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THE EFFECT OF *Trichoderma* AND DIATOMITE ON THE GROWTH AND DEVELOPMENT PARAMETERS OF SOME BELL PEPPER SPECIES

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Abstract

Within the Vegetable Research and Development Station Buzău, aspects were determined and monitored regarding the effectiveness of products based on Trichoderma T85, administered at planting 3 granules/plant, for bell pepper culture and observations regarding the effectiveness of growth and development parameters for bell pepper, Cantemir (variety approved at V.R.D.S. Buzău). Trichoderma viride T85 is a fungal inoculant that was applied to variant V5 - three granules at planting and solid diatomite, which was incorporated into the soil during the vegetation period at V1, V2, V3, V4. The obtained results confirm the data presented in the specialized literature. Treatments with mixed bacterial preparations, with Trichoderma spp. and with solid diatomite can have a beneficial influence on the growth and development of vegetable species cultivated in organic or conventional systems, according to studies carried out over time, both in the country and abroad. This paper evaluates the effectiveness and benefits of using these bio-stimulants.

Key words*: Trichoderma, Diatomite, Capsicum annuum, fertilizer, pepper fruit, biological control.*

INTRODUCTION

Plant diseases must be controlled for sustainable, sustainable agriculture as they are responsible for the destruction of natural resources. In the agricultural and horticultural sector, these diseases cause huge financial losses to farmers. Plant pathogens can cause major production losses and reduce economic yield worldwide. Leaching into groundwater, persistent residues in soil, and accumulation of heavy metals in food chains are some of the main impacts of pesticides on the environment.
Pesticides have become less active against too many crop pests, which has strengthened farmers to increase the quantity or practice additional influential compounds for pest control. In Pakistan, these soil-borne pathogens occur as underground forms, hence chemical control is not practicable unless highly selective fungicides are available in the market. Chemicals cause unfavorable conditions for plants by affecting microbial activity in the soil, in addition to being very expensive (Chaoui et al., 2003).
Fungi of the genus *Trichoderma* are a large group of microorganisms that have a significant contribution to the environment.
Trichoderma has been largely associated with enzyme production, plant protection and growth promotion, but the importance of this genera goes far beyond this, due to the vast amount of possible applications in agriculture and industry in the form of bioremediation, industrial enzymes, food additives, probiotics, (Chowdhury et al., 2000), antibiotics, pigments, biofuel production and battery components (Briassoulis et al., 2007). Diatomite is a sedimentary rock with a high silica content: 23% quartz and clay minerals up to 77% (Dumitras et al., 2017). By mechanical processing of diatomite are obtained particles that reach submicron dimensions creating amorphous powders with specific properties of nanomaterials. (Atiyeh et al., 2000).
Diatomite has a high silicon content, porosity greater than 80% and very little pollutant, friendly to the environment, so it would be an option to be tried in sustainable agriculture.
The main objective of this research was to evaluate the effect of the application of the two products (*Trichoderma viride* T85 and diatomite powder). At the end, the statistical calculation was performed to determine the impact of the treatment on the bell pepper plants, the Cantemir variety.

MATERIALS AND METHODS

The biological material used was bell pepper, Cantemir variety, creation of V.R.D.S (S.C.D.L.) Buzău (Figure 1). The Cantemir pepper crop (*Capsicum annuum*) is a popular species of the *Capsicum* genus that is part of the *Solanaceae* family. This species turns out to be the most cultivated of all 4 known types of peppers and is of interest to farmers. (Catalog with germplasm collection of Vegetable Research Development Station Buzau, July 2013; www.scdlbuzau.ro)

Figure 1. Appearance of Cantemir bell pepper fruits, fruits in different stages of development

V.R.D.S. (S.C.D.L.) Buzău, owns a *Capsicum* species germplasm base composed of over 305 lines in various breeding stages: stable, advancing and segregating. The research undertaken by the Improvement Laboratory at V.R.D.S. (S.C.D.L.) Buzău on obtaining a new variety of bell pepper adapted to the climatic conditions and the ever-increasing demands of farmers, consumers and processors were completed with the obtaining of a variety, Cantemir. The variety was obtained through repeated individual selection, and the main characteristics have a small margin of variability, which corresponds to the specific objectives proposed for improvement.

