INFLUENCE OF PLANT GROWTH REGULATORS ON ANATOMICAL OF FODDER BEAN LEAVES

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Abstract

It was studied the mesostructure organization of leaf apparatus and pigment content of leaves under application of growthregulators with different mechanism of action – esfon (2-HEFC) (0,2%) (ethylene producer) and Epin (0,1 ml/l) (growth stimulator) on broad bean plants. The plant growth regulators treatment on broad beans led to the thickening of leavesdue to increase in the growth of columnar and spongy leaf parenchyma. Growth regulators influenced on the formation of stomatal apparatus of broad beans leaves in different ways. The inhibitory compound esfon caused a decrease in the number of lower epidermal cells and stomata with a simultaneous increase in the stomatal cells area. The application of stimulator compound Epin led to an increase in epidermal cells, without differences in the number of stomata but the area of stomatal cells increased significantly. It has been established the enhancement of photosynthetic processes due to increase in the chlorophyll content in assimilative cells of leaves under esfon on broad beans.

Keywords: plant growth regulators, donor-acceptor system ("source-sink"), mesostructure organization, stomatal apparatus, chlorophyll, broad beans

Formulation of the problem. The plant organism can be represented as the only donor-acceptor system (“source - sink”), in which the plant is considered as a system of donors (source) and acceptors (sink) of assimilates. The functioning of donor-acceptor system is determined by the genetic programof development. Donors and acceptors can be considered as individual plant structures – organs,

tissues, cells and organelles, and as processes – photosynthesis, respiration, transport, assimilation (Kiriziy et al. 2014). It is known that regulation of source-sink system of a plant organism can be carried out artificially by growth regulators application, it causesan increase in crop production process (Kuryata & Khodanitska 2018; Shevchuk et al. 2019; Shevchuk 2020) and improve crop quality (Khodanitska et al. 2019; Shevchuk 2020) due redistribution of assimilate flow to economically valuable organs. Biologically active substances act on the regulatory mechanisms in cells of a plant organismat metabolic level (Bhatla 2018).

One of the modern method to increase the crop yield is an application of synthetic plant growth regulators and compounds that made on a natural substance basis and acts similarly to phytohormones (Kuryata et al. 2019; El Karamany 2019; Khodanitska et al. 2019). These compounds are environmentally friendly and positively affect on the microflora of soil, increase the resistance of plants to adverse environmental factors (extreme temperatures, drought and heat resistance, frost resistance) (Khan et al. 2019). The most common groups of synthetic plant growth regulators is retardants – antigibberellin compound. Retardants are widely used to increase the yield of oilseeds (Kuryata & Khodanitska 2018; Khodanitska et al. 2019; Kuryata et al. 2019), vegetables (Kuryata & Kravets 2018; Rohach et al. 2020), legumes (Kuryata et al. 2019; Shevchuk et al. 2020; Shevchuk 2020; Marchuk et al. 2016; Shevchuk et al. 2018; Shevchuk & Didur 2019) and industrial crops (Shevchuk et al. 2019; Shevchuk et al. 2017).

It is necessary to make attention to legumesdue to the growing deficiency of protein. The value of these crops lies in the fact that they not only increase the resources of food and feed grains but also increase soil fertility and crop production (Pankievicz et al. 2019). The broad bean plants havea great importance among legumes grown in our country for the grains and a green manure. They produce high yields on heavy clay soils compared to peas and fodder lupins, fix nitrogen from the atmosphere and is a good predecessor for winter and spring wheat. In this case, the issue of this study was to establish the application of

stimulator Epin and inhibitor esfon (2-HEFC) on the mesostructure features of leaf apparatus of broad bean plants.

Conditions and methods of research. Broad bean plants cv. Vizir were treated with aqueous solutions of esfon (2-HEFC) (2 %) and growth stimulator Epin (0,1 ml/l) to complete wetting of leaves at shoot height 10-15 cm. Mesostructure organization of leaves were studied on a fixed materialaccording to the generally accepted method of Mokronosov A.T. and Borzenkova R.A.

It was used a mixture of equal parts of ethanol, glycerol and water with addition of 1 % formalin for preservation of leaves. The maceration agent was a 5 % solution of acetic acid in 2 mol/l hydrochloric acid. The method of partial maceration of leaf tissue was used to determine epidermal cells. Measurement of the area of epidermal cells was carried out by using a microscope and an ocular micrometer MOB-1-15x.The number of cells in the tissue per unit area of the field of view was calculated with followed calculation of one cell and its volume. The chlorophyll content wasdetermined in fresh matter by spectrophotometric method on the spectrophotometer SF-16. The analytical repeatability of the research is fivefold (AOAS, 2010). The statistical processing of results was performed by the method of one-way analysis of variance using the computer program Microsoft Excel 2010.

Research results. The results of the study of anatomical structure of leaves indicate the restructuring of leaf apparatus of treated plants under application of growth inhibitor esfon and stimulator Epin on broad beans (Table 1). It was observed that the thickness of leaf bladeof treated plants increased due to the growth of parenchyma. It was found that both growth regulators increasedthe volume of columnar cells and the size (length and width) of spongy parenchyma cellsofleave.

