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THE INFLUENCE OF SOIL-BORNE PATHOGENS ON PLANT EMERGENCE IN DIFFERENT VEGETABLE SPECIES DEPENDING ON SOIL SAMPLE AND PREVIOUS CROP

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ABSTRACT

The fungi Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani and Fusarium spp. are some of the most destructive soil-borne pathogens, causing significant damage to a wide range of vegetable species. These species were identified in 7 soil samples from different areas of Romania. The "trap plants" method was used to detect the presence of soil-borne pathogens. Seeds from 4 vegetable species (tomatoes, peppers, eggplants and melons) were sown in the tested soil samples. Every 2 days, the emergence dynamics and the appearance and evolution of the attack of the mentioned pathogens were monitored and the frequency of rotten seeds and "fallen seedlings" were calculated. Tomatoes, peppers, eggplants and melons plants emerged best in soil samples 6 (Dolj County) where the predecessor plant was cauliflower, with an average of 94 %, 3 (Neamț County) also with cauliflower as the predecessor plant, with an average of 74% and sample 5 (Bucharest / Ilfov County) with eggplant as the predecessor plant with an average of 72 %.

INTRODUCTION

Currently, there are numerous fungal pathogens that infect vegetable species of great economic importance such as tomatoes, peppers, eggplants or cucumbers. They infect the root system, the base of the stem, preventing the absorption of water, nutrients and salts from the rhizosphere (Mannai et al. 2018).

The soil-borne pathogens *Pythium debaryanum*, *Phytophthora parasitica*, *Rhizoctonia solani* and *Fusarium* spp. cause seed rot and "damping-off" on seedlings.

Vegetable growers, in order to control these soil-borne pathogens, rely predominantly on the application of various synthetic fungicides which, in addition to providing unsatisfactory control, exhibit various side effects, including hazards to human health and environmental contamination (Harris et al. 2001).

"Damping-off", caused by *Pythium debaryanum*, is one of the most widespread and damaging diseases that occurs in seedlings for vegetable crops (Costache et al. 2023). The attack of the fungus *Pythium debaryanum* has an acute character, a tomato plant can be affected, depending on temperature and humidity, in 12-24 hours. In seedling greenhouses, most of the plants can die in a few days. At a humidity of 60 % in the soil and at a temperature of 16 °C, the pathogen is very virulent (Baicu et al. 1996).

Phytophthora parasitica also attacks seedlings under conditions of temperatures between 20 and 25 °C and 100 % humidity (water film).

Rhizoctonia solani is present in the soil as mycelium and sclerotia. It is a polyphagous pathogen (over 25 known hosts), able of attacking and surviving on plant debris from different plant species. It can develop in humid conditions, heavy soil or lighter, dry soil, at temperatures between 15° and 26 °C (Blancard 1997; Șovărel et al. 2022).

Fusarium spp. survives very long periods of time in the soil and on plant debris due to very resistant spores-chlamydospores. *Fusarium* spp. colonizes the soil at great depth (over 80 cm). Transmission is through soil particles, water, agricultural tools, plant debris and insects. The optimal development temperature is 28°C. It prefers acidic and sandy soils. Plants are particularly susceptible to this pathogen when they are deficient in nitrogen, phosphorus and calcium (Blancard 1997; Șovărel et al. 2022).

This study, conducted under laboratory conditions, aimed to evaluate the frequency of attack of 4 very dangerous soil-borne pathogens, present in 7 different soil samples, taking into account the preceding crops, on the vegetable species tomatoes, peppers, eggplants and melons.

MATERIAL AND METHODS

To detect the presence of soil-borne pathogens, 7 soil samples from different areas of Romania were used: sample 1, from Cluj County, which had root crops (carrots and beetroot) as previous crops; sample 2, from Iași County, which had pepper as previous crop; sample 3, from Neamț County, which had cauliflower as previous crop; sample 4, from Galați County, which had white cabbage as previous crop; sample 5, from Bucharest/Ilfov County, which had eggplants as previous crop; sample 6, from Dolj County, which had cauliflower as previous crop and sample 7, from Arad County, with tomato as previous crop.

In the 7 soil samples received for phytopathological analysis, the presence of the soil-borne pathogens *Pythium debaryanum, Phytophthora parasitica* and *Rhizoctonia solani*, which cause „damping-off", was detected. To detect the presence of soil-borne pathogens, the “trap plants” method was used.

