

A Review of Research on the Effects of Γ -Aminobutyric Acid on Plant Growth

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Abstract

γ -aminobutyric acid is a four-carbon non-protein amino acid that exists in all organisms. In recent years, with the advancement of science and technology, people's research contributions in molecular biology have become increasingly prominent. This article discusses the role of γ -aminobutyric acid in the process of plant growth and development, reviews the current research status at home and abroad, and prospects the future research prospects of γ -aminobutyric acid.

Keywords

GABA; Plant; Research review.

1. Introduction

γ -aminobutyric acid (GABA) is a four-carbon non-protein amino acid with a relative molecular mass of 103.2. GABA exists in all organisms. At the end of the 1940s, GABA in plants was first discovered in potato (*Solanum tuberosum* L.) tubers [1]. When drought, salt stress and pest threats occur, plants will respond accordingly to these situations. At this time, the accumulation of GABA in plants will increase rapidly [2, 3].

2. GABA Formation Mechanism

Studies have shown that there are two main pathways for the synthesis and transformation of GABA in plants. The first is GABA shunt [4], and the other is polyamine degradation pathway [5]. The GABA metabolic shunt is composed of three enzymes, which are cytoplasmic glutamate decarboxylase (GAD), mitochondrial GABA transaminase (GABA-T) and mitochondrial succinate semialdehyde dehydrogenase (SSADH). GABA enters the TCA cycle after the action of GABA-T and SSADH. GABA shunt is involved in the regulation of a variety of physiological functions in organisms [6], GABA branch plays a very important role in the regulation of the animal nervous system and the regulation of plant anti-stress molecular signals. The polyamine degradation pathway is another important way to synthesize GABA, but in monocots, the ability of this pathway to synthesize GABA is not as good as the GABA shunt. Therefore, the current research on the polyamine degradation pathway is mainly concentrated in dicots. In other plants, the GABA shunt is the main research [7].

3. Research on the Role of GABA in Plants

A large amount of research data shows that GABA is an important part of the free amino acid pool of plant cells, and it is indispensable in the process of plant growth and development. GABA can promote the metabolism of carbon and nitrogen in plants [8,9]. At the same time, GABA can also regulate the pH of the cytoplasm, participate in the regulation of Ca^{2+} [10] and the removal of metabolic shunt of the TCA cycle and the removal of reactive oxygen species, thereby

regulating the growth and development of the plant itself [11]. In addition, GABA can also respond to the stress caused by salt [12, 13], low temperature [14] and insects [15].

GABA is a physiologically active substance with very high application value. Studies have shown that GABA is closely related to human health. GABA-rich rice and tea can regulate endocrine, have the effects of lowering blood pressure, soothe the nerves, and delay aging. Therefore, it has attracted more and more attention [16]. The effect of GABA on vegetative growth by modifying gene expression patterns indicates that GABA and its derivatives may play a wide range of roles in plant growth and development. It has recently been reported that GABA and malate transporter (ALMT1 protein) affect plant growth through physical interactions [17]. In 2015, Ramesh et al. discovered the existence of GABA receptor channels in plants, which provided evidence for the metabolism and signaling functions of GABA in plants [18].

4. The Effect of Exogenous GABA on Plant Growth under Adversity Stress

In recent years, exogenous substances such as exogenous betaine [19], appropriate concentration of sucrose [20], exogenous SA [21] and ABA [22] have been used to alleviate the effects of adversity stress on plants. The influence of growth and development has received more and more attention from researchers.

There are also many related research reports on using GABA as an exogenous substance to alleviate the effects of adversity stress on plants. Studies by Zheng and Wang pointed out that exogenous GABA can improve the salt tolerance of wheat (*Triticum aestivum* L.) seedlings [23] and the resistance to waterlogging stress [24]. Since then, Shan et al. conducted a study on the germination rate of corn (*Zea mays* L.) seeds under salt stress in 2018, and the results showed that GABA can alleviate the damage to corn seeds caused by salt stress and increase the germination rate of seeds under salt stress conditions [25]. Studies have also shown that spraying low-concentration of GABA with exogenous sources can increase the grain yield of japonica rice and the enzyme activities of aspartate transaminase (GOT) and alanine aminotransferase (GPT) under drought conditions [26]. In addition, external spraying of 20 mmol/L GABA can promote the growth of melon (*Cucumis melo* L.) seedlings under drought stress and reduce the damage caused by drought stress to seedling growth [27].

5. Prospect

As a four-carbon non-protein amino acid, GABA is widely present in animals and plants. At present, the research on GABA in animals is becoming more and more mature. However, how GABA plays a specific role in plants is still unclear, and further research is needed. With the advancement of science and technology, people's research in the field of molecular biology has matured day by day, which has opened the door for mankind to explore unknown fields and laid a foundation for further exploration of the specific pathways of GABA in plants. In addition, studying the mechanism of GABA's action under adversity stress will help humans better explore the resistance mechanism of plants.

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