

EFFECT OF ECOLOGICAL PRODUCT CARBECOL AND BIOFERTILIZER ECOLIT ON MANAGEMENT OF LATE BLIGHT (PHYTOPHTORA INFESTANS) AND PRODUCTIVITY OF TOMATO (SOLANUM ESCULENTUM) PLANTS

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Abstract

Organic agriculture is gaining importance and the market for organic products has been significantly increasing nowadays. Different diseases affect tomato especially the pathogen *Phytophthora infestans*, which is a major threat in organic and durable agriculture. A greenhouse experiment was carried out to evaluate the effect of new biorational protection product Carbecol and humic substances Ecolit in late blight management in tomato and their impact on the productivity. Tomato plants during vegetation period were treated four times with Carbecol in dose 6 kg/ha alone as well as in combination with application of biofertilizer Ecolit in doze 3L/ha. Control were untreated plants.

Experimental results revealed that foliar diseases like late blight of tomato were significantly reduced by treatments applied either alone or in combinations compared to untreated plants. However, the best results were obtained in variant with integrated application of Carbecol, Ecolit plus ecological protection product Funecol in concentration 0,4%. The treatments had beneficial impact on fruits productivity of tomato. Experimental results demonstrated that application of Carbecol alone did not significantly increase the yield.

However, the integrated use of Carbecol, humic substances Ecolit and Funecol gave better effect and the yield increased by 15,7% compared to untreated plants.

Hence, experimental data suggests that the combined application of Carbecol, Ecolit and ecological fungicide Funecol could reduce the incidence of *Phytophthora* disease and increase tomato productivity. The integrated application of these ecological products of plant protection and biofertilizer could be an option for development of durable agriculture.

Key words: *Solanum lycopersicum L.*, Carbecol, Ecolit, late blight, productivity

INTRODUCTION

Tomato (*Lycopersicon lycopersicum L.*) is the second most important vegetable crop after the potato (Massantini, et al., 2021). This species is cultivated on large area in many agricultural regions, in particular in Romania and the Republic of Moldova. Tomato fruits have a high importance due to their high nutritive values, antioxidants contents and curative properties (Sahu et al., 2013). For organic vegetable production, ecological products containing potassium bicarbonate are used to manage plant diseases, in particular late

blight of tomato. Their application is an alternative to 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 a large body of information that humic substances display an induced growth activity on crops as well as fungicide activity (Shah et al., 2018). Positive effects of humic substances on plant growth and yield have been documented for a range of crops,

particularly for tomato (Farnia and Moradi, 2015).

According to literature data, tomato plant is susceptible to various diseases caused by different agents, particularly by fungi *Phytophthora infestans* (Sahu et al., 2013). Without adequate control measures, this pathogen can cause major yield losses throughout the growing season due to leaf destruction and fruit infections. The growing public demand for reducing the use of conventional fungicides has promoted research to find innovative and environmentally friendly strategies to control *Phytophthora* disease. Yield losses of crops due to plant pathogens are a major threat in conventional and organic agricultural system. In view of environmental issues and legislative limitations for chemical crop protection products, the need to design new environmentally friendly disease management strategies has gained a big interest.

The individual influence of bicarbonates and humic substances to prevent plant

MATERIALS AND METHODS

To accomplish the purpose of the study, a greenhouse experiment was conducted with tomato plants (cv Manusa). The experiment was performed at the Institute of Genetics, Physiology and Plant Protection of the Republic of Moldova. The soil used for experimentation was carbonated chernoziom. Some chemical properties of the soil of experimental plots were determined before transplanting. The experiment included 6 treatments. The treatments are shown in Figure 1. Individual and combined applications of the Carbecol, Ecolit and Funecol were done at the following stages of development: 1st at 7 days after transplanting; 2nd - at the intensive growing stage; the 3rd - at flowering stage and the 4th - at the fruits development. Carbecol was applied taking in consideration the dose of 6 kg/ha. Humic

diseases was documented in literature (Ampong et al., 2022). However, most of the studies were conducted in order to determine the effects of their lone application on their protection capacity. Further studies are needed to study the impact of integrated application of plant protection products and biofertilizer on late blight management of tomato plants. According to literature data, there is a little scientific information regarding the concomitant evaluation of the effects of plant protection products on diseases management and their influence on crops yield. In particular, there are no studies to evaluate the impact of foliar application of a new protection product Carbecol and humic substances (Ecolit) on late blight control and productivity of tomato.

