as a standalone alternative in one dynamic model based on the problems that arise in modern agriculture. He came to the conclusion that both agriculture and the environment should focus on the minimum of production resources needed to maximize the use of other resources [2, 3].

In the early stages of potato development, it does not require special mineral nutrition, because the reserves of necessary substances are available in the tubers [11, 12]. In the later stages of development, the need for mineral nutrition increases. Accordingly, in this work, research was conducted to determine the state of changes occurring during the period of P and K element deficiency and the requirement for P and K during vegetative growth of potatoes.

Research Methodology

The studies were carried out on the potato variety "Picasso" under the influence of various concentrations of nutrients in the greenhouse of Gulistan State University.

In addition to the control version of the study, the experiments were carried out in four repetitions by selecting nutrient options in the ratios of phosphorus and potassium (T1, T2, T3, T4, T5, T6) shown in Table 1.

The average air temperature under research conditions was 22-24^{0}C. Natural lighting was 12 hours. In order to study the effect of macroelements on the physiological properties of potatoes, as well as to conduct a physiological and biochemical analysis, the Picasso variety, created from the Research Institute of Potato

Growing of the Republic of Uzbekistan, was brought for research. The seed pods selected for the study were placed for germination in 16-liter plastic containers filled with sand. Hoagland's solution (Hoagland & Arnon, 1950) was prepared and applied three weeks after planting. Four weeks after planting, the plant was transplanted into five-liter plastic pots. The soil placed in tubs was brought from the Syrdarya region of Uzbekistan, and the elemental composition and amount of soil were determined in the Experimental Biology laboratory using the SMART Fertility program using the LCK 339 test cell (LASA AGRO). In order to optimize the composition of the soil, based on the established composition, an additional amount of mineral nutrients was calculated to determine and prepare the optimal nutrient for growing potatoes in the soil using the SMART Fertility program.

In total, during the development phases (growth, budding, and flowering), the plants were fed three times. They were fed with mineral fertilizers containing the following elements: $N_{90}P_0K_0Zn_5Mg_3$, $N_{60}P_{30}K_{40}Zn_5Mg_3$, $N_{90}P_{60}K_{20}Zn_5Mg_3$, $N_{90}P_{60}K_{40}Zn_5Mg_3$, $N_{120}P_{80}K_{60}Zn_5Mg_3$, $N_{120}P_{80}K_{60}Zn_0Mg_0$. $NH_4H_2PO_4$ was used as a phosphate fertilizer, and K_2SO_4 was used as a potash fertilizer.

In connection with the expansion of leaf area that occurs during the growing season of a plant, it is of great importance to determine the photosynthetic activity of leaves by the magnitude of the photosynthetic potential [9].

The photosynthetic efficiency of plant leaves in connection with harvesting is determined mainly along the entire stem. The net productivity of photosynthesis (NP of Photos.) of potato plants grown in various ratios was determined by the following formula at the stages of vegetative development.

$$\text{NP of Photos.}=(V_2-v_1)/(L_1+L_2)xnx0,5$$

where V_1 and V_2 are the amount of dry matter formed in the plant at the beginning and end of the experiment (g), L_1 and L_2 are the surface of the plant leaf at the beginning and end of the experiment (m^2), n is the number of days of the experiment, "NP of Photos." is the amount of accumulated organic matter (g/m^2) [10].

Analysis and Results

A balanced supply of nutrients is essential for good potato yields. Too much or too little of any mineral elements negatively affects the growth and yield of potatoes [1].

One of the factors affecting plant productivity is the leaf index (number of leaves, leaf surface area). It is known that the number of leaves in plants depends on the height of the plant. This can also be seen in Table 1 below.

The productivity of photosynthesis is one of the important parameters that determine the biological yield. According to scientific sources, the daily productivity of photosynthesis in potato varieties treated with biostimulants before planting was 4,50 g/m^2 in the control and 5,12 g/m^2 in the variants [11]. These data show that the effect of the biostimulator on the photosynthetic productivity of potatoes increased its daily productivity by 0,62 g/m^2.

