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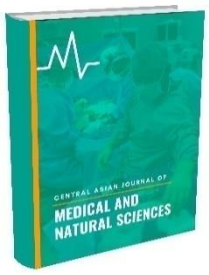

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Influence of Different Growth Stimulators on the Formation of a Photosynthetic Apparatus in Vegetable Soybean Plants

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Abstract: This article describes that when using various growth stimulants, the largest leaf area and formed of photosynthetic potential. It was revealed that, depending on the various growth stimulators of seed treatment in vegetable soybeans, the content of protein, fat, total sugar, vitamin C, starch and nitrates was different.

Key words: vegetable soybeans, stimulants, leaf area, photosynthetic potential, net productivity.

Introduction

At the present stage of development of technologies for growing agricultural crops, one of their most important elements has become chemical substances that can regulate plant growth - the so-called plant growth regulators [2, 8, 16].

Back in 1880, Charles Darwin suggested that plants can also have hormones, like animals [4]. He noted that an impulse spreads from the irritated cells, stimulating the division or stretching of other cells in the form of a response. Although hormones do not belong to nutrients, their importance is very great: under their influence on metabolism, the interconnection of cells, tissues and organs occurs.

In vegetable growing, to accelerate and increase fruiting, the ability of auxins to inhibit vegetative growth of plants and, as a result, increase the nutrition of fruits and seeds is also actively used. The use of 4-chlorophenoxyacetic acid (4-CFC) for the treatment of tomato ovaries stimulates the formation of parthenocarpic fruits, which also differ from seed fruits in a faster development [17, 22, 23].

A group of hormones was named Gibberellins in honor of their discovery in the mycelium of the fungus *Gibberella fujikuroi*, and soon they were also identified in plants. They are especially intensively synthesized in the aboveground plant organs with different activities depending on the stage of plant development. More than 70 species of gibberellins have been discovered, which in terms of chemical composition belong to tetracyclic carboxylic acids, despite the differences in individual structural details. However, gibberellin isolated from the mycelium of the fungus *Gibberella fujikuroi* (gibberellin A_3 or gibberellic acid (GA_3)) has the highest activity and is used for the preparation of growth regulators [5, 12, 25].

The multifactorial influence of gibberellins on plant development is striking. The most prominent are their abilities, such as increasing the linear growth of plants, changing the activity of enzymes, increasing the intensity of respiration, and enhancing photosynthesis [3, 14, 24].

In cereals, gibberellins affect the size and shape of the leaves. And through a change in metabolism, they control the growth and development of plants. Despite the differences in the effect on plants of gibberellins and other growth regulators (for example, auxins), they jointly control the growth and development of plants. In the natural environment, the level of natural gibberellin is not enough for the development of the flowering process, plants need conditions for a long day. And stimulation with gibberellins accelerates the flowering of plants [6, 10, 13, 26].

However, the effect of gibberellin treatments on different plants is expressed in different ways. In some plants, they can prevent a decrease in the amount of chlorophyll and weaken the accumulation of carotenoids in fruits, enhance the processes of axillary branching, and in others, they inhibit chlorophyll synthesis, lengthen the stem and leaf petioles, and in dwarf forms of plants, increase the length of internodes and delay the branching of secondary shoots [15, 19, 20].

In other works, it was found that when potato tubers leave the state of deep dormancy and germinate, the ratio of hormones changes (the amount of ABA decreases, while the amount of gibberellin and ethylene increases). The provocation of leaf fall is caused by an increase in the concentration of abscisin and a decrease in the influence of stimulating hormones in the plant [7, 9, 11].

It was noted that seeds have an increased susceptibility to their treatment with gibberellin, since it takes part in accelerating seed germination. In this case, gibberellins act together with cytokinins in this way: first, gibberellins enter the germination process, directing nutrients to the germination site, and later cytokinins are connected, stimulating the formation of new proteins and cells [1, 18, 21].

Research method and material

Material for research: vegetable soybean seeds of the Emerald variety, various plant growth stimulants, sodium humate, succinic acid, gibberellin.