In the southern part of Romania, more precisely in the Buzău vegetable basin, pepper has found favorable conditions for development and currently occupies a leading place among cultivated vegetables.

Trichoderma induces an increase in plant productivity, due in part to inhibiting the activity of toxic compounds in the root zone and increasing the absorption of nutrients. It also increases the efficiency of nitrogen use, as well as an increase in the solubility of nutrients in the soil.

Trichoderma is a genus of fungi in the Hypocreaceae family, which is present in all soils, where the most common fungi are. Many species of this genus can be characterized as opportunistic avirulent symbionts of plants.

This fungus induces root formation and stimulates colonization with the rhizosphere and other beneficial microorganisms on the roots. It also has the ability to phytoremediation of plant tissues, caused by some residual (persistent) pesticides in the environment.

In the research field of the Vegetable Research and Development Station from Buzău, research was carried out on the influence of the growth and development parameters of bell pepper plants, which were treated with *Trichoderma viride* T85 (Figure 2) (3 granules/plant) which - I administered in the seedling phase and the application of 100 g of diatomite (Figure 3) dust during vegetation.

Figure 2. Granules of *Trichoderma viride* T85

Figure 3. Diatomite dust

The culture technology we applied was the culture technology specific to this species, which was adapted to the climatic conditions of the year 2022, in the conventional experimental field.

The seeds were sown in alveolar pallets of 70 cubes, with a volume of 50 ml, in partially decomposed blond peat with the addition of microelements. The emergence period was in the range of 11-24.04 and the emergence percentage ranged between 94.28-98.57%. (Benitez et al., 2004)

This technology applied in the experimental culture is part of the general technology of pepper cultivation in the open field, adapted to the specifics of the experience.

It is recommended to treat the seeds before sowing. The optimal period for sowing in protected areas takes place in the first decade of January. The planting material was sown in alveolar trays at one of the farms of the Vegetable Research and Development Station Buzău, in order to create optimal conditions for the development of the seedlings.

In order to obtain highly productive, good-quality harvests as early as possible, the quality of the seedlings at planting is essential (Briassoulis et al., 2007).

Sowing pattern: 100 cm between rows and 30-40 cm between plants/row. Density: 55000-65000 pl/ha. Weeding is done post-emergence, then the necessary irrigation and 2-3 mechanical and manual weeding are carried out.

Planting of seedlings was done according to the scheme from experience on variants and repetitions at the optimal time, namely the end of the first decade of May.

The care works applied after planting aimed at the good progress of the culture until its abolition (Cannelas et al., 2002).

The choice of land is made according to the preceding plant. The best precursors are leguminous species (peas, beans).

The experiment was designed by the method of randomized blocks, of 5 variants (V1- Control; V2-with the addition of diatomite in 52.5 g; V3-with the addition of diatomite in 105 g; V4-with the addition of diatomite in 210 g; and V5-*Trichoderma* with addition of 3 granules/plant) and 4 repetitions (R1, P2, R3 and R4), according to the data included in Table 1 and the explanatory legend.

Variant 1, being the control version that was not given any treatment. The amount of *Trichoderma* was established at a dose of 3 granules/cube, at planting, which took place on April 01, 2022.

Table 1. Planting scheme in randomized blocks of bell pepper, Cantemir variety

V5R1	V2R2	V4R3	V1R4
V4R1	V1R2	V3R3	V5R4
V3R1	V5R2	V2R3	V4R4
V2R1	V4R2	V1R3	V3R4
V1R1	V3R2	V5R3	V2R4

Legend: V1 - Control; V2 - diatomit (52.5 g); V3 - diatomit (105 g); V4 - diatomit (210 g); V5 - *Trichoderma* (3 g)

Bell pepper variety with large fruit firmness, which means that the fruits have a good shelf life;

• The variety has a vegetation period between 110-125 days, falling into the semi-early period;