Table 1 Photosynthetic productivity of Picasso potato plants

№	Experience options	Plant height, sm	The number of leaves in one plant, pcs	Leaf volume per plant, m^2	Photosynthesis is productive ligi, g/m^2 per day	The leaf area per hectare is thousand/ m^2
1	**Control**	52,50	75,00	0,17	4,63	21,82
2	**T1**	53,60	76,00	0,25	5,64	37,79
3	**T2**	54,50	86,00	0,36	6,93	59,31
4	**T3**	52,50	81,00	0,29	5,62	42,19
5	**T4**	57,30	88,00	0,42	5,64	61,23
6	**T5**	56,20	87,00	0,41	5,87	58,97
7	**T6**	55,80	80,00	0,30	5,42	45,53
8	**Average indicator**	**54,62 0,71±**	**81,85 ±1,99**	**0,31 ±0,03**	**6,05 ±0,51**	**46,69 ±5,43**
9	**Minimum**	52,50	75,00	0,17	4,63	21,82
10	**Maximum**	57,30	88,00	0,42	7,94	61,23

In our experiment, the daily productivity of photosynthesis was 4,63 g/m^2 in control, -6,93 g/m^2 in T-2, and 5,64 and 5,87 g/m^2 in T-4 and T-5. A relatively high rate was recorded for variants T-2, T-4 and T-5. In these variants, the daily productivity of photosynthesis increased by 1,0-1,20 g/m^2 compared with the control (Table 1).

The foliage per hectare was 21,82 thousand/m^2 in the control, in the variants this figure was 37,79-61,23 thousand/m^2. In the variants of the experiment T-2, T-4 and T-5, this figure was 59,31-61,23 thousand m^2. The researchers found that the increase in the level of the leaf surface of potatoes is associated not only with the biological characteristics of varieties, but also with soil fertility. In studies conducted in the field of the Samarkand region, the leaf surface area of the "Sante" potato variety when sowing green manure (goroks + oil radish) was 67,9-69,8 thousand m^2 /. At the same time, the level of the leaf surface increased by 18,8-19,1 thousand m^2/ compared with the control [10].

In our experience, it was found that the surface level of the sheet increased by 37-39 thousand m2 in the T-2, T-4 and T-5 variants. Thus, the number of nutrients and their composition strongly influenced the level of the potato leaf surface.

Leaf surface area is primarily related to the size of the resulting leaves. The average leaf size during the tillering period was 9,48 m^2. This indicator was -6238 sm2 in the control, 8233 sm2 in the T-1 variant, and -13291 sm2 in the T-4 variant. Relatively high values of leaf volume were noted in variants T-4 and T-5, and it was found that it increased by 7-7,7 sm2 compared to the control.

It has been found that leaf size increases during the flowering period compared to the pruning period. It should be noted that the average leaf volume during the flowering period was 9,48 sm2, and during the flowering period it was 11,11 sm2. This indicates an increase in the level of leaves during the flowering period. On fig. 1 clearly shows that the leaf layer has changed.

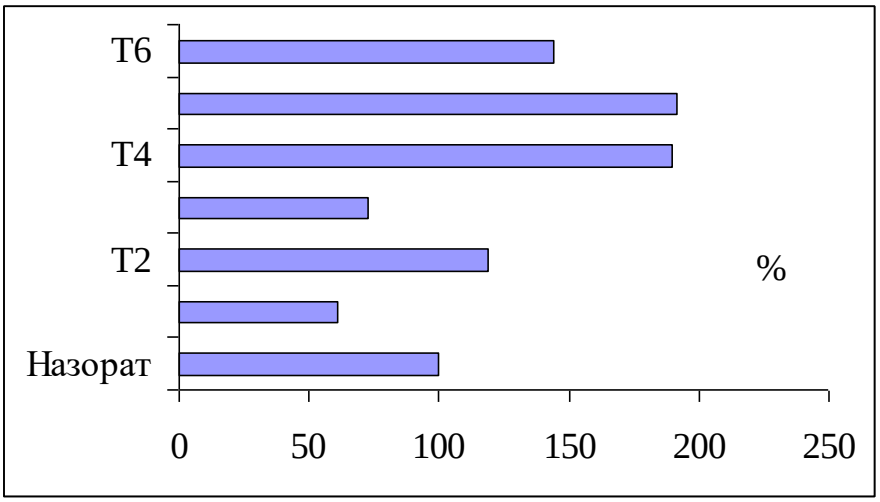
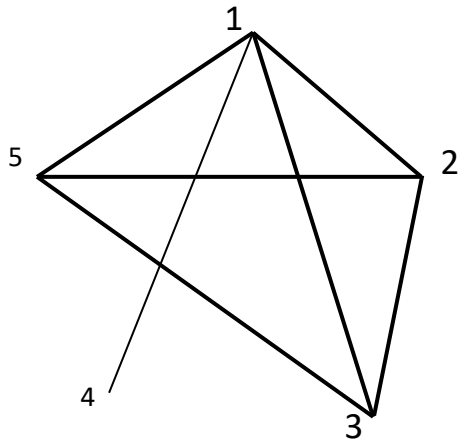