Vegetable soybean seeds were soaked in various solutions of growth stimulants for 6 hours, followed by sowing in a previously well-watered soil.

Leaf area and net productivity of photosynthesis were determined by phases: branching, flowering, bean formation, and onset of ripening.

Determination of the leaf area was carried out by the method of incisions and dry mass of plants. Samples were taken in four repetitions at three points of a plot with a size of 0.5 m2 typical in terms of plant density. In laboratory conditions, the number of plants was counted, their height, the number of branches, trifoliate leaves and beans were determined.

Then the leaf blades were separated from the petioles (petioles were attached to the stems), and the leaves, stems, and beans were weighed separately. 25 leaf blades were taken from the sample, and 100 punches were taken in four places of each plate with a special drill. Weighed leaves, stems, and beans were ground, taken on an analytical balance, two portions weighing 10 + 0.01 g of each organ into weighing bottles and dried in a drying cabinet at a temperature of 105 ° C for 4 hours until constant weight. The selected cuttings of the leaf blades were also dried. After drying, the weighing bottles were weighed and the value of the absolutely dry matter of each organ and cuttings was calculated according to the generally accepted technique (Methodology for conducting field agrotechnical experiments with oilseeds, 2010). According to the value of the absolutely dry mass of leaves and the mass of cuttings, the leaf area per 1 m^2 of sown area was calculated according to the generally accepted method (Nichiporovich A.A., 1956).

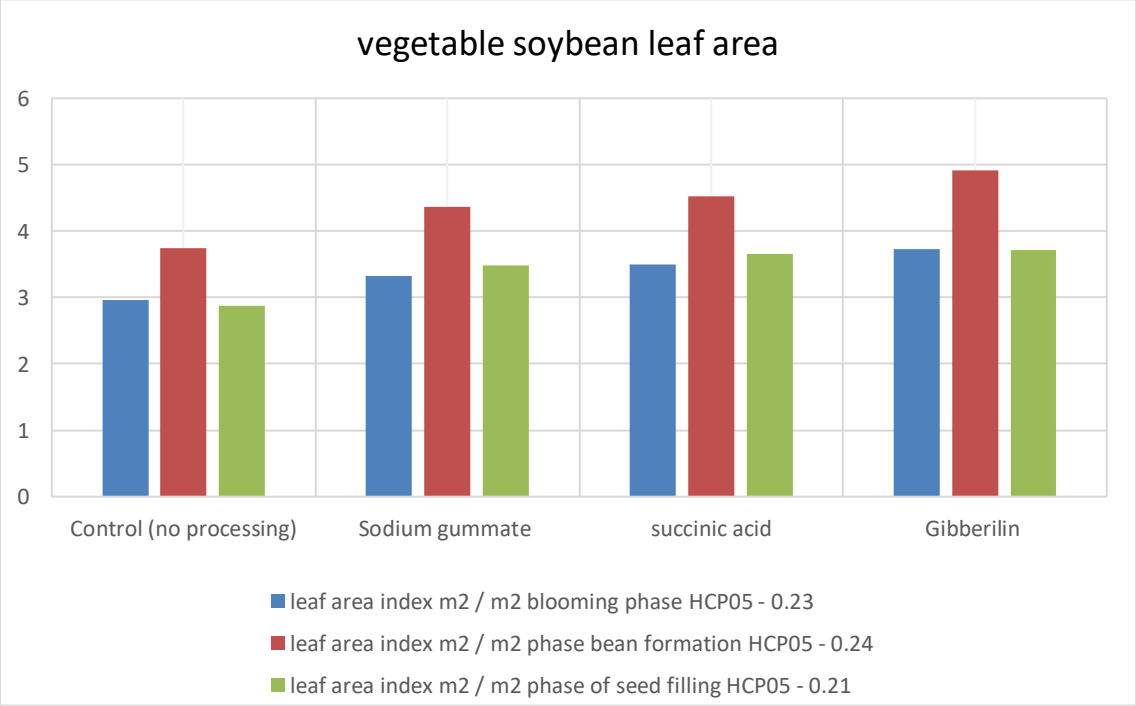
Counting the yield was carried out by a continuous method: immediately after harvesting, the seeds from the counting area of each plot were weighed, and after weighing, single samples of seeds weighing about 0.5 kg were taken to determine moisture and weediness. The harvest was brought to 100% purity and standard (14%) moisture content of pure seeds according to the generally accepted method of conducting field agrotechnical experiments with oilseeds, 2010).