Therefore, the main objective of the research was to determine the interactive effects of new ecological products Carbecol and Ecolit treatments on the control of *Phytophthora infestans* and yield of tomato plants in a protected system of cultivation.

substances Ecolit was applied at dose 3 L/ha and ecological fungicide Funecol at 0,4%. Each treatment was replicated three times. Treatments were applied by spraying the solution on the tomato foliage. During the growing period, plants were drip irrigated as needed. Weeds control was performed manually.

The disease incidence was recorded four times at ten days interval after the final spray. Disease severity was scored per treatment using scale of 0–5 (Cohen et al., 1991). The percent disease index (PDI) was calculated by the formula described by Pandey et al. (Pandey et al., 2003). At physiological maturity, tomato fruits from each variant were harvested (total of 9 harvests were done) and weighed separately to determine fruit yield. The factorial treatments were distributed in three replicates according to the Complete Randomly Block Design. The data were analyzed by using STATISTIC 7 program.

RESULTS AND DISCUSSIONS

To our knowledge, the results of this study present here for the first time the evaluation of effectiveness of plant protection products Carbecol and Funecol together with biofertilizer Ecolit on foliar

pathogen (*P. infestans*) development in tomato plants and their impact on fruits yield. The experimental results regarding disease incidence of tomato plants are presented in Figures 1-3.

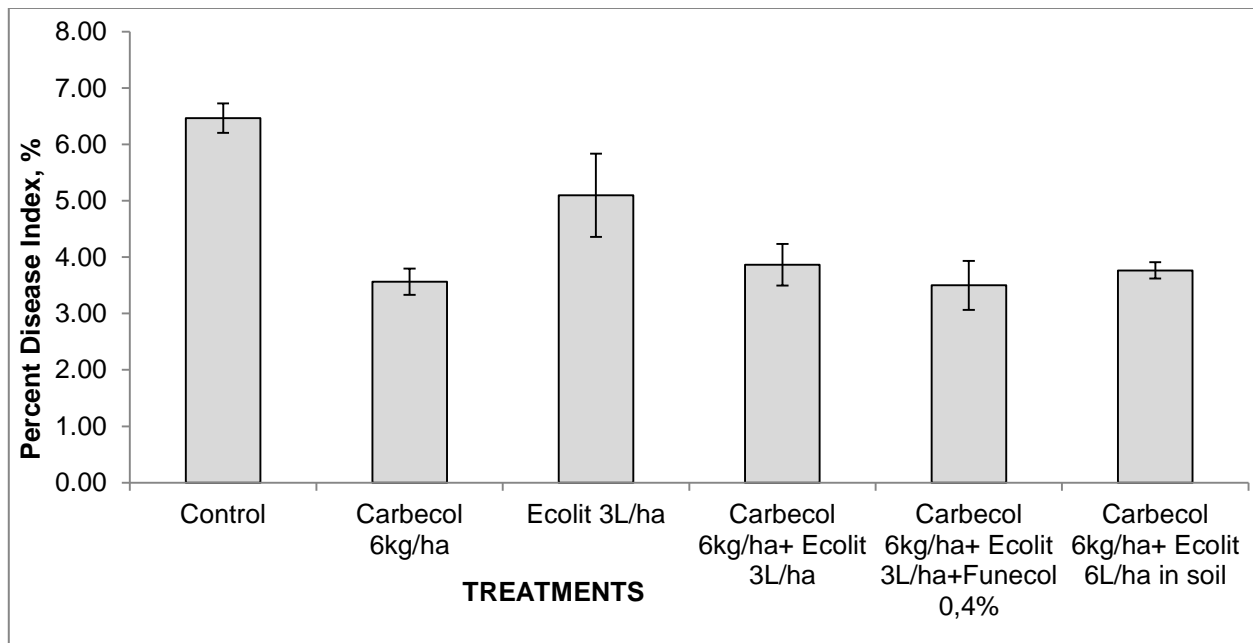


Figure 1. Effect of treatments with Carbecol alone or in combination with Ecolit and Funecol on disease incidence under greenhouse conditions (the first evidence). Vertical bars show mean values and standard error (SE).

