INTERACTIVE EFFECTS OF TREATMENTS OF ECOLOGICAL PLANT PROTECTION PRODUCT CARBECOL ON THE CHLOROPHYLL AND CAROTENOIDS CONTENTS OF TOMATO PLANTS

EFECTUL INTERACTIVE AL PRODUSULUI ECOLOGIC DE PROTECȚIE A PLANTELOR CARBECOL ASUPRA CONȚINUTULUI DE CLOROFILE ȘI CAROTINOIZI LA PLANTELE DE TOMATE

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Abstract. *Plant pigments play a key role in the photosynthetic process of plants and their levels provide a physiological marker to evaluate plant health and determine stress response to application of different kinds of plant protection products. The aim of this work was to determine the response of leaf chlorophylls and carotenoids content in tomato plants to application of ecological plant protection product Carbecol alone or in combination with humic substances Ecolit. A greenhouse experiment was conducted in triplicate by employing distinct treatments of both Carbecol and biofertilizer Ecolit. Results showed that application of Carbecol increased the content of leaf pigments in tomato plants. The highest concentration of green photosynthetic pigments concentrations was registered in treatment with integrated application of Carbecol and Ecolit. Hence, experimental results demonstrated that the photosynthetic pigment status is affected by the application of plant protection product and humic substances*.

Key words: Carbecol, Ecolit, chlorophyll, carotenoids, tomato

Rezumat. *Pigmenții asimilatori au rol cheie în procesul de fotosinteză a plantelor și conținutul lor în frunze servește ca marker pentru evaluarea stării de sănătate și a reacției de răspuns a organismelor vegetale la aplicarea produselor de protecție a plantelor. Scopul al acestei lucrări a fost de a determina modificările în conținutul clorofilei și carotinoizi în frunze la plantele de tomate la utilizarea produsului ecologic Carbecol aplicat separat sau în combinare cu substanțele humice Ecolit. S-a organizat o experiență în seră în trei repetări, aplicându-se diferite tratamente cu Carbecol și Ecolit. Concentrația maximă a pigmenților fotosintetici s-a înregistrat în varianta cu aplicarea integrată a Carbecolului și Ecolit. Așadar, rezultatele experimentale au demonstrat că statusul pigmenților fotosintetici a fost marcat de administrarea produsului ecologic Carbecol și a substanțelor humice.*

Cuvinte cheie: Carbecol, Ecolit, clorofile, carotinoizi, tomate

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INTRODUCTION

Organic agriculture production provides for utilization different kinds of inoffensive plant protection products (Suja, 2013). For organic vegetables production ecological products containing potassium bicarbonate are used to manage plant diseases, in particular late blight of tomato. Their application is an alternative of chemical fungicides (Kamel *et al.,* 2014). Abd-El-Kareem *et al*., (2012) revealed that natural products utilization could attenuate late blight disease of potato. Besides bicarbonates there is large body information that humic substances display an inducer growth activity on crops as well as fungicide activity (Shah *et al*., 2018). Humic acids are the most active components of soil and compost organic matter, stimulate plant growth and consequently yield by acting on mechanisms involved in cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities (Jindo *et al.,* 2020). Positive effects of humic substances on plant growth and yield have been well documented for a range of crops, particularly for tomato (Farnia and Moradi, 2015). The individual influence of bicarbonates and humic substances to prevent plant diseases is well reported in literature. It is known that chlorophyll level in plant tissues determines the photosynthetic potential of crops. These pigments play a key role in the photosynthetic process to form valuable compounds used as energy for growth and physiological processes of crops. The leaf chlorophyll content provides an essential parameter of the photosynthetic capacity (Cerullo et al., 2002) and state of stress in crops (Hazem *et al.,* 2016). Salbitani *et al.* (2020) reported that the application of bicarbonates increased the chlorophyll contents in *Chlorella Sorokiniana*. Besides green pigments, the carotenoids have important role in physiological processes. Carotenoids are involved in the defense mechanism against oxidative stress and play an important role in the dissipation of light energy (Cerullo *et al*., 2002). The status of green pigments and carotenoids in plants could be affected by the application of agrochemical products used in conventional or ecological plant protection systems. However, their effects on physiological indices of plants is insufficiently studied, in particular the changes of photosynthetic pigments (Abd-El-Kareem *et al*., 2009). The most of the studies were conducted using these products alone on plant growth and their protection capacity. Further studies are needed on the impact of integrated application of plant protection products and biofertilizer on chlorophyll content in plants. Analysis of literature data reveal there is little information regarding the effect of the foliar application of Carbecol and humic substances (Ecolit) on photosynthetic pigments contents in tomato plants.

Therefore, the main objective of the research was to determine the interactive effects of Carbecol and Ecolit treatments on the chlorophyll and carotenoids contents in tomato plants grown in greenhouse condition.