Determination of oil content, protein content and TIA of vegetable soybean seeds was carried out in the laboratory of biochemistry (together with D. Kadyrkhodzhaeva) on an IR analyzer Matrix-I in accordance with standard methods, the spectra were recorded according to the OPUS software manual in the spectral range 3500–12500 cm^{-1} with a resolution of 16 cm^{-1} (Efimenko S.G. et al., 2016).

Research results

The formation of the photosynthetic apparatus, as indicated by A.A. Nichiporovich (cited in: Nutmen P.S. 1979), is a complex process. In the initial period of plant growth, the leaf area increases, and in later phases it decreases due to the formation of reproductive organs. Yield formation is closely related to the photosynthetic activity of plants. Indicators of leaf area, photosynthetic potential, and productivity of photosynthesis are fundamental for the characteristics of photosynthetic activity of plants.

We studied the effect of processing vegetable soybean seeds with various growth regulators and found that the leaf surface area of plants in all variants increased from flowering to the formation of beans, and a decrease in photosynthetic activity was observed from the formation of beans to the filling of seeds (Fig. 1). The largest indicators of the leaf surface area of vegetable soybean plants were in the growing season of 2021, favorable in terms of an increasing increase in heat, in comparison with the rainy and cold spring of 2020.



Rice. 1 - Leaf surface area of vegetable soybean plants depending on seed treatment with growth stimulants, average for 2020 - 2021.

As shown by the studies carried out in diagram 1., seed treatment with various growth stimulants had a significant effect on the dynamics of growth of the leaf surface of vegetable soybeans, which was noted already in the first half of the growing season.

In variants in which the conditions of symbiotic activity were optimized, the leaf surface area reached the highest values. So, in the flowering phase, on average over the years of research in the control variant, the leaf surface index for vegetable soybeans was 2.96 m^2/ m^2, and in the phase of pods formation - 3.75 m^2/m^2, and in the phase of seed filling - 2.87 m^2/m^2. The largest leaf surface index was in the gibberellin variant, the flowering phase was 3.73 m^2/m^2, the bean formation phase was 4.91 m^2/m^2, and in the seed filling phase - 3.71 m^2/m^2.

After two years of study, the assimilation surface of the leaves reached its maximum value in the phase of bean formation. The highest indicators of leaf area were observed in the variants gibberillin and succinic acid - (3.73 and 3.49 m^2/m^2).

The yield of soybeans, like that of other agricultural crops, is closely related to the dynamics of the growth of leaf area.

It was revealed that during two years of research, seed treatment with stimulants gibberilin and succinic acid contributed to a significant increase in the photosynthetic potential (FP), which exceeded the control by 219.7 and 169.7 thousand m^2/ha/day. (Table 1).

The highest FP was established when processing vegetable soybean seeds with a stimulant Gibberillin — 1.006.2 thousand m^2/ha/day in comparison with the control variant (without treatment) - 786.5 thousand m^2/ha/day.

The net productivity of photosynthesis reached its maximum value in the phase of bean formation, but no direct dependence on FP was established.

Table 1. Indicators of photosynthetic activity of vegetable soybean plants of the Izumrud variety depending on the treatment with growth stimulants for 2020-2021

Preparation	Maximum leaf area, thousand m^2/ha	FP, thousand m^2/ha/day	PPF, g/m^2/day
Control (no processing)	29,6	786,5	2,83
Sodium gummate	31,6	884,8	2,76
Succinic acid	38,7	956,2	2,72
Gibberilin	39,2	1 006,2	2,60
SAD_{05}	2,3	46,7	0,12

It was revealed that the indicator of the net productivity of photosynthesis decreased in those variants where the photosynthetic potential increased. This means that the highest photosynthetic potential was observed in the treatment of vegetable soybean seeds with gibberellin and succinic acid, in comparison with the control variant, while the net productivity of photosynthesis in the same variants decreased, remaining the highest in the control variant.