• The variety shows an average tolerance to the attack of pathogens;

• The diameter of the bush varies from 50.3-68.9 cm, the branching is intermediate and has a number of 3-4 main shoots;

• The fruits have a pleasant commercial appearance and can be consumed both in the green stage and at physiological maturity;

• The taste of the fruits is sweet, aromatic, specific;

• The production potential varies from 38.5 t/ha to 62 t/ha, depending on the culture technology applied;

• Pepper fruits have a high content in vitamin C, a medium fruit of 100 g exceeds the daily requirement of ascorbic acid in human nutrition;

• The fruit has 3-4 lobes;

• The persistence of the pedicel fruit is intermediate, and the persistence of the pedicel with stem is also intermediate;

• Dry matter content varies depending on the culture technology from 6-10%;

• The distribution of production is done according to the diameter, which must exceed 70 mm, in this case, over 90% of the fruits fall into the Extra category, and into the I quality, 6.4%;

• The fruits can be consumed both fresh and for industrialization;

The plant is compact and the bush has medium vigor. The fruits are blocky, with a longitudinally furrowed surface with well-marked furrows.

Morphological characterization aspect of biological material of Cantemir pepper variety, is presented in Figure 4.

Figure 4. Bell pepper plant of the Cantemir variety, detail with ripe fruits

Table 2. Pathogenic agents and treatments applied to them

The damage agent: Disease/harmful agents	The name of the product	Dose used
Phytophthora capsici	Dithane, Mavrik	2%; 5%
Spider	Nissorum	1 kg/ha
Thrips	Actara	2 kg/ha
Bacteriosis, Vascular disease	Dithane, Topsin,	2 kg/ha; 1 kg/ha

Phytosanitary treatments (Table 2) were applied throughout the vegetation to improve the culture. In Table 2, the treatment scheme applied for the studies in this research is presented.

The year 2022 was the third warmest year in the history of meteorological measurements in Romania. The average annual temperature was 11.77 degrees Celsius, and the thermal deviation of 1.55 degrees Celsius.

Average temperatures varied (see list below):

- in April between 11 and 14.1°C;
- in May between, 11.2 and 15.3°C;
- in June between 19.5 and 23°C;
- in July between 21.03 and 25°C;
- in August between 22.6 and 23°C;
- in September between 17 and 22°C.

In the months of April and September, the following precipitations were present:

- April - 0.5 l/sqm;
- May -25 l/sqm;
- June - 63 l/sqm;
- July - 81 l/sqm;
- August - 31 l/sqm;
- September -3 l/sqm).

Predominant are the mollisols from the subsidence plain of Buzau, of the clay-iluvial chernozem type, (46.5%) within farms numbers 2 and 5.

In the Buzau meadow (former minor and major bed), in dammed enclosures with an adequate drainage and irrigation system, we find alluvial soils (38.1%) and alluvial protosols (10.0%).

During the vegetation period, the control of the reported diseases and pests was monitored and ensured, namely bacterial spot *(Xanthomonas campestris*), pepper powdery mildew *(Phytophtora capsici*) and pests that affected the crop, namely aphids *(Aphidoidea*), thrips (*Thrips tabaci*) and the red spider common (*Tetranychus urticae)* (Ciofu et al., 2003)

RESULTS AND DISCUSSIONS

The statistical calculation (Figure 5 and Table 3) recorded the following data: in the months of June and July, significant amounts of water were recorded: 63 l/m^2 and 81 l/m^2 and they favored the occurrence of specific pepper diseases (*Phytophthora capsici*) (Figure 6), it is a disease found in the pepper culture in all phenophases, which cause rotting and rotting of pepper fruits. Later, this pathogen was stopped with the treatments applied based on *Trichoderma viride T85* and diatomite, from the table above (Figure 5 and Table 3).