MATERIAL AND METHOD

To accomplish the purpose of the study, a greenhouse experiment was conducted with tomato plants (cv Tolstoy). Some chemical properties of the soil of experimental plots were determined before transplanting. The experiment included 6 treatments and three repetitions. Individual and combined applications of the two factors (Carbecol and Ecolit) were sprayed at the following stages of tomato development: 1st at 2 weeks after transplanting; 2nd at flowering stage and the 3rd at the beginning of fruits growth. Carbecol was applied taking into consideration the doses of 4 kg/ha and 6 kg/ha. Humic substances Ecolit was applied at the dose of 3 L/ha. During the growing period plants were drip irrigated as needed. Weeds were controlled by hand. Leaf samples from each treatment plant were collected after three treatments with Carbecol and Ecolit. Leaf chlorophyll and carotenoids contents were determined by spectrophotometric analysis of chemically extracted pigments (Lichtenthaler, 1983). The factorial treatments were distributed in three replicates according to the randomized complete block design. The data was analyzed by using STATISTIC 7 program.

RESULTS AND DISCUSSIONS

The pigments content in leaves is a suitable marcher to estimate the state of physiological health and plant tolerance to abiotic and biotic stress factors. A range of natural products to control plant diseases in organic system production of vegetables are used. However few data exist regarding their impact on physiological parameters, in particular on chlorophyll status of plants. This study showed that contents of chlorophyll *a* and *b* in tomato leaves were affected by treatments with Carbecol and Ecolit. Based on the results, the values of chlorophyll *a*, chlorophyll *b* and carotenoids in leaves of tomato plants are presented in Figures 1-3.

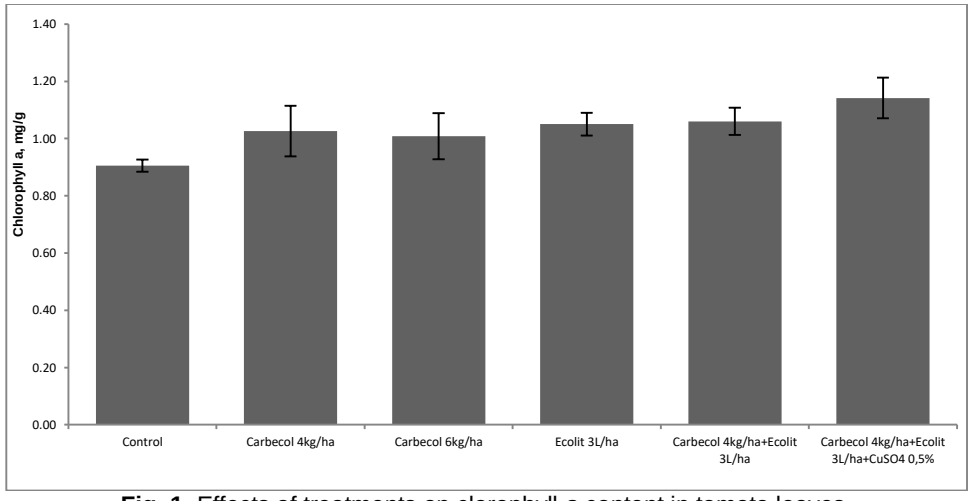

Fig. 1. Effects of treatments on clorophyll ***a*** content in tomato leaves.
Data are mean values ± standard error (n = 3).

The experimental results of the present study revealed that the application of Carbecol alone or in combination with humic substances Ecolit had a beneficial effect on chlorophyll contents in tomato leaves (fig. 1, 2). There was a synergistic effect of integrated application of Carbecol and Ecolit on this parameter. The combined administration of both products with supplementation of cupric sulphate (0.5%) increased the content of chlorophyll *a* by 25.3% and chlorophyll *b* by 38.9% compare to control plants.