All treatments were found more effective than the control in reducing development of the late blight disease. However, the treatments had different influence to combat the disease development. As shown in Figure 1 (the first estimation) the application of Carbecol alone reduced significantly the disease incidence of plants.

The recorded foliar disease of late blight of Tomato has significantly reduced for all treatments. This influence was observed in treatment with Carbecol administered either alone or in combinations (Figure 1-3) compared to untreated plants. Experimental data revealed a reduction of disease incidence by 24-45% against the control variant. It is worthy to note that biofertilizer alone and it did not significantly reduce the infection of plants by phytopathogen *P. infestans*. However, with the integrated application of

Carbecol, Ecolit and Funecol have given the best results. A synergic effect was obtained by their integrated application in regards to plants affection by *P. infestans*. This effect can be attributed to the fact that compounds in these products could inhibit the development of late blight disease. Hence, the most significant reduction in disease incidence of tomato plants was recorded in combined treatments (Carbecol + Ecolit + Funecol) compared to other applied treatments as well as untreated control. Based on the research results, it could be proposed that the integrated use out of all ecological plant protection products (Carbecol and Funecol) and biofertilizer Ecolit could be applied in organic vegetable production. These treatments are safe and contribute to control against such foliar plant diseases as late blight of tomato. Therefore, the integrated

application of these products is effective to combat *Phytophthora* of tomato and

could play an important role in durable agriculture development.

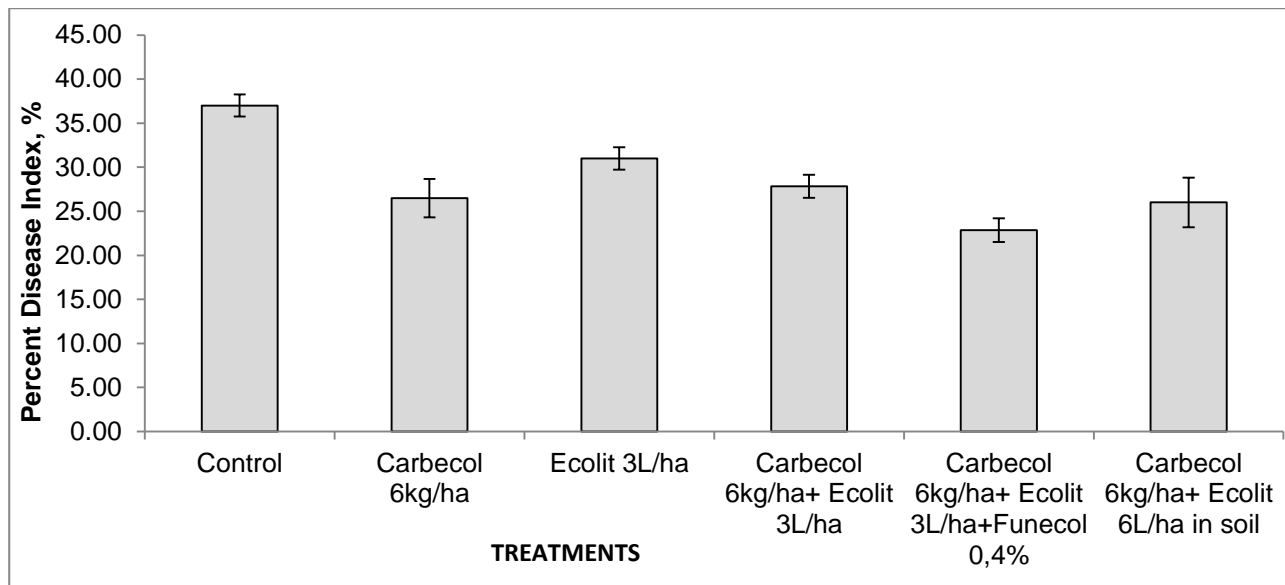


Figure 2. Effect of treatments with Carbecol alone or in combination with Ecolit and Funecol on disease incidence under greenhouse conditions (the second evidence). Vertical bars show mean values and standard error (SE).