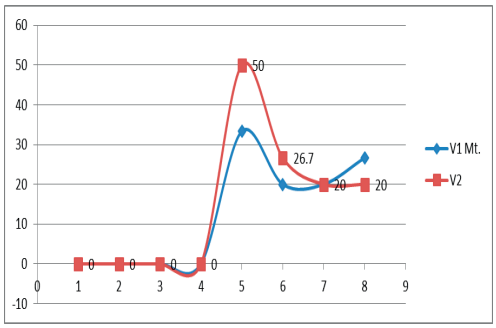

Figure 5. Evolution of growth and development of pepper plants, Cantemir variety

Table 3. Statistical calculation - Number of fruits on bell peppers Cantemir

No	V	No. fruit	P%
1	V1 Mt.	6.23	-
2	V2	8.21	25.1
3	V3	8.01	29.1
4	V4	7.24	56.0
5	V5	8.08	29.1

The administration of *Trichoderma viride T85* had a positive influence on the culture of bell pepper, the Cantemir variety, the one under study, and it is a very friendly solution for the environment, because it is non-polluting according to specialized studies.

Figure 6. Phytophthora capsici in the cultivation of bell peppers

Use of *Trichoderma* in field crops benefits fruit/plant production. The fruits are larger, of superior quality, in the version treated with *Trichoderma,* the results being at the threshold of statistical significance (Table 4).

Table 4. Average root mass at harves

V/R	The plant	Top (g)	Root (g)
V5R3	1	171	33
	2	264	20
	3	152	49
	4	309	39
	5	234	40
	6	141	34
Mediate		211.83	35.83

V/R	The plant	Top (g)	Root (g)
V1R3	1	185	30
	2	162	23
	3	158	28
	4	172	29
	5	133	22
Mediate		162.00	26.40

It has an important nutritional and phytostimulating activity. *Trichoderma* brings an increase in plant productivity, due to the inhibition of the activity of toxic compounds in the root zone and the increase of nutrient absorption. At the same time, it increases the efficiency of nitrogen use, as well as an increase in the solubility of nutrients in the soil.

This fungus induces the formation of roots and stimulates colonization with rhizosphere and other beneficial microorganisms on the roots. It also has the ability to phytorepair plant tissues, caused by some residual (persistent) pesticides in the environment (Chaoui et al., 2003).

The analysis of the root mass shows that variant V5 (treated with *Trichoderma*) was superior, compared to variant V1 (Control).

CONCLUSIONS

The treatments carried out had a positive influence and determined a harmonious development of plants, leaf mass and production in the bell pepper culture, Cantemir variety. At the same time, this fertilization is an environmentally friendly option, because it does not pollute the water table.

I propose and recommend to all farmers, local producers the optimized culture technology for bell pepper, technology that can be applied to other biological creations as well.

In the experimental block with peppers, the ecological status of the epigean fauna in all the experimental variants in which there were diatomite 52.5 g (V2), 105 g (V3) and 210 g

(V4) and the antagonistic fungus *Trichoderma* isolated T85 (3 granules administered to the root at planting) it was good, similar to V1 without administration.

The treatment variants with products based on *Trichoderma* T85 and Diatomite did not show phytotoxicity to bell pepper plants.

Following the treatment with *Trichoderma* administered at planting in Cantemir bell pepper culture, a beneficial effect on fruit quality, development and crop production resulted. At the same time, this fertilization is an environmentally friendly option, because it does not pollute the groundwater.

The effect of the application of diatomaceous earth on the physical and chemical properties of the soil, on the samples taken before and after its application, was analyzed. From a physical point of view, the soil texture was analyzed, finding a clay-sandy texture for all crops. Diatomite was applied in 3 different amounts, and the maximum amount (210 g) was not sufficient to demonstrate significant changes in soil texture. From a chemical point of view, the soil properties meet the requirements of pepper cultivation and have great favorability in the analyzed area. A slightly alkaline pH has been identified and the amount of heavy metals does not exceed the alert threshold. Diatomite applied as an ecological alternative insecticide in the second campaign, did not show significant differences in terms of physical and chemical properties of the soil.

Following the experiences within the Vegetable Research and Development Station Buzău, it was found that diatomaceous earth can also be used to protect plants, to fight diseases and pests, because it offers protection against them.

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