It was revealed that, depending on the different methods of seed treatment in the vegetable soybeans, the content of protein, fat, total sugar, vitamin C, starch and nitrates was different (Fig. 2).

As shown by biochemical analyzes, depending on the various methods of pre-sowing preparation of seeds for sowing in the beans of vegetable soybean variety "Izumrud", the protein content varied from 42.3 to 44.7 %, oil 19.1-19.3 %, total sugars – 4.8-5.1%, vitamin C - 125-133 mg%, starch - 2.6-2.9 %, nitrate nitrogen - 97-100 mg/kg, which is significantly lower than the MPC (200 mg/kg).

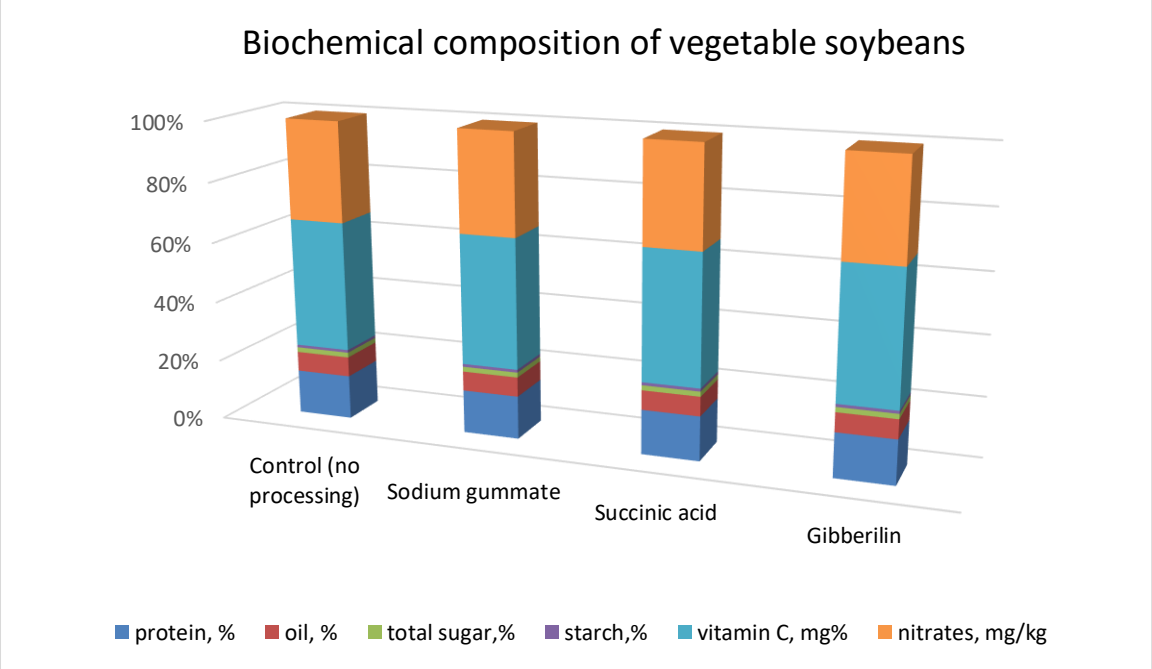


Fig. 2. The biochemical composition of the beans of the vegetable soybean variety "Izumrud" in the phase of technical ripeness (green beans), depending on the seed locks in various growth stimulants (2020-2021)

Conclusions

Based on the foregoing, it can be concluded that, using various growth regulators, it is possible to influence the physiological processes and biological properties of plants in the direction desired for humans.

In general, it can be noted that when using various growth stimulants, the largest leaf area and photosynthetic potential are formed.

It was revealed that, depending on the various growth stimulators of seed treatment in vegetable soybeans, the content of protein, fat, total sugar, vitamin C, starch and nitrates was different.

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