This study found that three products are effective to reduce the disease levels of late blight in tomato plants. Therefore, these ecological products have a

protection potential and may be incorporated in tomato biotechnology cultivation for diseases management in an eco-friendly way.

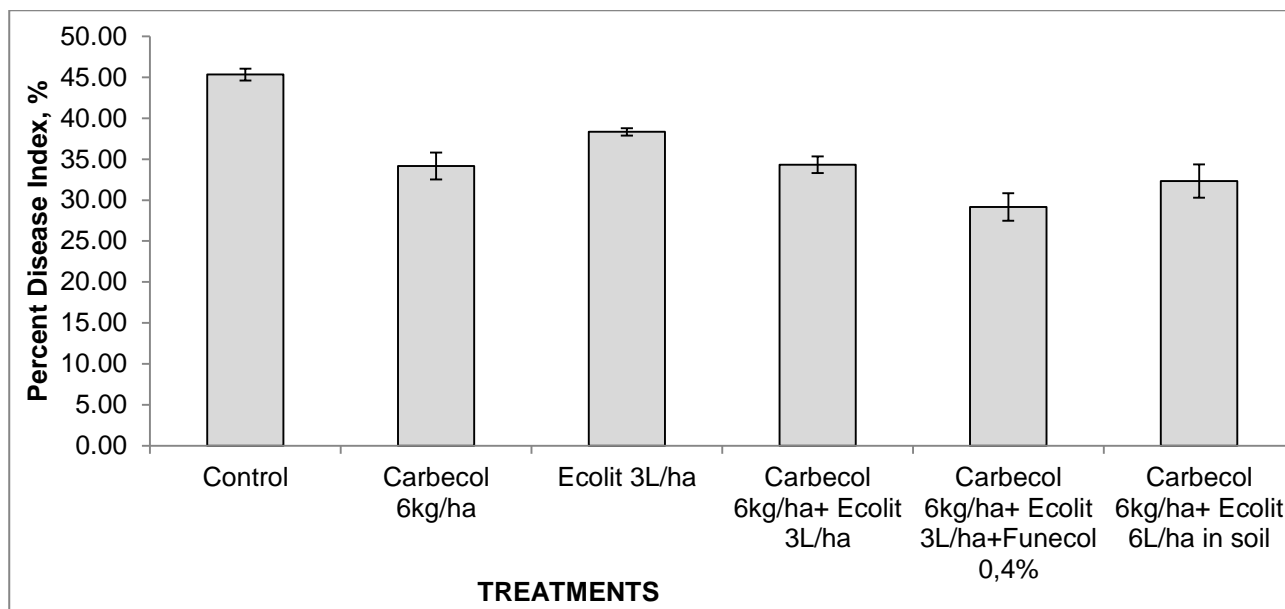


Figure 3. Effect of treatments with Carbecol alone or in combination with Ecolit and Funecol on disease incidence under greenhouse conditions (the third evidence). Vertical bars show mean values and standard error (SE).

Humic substances are a suspension based on potassium humates and humic acids which can be applied successfully

in many areas of plant production as a plant growth stimulant or soil amendment for enhancing natural resistance against

plant diseases and pests (Jindo et al., 2020, Scheuerell and Mahaffee, 2006). The application of ecological protection products and biofertilizer Ecolit showed significant increases in photosynthetic pigments concentrations in leaves of tomato plants (data are not shown). Therefore, these positive changes of physiological parameters affected growth and productivity of tomato plants.

