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TYPES OF PLANT GROWTH REGULATORS AND THEIR APPLICATION IN AGRICULTURE

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Abstract: Development of intensive productivity in modern conditions, creation of quickly and regularly productive varieties of agricultural crops, allowing to grow as much as possible and high-quality products per unit of sown area, discovery of groups of chemical substances involved in the processes of plant growth and development.

Keywords: auxin, phytoharmone, cytokinin, stimulant, ethylene, gibberellin.

Introduction. The discovery of groups of chemical substances involved in plant growth and development processes has, to date, opened the way to significant changes not only in biology but also in the fields of chemistry and agriculture. In scientific literature, such compounds are referred to by various terms, including *phytohormones*, *growth promoters*, *growth inhibitors*, *stimulators*, and *auxins* [1].

Plant growth can be regulated through phytohormones such as cytokinins, auxins, gibberellins, abscisic acid, and ethylene. Endogenous growth stimulators include auxins, cytokinins, and gibberellins, whereas abscisic acid and ethylene are considered endogenous growth inhibitors. Currently, eight groups of phytohormones are known. These include gibberellins, auxins, cytokinins, abscisic acid, ethylene, brassinosteroids, salicylic acid derivatives (silantranes), and fusicoccins [2, 3].

Researchers are actively exploring the synthetic development of growth stimulators tailored to each crop, with the aim of directing cultivated plants to produce high yields at desired stages, improving yield quality, and accelerating or delaying maturation, based on the premise that regulating the development of cultivated plants can bring significant benefits to humans [4].

In agriculture, plant growth regulators are synthetic substances that, when applied in small quantities, influence physiological processes in plants, producing either inhibitory or stimulatory effects on growth. These substances act similarly to phytohormones in plants but are not found in nature. Synthetic growth regulators differ significantly from nutrients and assimilates in both function and composition.

In general, synthetic growth regulators enable control over plant growth and development by modulating the activity of natural (endogenous) hormones within the plant organism to a desired extent and in a targeted direction [5].

Most growth regulators possess selectivity, meaning they affect specific plant species, varieties, tissues, or organs. As a result, they can contribute to increased biomass, enhanced cold resistance, and improved crop yields.

In Uzbekistan, the use of plant growth regulators is regulated by the Resolution of the Cabinet of Ministers No. 765, dated December 2, 2020, which approves the "Regulations on the Procedure for Testing and Registering Chemicals and Plant Protection Products" [6].

Under current modern conditions, achieving intensive productivity requires a comprehensive approach. This includes the development of crop varieties that provide high and consistent yields per unit area and the application of effective physiologically active substances—growth regulators—to manage their growth and development [7].

However, the effectiveness of growth regulators depends on proper plant nutrition, adequate water supply, appropriate care, and good agronomic practices [8, 9].

As early as 1984, L.J. Nickell stated, based on his research: *"The importance of growth regulators will continue to increase. Due to rising energy costs and the expansion of urban and industrial areas reducing arable land, a twofold increase in global food production by the end of the 20th century can only be achieved through the use of plant growth regulators. Without them, it will be impossible to significantly increase agricultural output."*

Indeed, in recent years, the scope of studying and applying growth regulators has expanded, making them one of the essential components of modern agricultural production technologies. In developed countries, up to 50–80% of crops are cultivated using plant growth regulators [7].

Given the increasing use of growth regulators in household plots, as well as in dehqon (peasant) and farming enterprises, it is reasonable to expect a further expansion of the areas where these substances are applied.

New groups of plant growth regulators not only exhibit high physiological activity and fungicidal effects, but also demonstrate anti-stress and immunoprotective properties at very low concentrations (5–50 mg/ha). Phytohormones and hormone-like substances—such as epibrassinolide, sodium salts of gibberellic acids, and fungal metabolites—participate in the plant's metabolic processes, and their resulting natural compounds do not have a harmful impact on the soil or the environment [7].

Plant growth regulators are also widely used in horticulture. Their application in the growth and development of fruits is especially important from an industrial standpoint [10].

New substances derived from natural microbes and biotechnological processes enhance metabolic activities by increasing the concentration of amino acids, proteins, carbohydrates, vitamins, and minerals involved in protecting plants from stress conditions [11]. According to research conducted by V.A. Alferov, V.O. Khrapova, and T.G. Prichkolar (Russia), the physiologically active compound "Antifreeze" not only protects fruits from spring frost damage, but also improves pollination and fruit set under cold and rainy weather conditions. Specifically, a single application of this product

increased fruit set by 2.1% compared to the control, while two applications resulted in a 10.6% increase.

In horticulture, growth regulators are used to accelerate plant growth, stimulate rooting of cuttings, aid in seedling transplantation, increase yields, induce leaf drop, inhibit vegetative growth, prevent premature fruit drop before harvest, and promote thinning during flowering and fruit set stages [12, 13].

Significant contributions to this field have been made by researchers such as R. Stowe, L. Edgerton, E. Fisher, M. Hoffman, E. Kraus, M. Berezovsky, L. Laquilla, and others. Their studies have led to the development of several effective strategies aimed at improving the yield and quality of various fruit crops.

Among physiologically active substances, *retardants* are among the most widely used in horticulture. These compounds disrupt the synthesis of gibberellins and auxins in plant tissues, slowing down vegetative growth and enhancing the plant's resistance to adverse conditions [14, 15]. Retardants also promote generative processes in plants, accelerate the onset of fruiting in young trees, and increase their productivity, thereby intensifying crop performance [16, 17].

Studies on the effects of retardants on fruit trees began in the 1960s and continue to this day [16, 18, 19, 20].

In young trees treated with retardants, characteristics typically observed in dwarf rootstock grafted trees—such as reduced height, shorter branches and shoots, early and abundant bud formation, and high productivity—were also exhibited [14, 21, 22]. In subsequent years, flowering and yield in these trees increased up to fourfold.

In conclusion, it can be stated that the range of research and application of plant growth regulators and their various types in agriculture is steadily expanding. In modern agriculture, growth regulators are also being widely used in horticulture. Enhancing fruit growth and development, improving their quality and stress resistance, and further developing the relevant technologies remain among the most important tasks ahead of us today.

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