Table 1.

Leaf mesostructure indicators under plant growth regulators treatment on broad bean cv. Vizir

Measurements	Control	Esfon (2 %)	Epin (0,1 ml/l)
Thickness of leave, μm	236,5±0,17	258,4±2,23*	262,1±7,48*
Volume of palisade parenchyma, μm^3	3989,6 ±70,03	4656,7 ± 52,61*	6397,2 ± 69,73*
Length of spongy cells, μm	26,8±1,10	29,8±1,12	29,2±0,56
Width of spongy cells, μm	18,9±0,65	19,3±0,87	20,1±0,98
Number of stomatason 1 mm^2 of the abaxial leaf surface, pieces	10,6±0,93	7,8±0,22*	11,6±0,28
Area of a stomata, μm^2	420,6±7=6,24	451,0±7,87*	479,9±5,87*
Number of epidermal cellson 1 mm^2 of the abaxial leaf surface, pieces	27,7±0,37	18,4±0,42*	32,1±0,41

Note: * – difference is significant at $p<0,05$.

It was found an increase of columnar parenchyma that isthe main assimilation tissue of leave. The stomata of lower epidermis are important for the transpiration processes – a physiological process that creates a continuous flow of water from the root system to leaves, combining all plant in a single system, and protects the plant organism from overheating.

Plant growth regulators influenced on the formation of stomatal apparatus of broad bean leaves. The drugs had different effects on the number of stomata. The number of stomata decreased under esfon treatment and their number remained practically unchanged under Epin. The application of inhibitory compound esfon led to decrease in the epidermal cells and the number of stomata with a simultaneous increase in the stomatal cell area. The treatment of stimulator Epin led to an increase in the number of epidermal cells, but the number of stomata changed and the area of stomatal cells increased significantly.

The effectiveness of photosynthesis is determined by the functional state of photosynthetic apparatus, one of the indicators of which is the pigment content. An increase in photosynthetic processes at the beginning of vegetation can be

indicated by an increase in the chlorophyll content of broad bean plants cv. Vizir (Fig. 1). Application of 2 % esfon increased in the pigment content for 30 % compared to control. Growth stimulator Epin not affected on the pigment content, it was close to control at the last stages of vegetation.

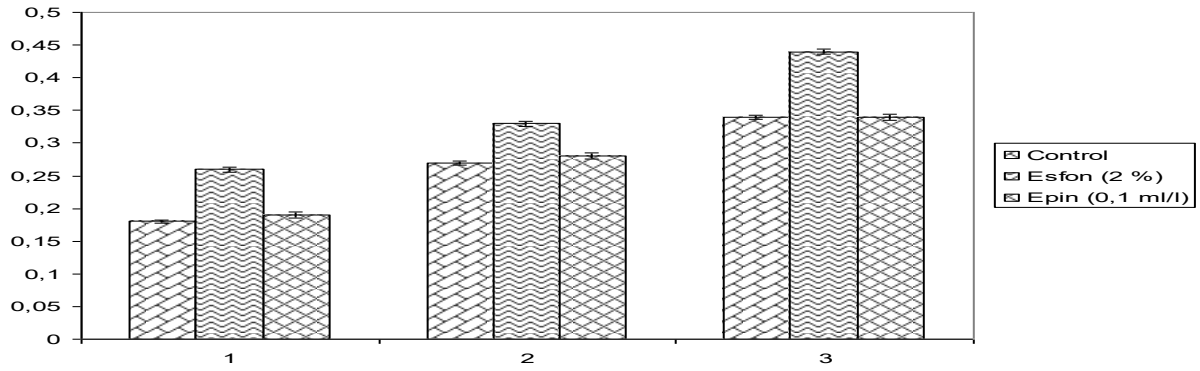

Figure 1. Leaf chlorophyll content under growth regulators treatment on fodder bean, %. 1, 2, 3rd-5th, 10th, 15th day after treatment with growth regulators.

The analysis of mesostructural indicators of photosynthetic apparatus of broad bean plants confirmed that quaternary ammonium compound esfon (2 %) and growth stimulator Epin (0,1 ml/l) enhanced formation of photosynthetic apparatus: the number of stomata increased, the area of stoma and the thickness of leave due to the growth of chlorenchyma. It was noted that chlormequat chloridet reatment increased in photosynthetic processes due to thechlorophyllaccumulation in assimilative cells of broad bean leaves. It is advisable toincrease the crop production of broad bean plants by quaternary ethylene producer esfon (2 %) treatment.

Conclusion. Application of plant growth regulators is a powerful methodto regulate the activity of assimilative apparatus, as one of the main component of donor-acceptor system of plants, and can be used for targeted regulation of plastic substances redistribution in board beans, that increased in the number of stomata, the area of stoma, and the thickness of leave due to the growth of chlorenchyma. It testifies to the fact that esfon treatment on broad bean plants leads to an increase in the leaf chlorophyll content and improve photosynthetic processes.

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