Figure 1. Increase in surface area of potato leaves fed during flowering compared to control (in %)

A relatively high rate during the flowering period was noted in variants T-2 and T-4. In these variants, the increase in leaf size compared to the control was 150-170%. It is known that the signs of the organism are interconnected. It can also be determined by the level of correlation between the quantitative indicators of the studied potato traits, the data of which are presented in Figure 2 below. From the data in the figure, it can be seen that there is a strong correlation between the height of the plant (number 1 indicates the trait) and the number of leaves per plant (2). This means that tall plants also have an increased number of leaves.



Note: that numbers represent characters:

1-plant height, sm;

2 - the number of leaves on one plant, pieces;

3. Leaf volume per plant, m^2

4 - productivity of photosynthesis, g/m^2, daily;

5. The level of leaves per hectare is $1000/m^2$.

R=0.3-0.5;

R=0.5-0.7;

R=>0.7

Figure 2. Degree of correlation between potato traits

The same result was recorded for characteristics such as leaf volume per plant (3) and leaf area per hectare (5). Based on the above information, it can be noted that nutrients have a strong influence on the growth and development of potato varieties. At the same time, the height of the plant increased by 0,19 m^2 -0,42 m^2.
This, in turn, affects the photosynthetic productivity of potatoes. This indicator was relatively high in variants T-2, T-4 and T-5. In these variants, the daily productivity of photosynthesis increased by 1,0-1,20 g/m^2 compared with the control. The nutrient medium affected the increase in leaf surface area. In the variants of the experiment T-2, T-4 and T-5, it was found that the surface level of the leaves increased by 37-39 thousand m^2 compared with the control. It was also noted that the surface area of potato varieties during the flowering period increased and amounted to -6238 sm^2 in the control, and -13291 sm^2 in the T-4 variant. Relatively high values of the leaf surface area were noted in the variants T-2, T-4 and T-5, and it was found that it increased by 7-7,7 sm^2 compared to the control.
Effect of mineral nutrition on potato varieties. Data on the effect of nutrients on the number of stems and the mass of beans of potato varieties are presented in Table. 2. The number of stems formed on one plant in the control was 3,2, in the T-2 variant – 3,9, in the T-4 variant – 3,6 and in the T-5 variant – 3,5. The mass of one plate according to the experimental version was 222,60 g. A relatively high figure was recorded for the T-4 variant and amounted to 265,80 grams. The average value was 242,88 grams.

Table 2 The effect of the amount and composition of nutrients on the number of potato stalks and the mass of pods (Picasso variety)

№	Statistical indicators	The number of stems on a plant a piece	Weight of one plant, g
1	**Control**	3,20	222,60
2	**T1**	3,60	225,40
3	**T2**	3,90	245,60
4	**T3**	3,50	235,40
5	**T4**	3,60	265,80
6	**T5**	3,50	262,90
7	**T6**	3,60	242,50
8	**Average**	**3,55± 0,07**	**242,88 ±6,37**
9	**Minimum**	3,20	222,60
10	**Maximum**	3,90	265,80

Studies conducted on the Picasso potato variety showed that, compared with the control and solutions with a KH_2PO_4 concentration of 4 mg, the value of P accumulation in the leaves was higher in the variants with a concentration of 16 mg/l and 48 mg/l. But, despite the high levels of its content, it can be seen that the number of leaves is less in the variants with a concentration of 48 mg/l compared to the variants with a concentration of 16 mg/l, and the flowering period begins later. eleven].
Accordingly, T4 (3,60) was low compared to T2 (3,90).

Conclusion/Recommendations

1. It was established that the amounts of P and K elements in the T4 feeding variant ($N_{90}P_{60}K_{40}Zn_5Mg_3$ kg/ha) had a positive effect on the productivity of photosynthesis and the number of leaves, leaf surface area.
2. In addition to the control, T1 ($N_{90}P_0K_0Zn_5Mg_3$ kg/ha) had the lowest value of 37,79. This showed that P:K macronutrients in feed are important for potato growth and development.
3. The use of the following standards of salts NH_4NO_3, $NH_4H_2PO_4$, K_2SO_4, $ZnSO_4*H_2O$, $Mg(NO_3)_2*5H_2O$ for feeding potato varieties was recognized as appropriate: $N_{90}P_{60}K_{40}Zn_5Mg_3$.

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