In this study, we also evaluated the impact of treatments on tomato yield. Experimental results revealed that application of the protection products and organic fertilizer had a beneficial effect on the tomato yield (Figure 4).

The experimental results regarding the yield are shown in Figure 4. It is worthy to note that these substances did not cause

phytotoxic damage to leaves of or to fruits. According to the results of the study, total tomato fruit productivity did not increase significantly by application of Carbecol alone (Figure 4). Nevertheless, the yield increased after application of humic substances Ecolit by 9% compared to control plants. Our experimental results are in accordance with the findings of Abdellatif I. et al. (2017), who demonstrated a significant increase in yield of tomato fruits due to the application of humic acids. In our study, the highest total yield was registered in treatment with integrated application of all three products (Carbecol + Ecolit + Funecol). The increase of the yield in this treatment was 15,7% compared to untreated plants (Figure 4).

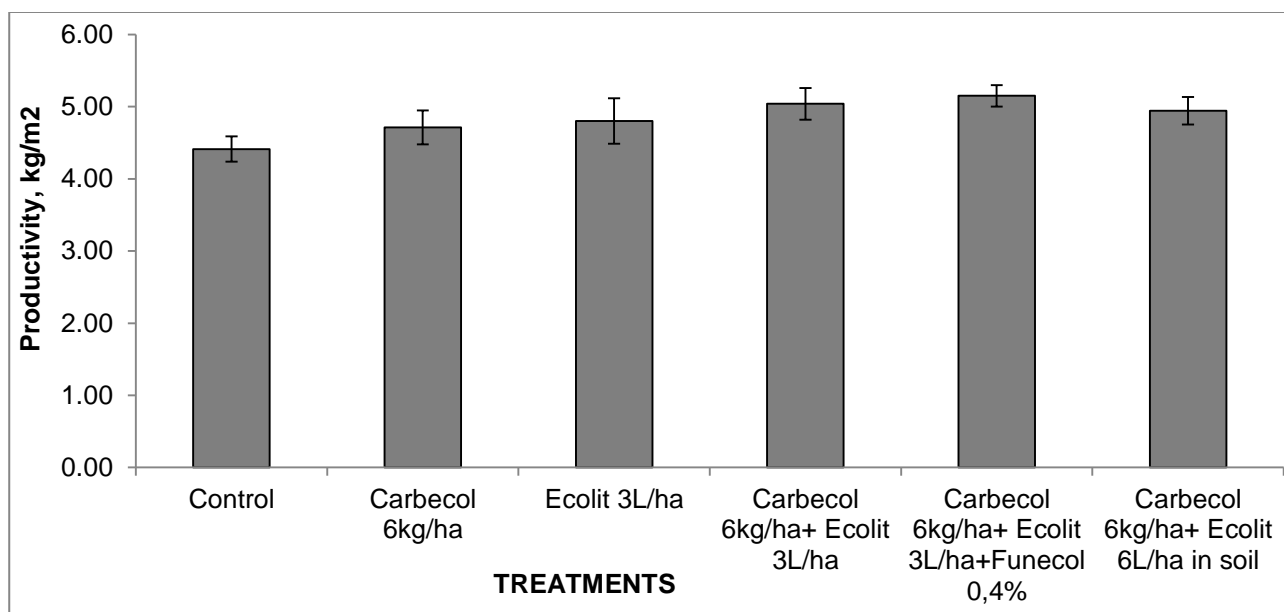


Figure 4. The effect of treatments on the yield of tomato plants. Error bars represent LSD at $p \leq 0.05$ of a mean pooled from three replications.

CONCLUSIONS

Study results suggest that spraying Carbecol, humic substances Ecolit and ecological fungicide Funecol has the potential to control late blight of tomato plants. The integrated use of these products decreased by 35% the disease incidence of late blight in tomato plants.

The combined application of Carbecol, Funecol and biofertilizer Ecolit enhanced the yield of tomato by 15,7%. Thus, the integrated application of plant protection ecological products with humic substances should be an effective biotechnological option for eco-friendly management of late blights disease.

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