The experiment was carried out during the period 17.12.2020-16.01.2021, in the laboratory condition, where the average values of the minimum, medium and maximum temperatures were 20.8 °C, 21.6 °C and 23.8 °C, respectively. The average values of the minimum, medium and maximum relative humidity were 50.0 %, 56.9% and 60.4 %, respectively.

Plastic trays measuring 25 x 20 x 5 cm high were used in which the soil samples were placed. On the same day, 100 seeds (10 rows of 10 seeds each) of tomato (Pontica variety), pepper (Asteroid variety), eggplant (Luiza variety) and melon (Festiv variety) were sown in the trays thus prepared. After sowing, the seeds were covered with 0.5 cm of soil (from the same soil sample) and watered with the same amount of water.

Next, every 2 days, the dynamics of emergence in the 4 vegetable species (tomatoes, peppers, eggplants, melons) and the appearance and evolution of the attack of the mentioned soil-borne pathogens (frequency of rotten seeds, frequency of "fallen plants") were monitored.

In the 7 soil samples received for phytopathological analysis, the presence of the soil fungi *Pythium debaryanum, Phytophthora parasitica* and *Rhizoctonia solani*, which cause "plants fall", was detected.

During the experiment, the temperature and atmospheric humidity in the laboratory where it was located were permanently recorded (using a CEM DT - 172 thermohygrometer).

RESULTS AND DISCUSSIONS

The observations made during this study were made for each soil sample separately. **In sample 1** (Cluj County) where the previous plants were carrot and beetroot, the highest percentage of emerged plants was recorded for eggplant (81 %) and the highest percentage of rotten seeds for pepper (91 %) and melon (70 %) (table 1).

In the case of the fungus *Pythium debaryanum* the percentage of "fallen plants" varied between 1 % (peppers) and 19 % (melons). The attack of *Phytophthora parasitica* was manifested only in eggplant plants (1 %). The frequency of *Rhizoctonia solani* attack varied between 2% (eggplants) and 6 % (melons). The highest total number of "fallen plants" was recorded in melons (25 %) and eggplants (7 %).

Table 1

Frequency of attack by soil-borne pathogens on the 4 vegetable species taken into study (sample 1, Cluj County)

Sample 1 (Cluj County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - carrot, beetroott	Tomatoes	36	64	0	0	0	0
	Peppers	9	91	1	0	0	1
	Eggplants	81	19	4	1	2	7
	Melons	30	70	19	0	6	25

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 2 (Iași County), previous crop – peppers, was recorded the highest percentage of emerged plants for eggplants (96 %) and tomatoes (87 %). The most rotten seeds were recorded for peppers (56 %) and melons (53%) (table 2).

In the case of the fungus *Pythium debaryanum*, the number of "fallen plants" ranged between 1 % (tomatoes) and 3 % (melons). The attack of *Phytophthora parasitica* was recorded only for pepper plants (1 %). The frequency of attack by the fungus *Rhizoctonia solani* varied between 1 % (eggplants) and 2 % (melons).

The highest total number of "fallen plants" was recorded in melons (5 %), peppers and eggplants (3 %).

Table 2

Frequency of attack by soil-borne pathogens on the 4 vegetable species taken into study (sample 2, Iași County)

Sample2 (Iași County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - pepper	Tomatoes	87	13	1	0	0	1
	Peppers	44	56	2	1	0	3
	Eggplants	96	4	2	0	1	3
	Melons	47	53	3	0	2	5

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 3 (Neamț County), previous crop – cauliflower.

The highest number of emerged plants was recorded for tomatoes (98 %), eggplants (85 %) and peppers (81 %) (table 3).

The most rotten seeds were recorded for melons (66 %), peppers (19 %) and eggplants (16 %).

In the case of the fungus *Pythium debaryanum*, the number of “fallen plants” varied between 7 % (tomatoes, eggplants) and 25 % (melons).

The attack of *Phytophthora parasitica* was manifested in tomato plants (5 %), eggplants (3 %) and peppers (2 %). The frequency of *Rhizoctonia solani* attack ranged from 3 % (peppers, melons) to 5 % (eggplants). The highest total number of "fallen plants" was recorded in melons (28 %), eggplants (15 %) and peppers (13 %).