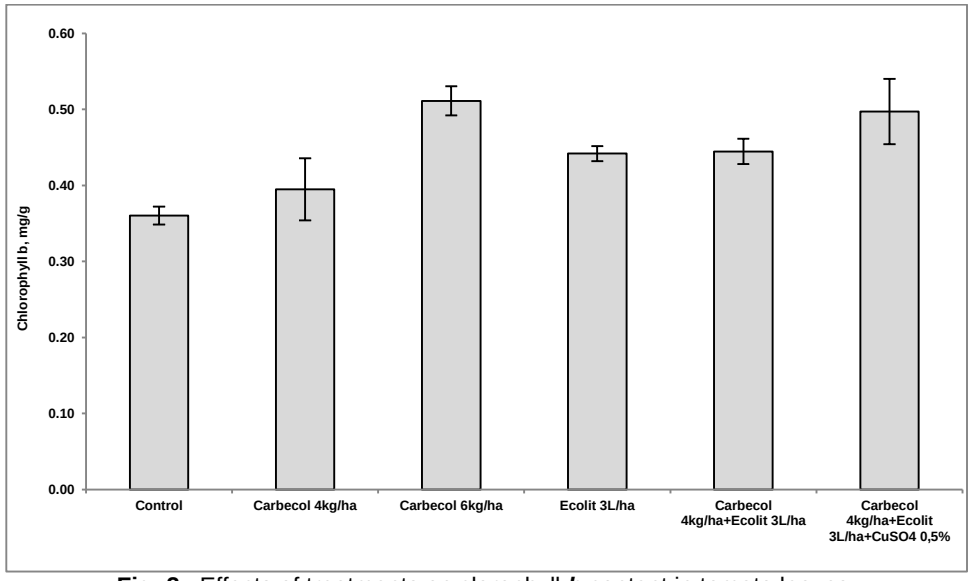

Fig. 2. Effects of treatments on clorophyll ***b*** content in tomato leaves. Data are mean values ± standard error (n = 3).

The stimulating effect of humic substances on plant growth and photosynthetic pigments levels of tomato may have been related to enhanced uptake of mineral nutrients (Yildirim, 2007) and the plant hormone-like activity of humic substances (Nardia *et al*., 2002). Hence, the highest content of chlorophyll registered in treatment of Carbecol + Ecolit + cupric sulphate. Probably, the integrated use of these compounds stimulated plant development, in particular canopy of tomato that ensure better assimilation of nutrients such nitrogen and magnesium. In addition, plants in that treatment were less affected by light blight disease compare to control plants (data not shown). These elements play central role in green pigments synthesis. Similar results were obtained by other researchers due to application of humic acids (Farnia and Moradi, 2015). In general, chlorophyll level was lower in plants without application of Carbecol and Ecolit.

Besides chlorophyll, carotenoids also play vital role in different biological processes, in particular in annihilation of SRO, stabilization of photosynthetic complex of plants. Likewise, they contribute to reduction the ecological stresses provoked by abiotic and biotic factors. The changes in carotenoids contents in

leaves in relation of treatments are presented in figure 3. Experimental results demonstrated that concentration of carotenoids was positively influenced by the application of Carbecol alone as well as in combined treatment with Ecolit. Especially, their content increased significantly due to application of Carbecol at dose 6 kg/ha.

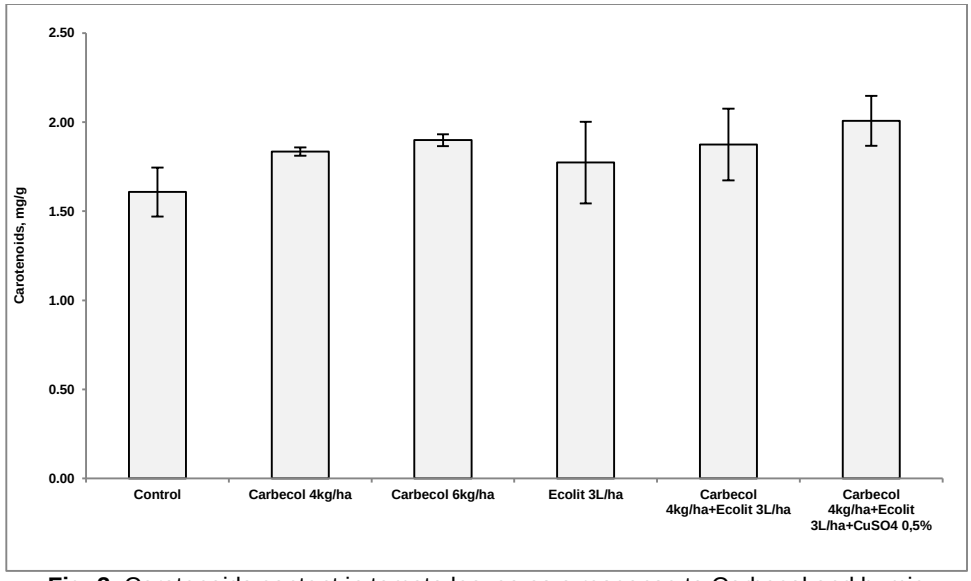

Fig. 3. Carotenoids content in tomato leaves as a response to Carbecol and humic substances applications. Each value is the mean of three replications ± standard error.

Therefore, it was observed that the plant treatments with Carbecol alone in dose at 4 and 6 kg/ha stimulated their accumulation by 13.7% and 18.0% respectively compared to control variant. The highest level of these pigments was registered in the combined treatment of Carbecol and Ecolit with supplementation of cupric sulphate (fig. 3). Hence, the combined applications of tested substances allow stimulating plant development and induce the photosynthetic activity of tomato plants.

CONCLUSIONS

Study results suggest that spraying Carbecol and humic substances Ecolit during vegetation of plants, individually or in combination improve photosynthetic pigments status of tomato.

The response of the chlorophyll and carotenoids content to application of plant protection products has similar responses in tomato plants.

Acknowledgments: The author is grateful to the National Agency for Research and Development of the Republic of Moldova for financial support, project 20.80009.5107.19.

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