Table 3

Frequency of attack by soil-borne pathogens
on the 4 vegetable species taken into study (sample 3, Neamț County)

Sample 3 (Neamț County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - cauliflower	Tomatoes	98	2	7	5	0	12
	Peppers	81	19	8	2	3	13
	Eggplants	85	15	7	3	5	15
	Melons	34	66	25	0	3	28

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 4 (Galați County), previous crop – cabbage.

The highest number of emerged plants was recorded for eggplants (100 %) and tomatoes (65 %) (table 4).

The most rotten seeds were recorded for melons (78 %) and peppers (49 %). In the case of the fungus *Pythium debryanum*, the number of “fallen plants” varied between 1 % (tomatoes, eggplants) and 2 % (melons).

The attack of the fungus *Phytophthora parasitica* was not present in the case of sample 4.

The attack of *Rhizoctonia solani* was recorded only for eggplant seedlings (1 %) and melons (1 %). The highest total number of "fallen plants" was observed in melons (3 %) and eggplants (2 %).

Table 4

Frequency of attack by soil-borne pathogens on the 4 vegetable species taken into study (sample 4, Galați County)

	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - cabbage	Tomatoes	65	35	1	0	0	1
	Peppers	51	49	0	0	0	0
	Eggplants	100	0	1	0	1	2
	Melons	22	78	2	0	1	3

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 5 (Bucharest City/Ilfov County), previous crop – eggplants.

The highest number of emerged plants was recorded for tomatoes (100 %), peppers (89 %) and melons (70 %) (table 5).

The most rotten seeds were recorded for eggplants (71 %) and melons (30 %).

The fungus *Pythium debaryanum* attacked only tomato plants (2 %) and melons (2 %). The attack of the fungus *Phytophthora parasitica* was present only in tomatoes (1 %). In the case of sample 5, the attack of *Rhizoctonia solani* was not present in any of the species taken into study. The total number of "fallen plants" was relatively low (2 % in melons and 3 % in tomatoes).

Table 5

Frequency of attack by soil-borne pathogens on the 4 vegetable species taken into study (sample 5, The city of Bucharest/Ilfov County)

Sample 5 (Bucharest City/Ilfov County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - eggplants	Tomatoes	100	0	2	1	0	3
	Peppers	89	11	0	0	0	0
	Eggplants	29	71	0	0	0	0
	Melons	70	30	2	0	0	2

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 6 (Dolj County), previous crop – cauliflower.

The percentage of emerged plants was good in all 4 species: 100 % in tomatoes and eggplants, 92 % in peppers and 84 % in melons (table 6).

The most rotten seeds were recorded in melons (16 %). The attack of the fungus *Pythium debaryanum* varied between 1 % (peppers, eggplants, melons) and 3 % (tomatoes). The attack of *Phytophthora parasitica* was only manifested in tomatoes (1 %).

The attack of *Rhizoctonia solani* was only recorded in tomatoes (1 %) and peppers (1 %). The highest total number of "fallen plants" was found in tomatoes (5 %).

Table 6

Frequency of attack by soil-borne pathogens on the 4 vegetable species taken into study (sample 6, Dolj County)

Sample 6 (Dolj County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - cauliflower	Tomatoes	100	0	3	1	1	5
	Peppers	92	8	1	0	1	2
	Eggplants	100	0	1	0	0	1
	Melons	84	16	1	0	0	1

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

Sample 7 (Arad County), previous crop – tomatoes stands out the highest number of emerged plants was recorded for peppers (65 %) and eggplants (58 %) (table 7) and the most rotten seeds for melons (96 %) and tomatoes (75 %).

The attack of the fungus *Pythium debaryanum* varied between 1% (tomatoes, peppers) and 4 % (eggplants). The frequency of attack by *Phytophthora parasitica* varied between 1 % (tomatoes, peppers) and 3 % (eggplants).

In the case of sample 7, the attack by *Rhizoctonia solani* was not present in any of the species. The highest total number of "fallen plants" was recorded in eggplants (7 %).

Table 7

Frequency of attack by soil-borne pathogens
on the 4 vegetable species taken into study (sample 7, Arad County)

Sample 7 (Arad County)	Species	No. emerged plants	Rotten seeds*)	Sick plants (fallen plants)			
				*P. d.**)	*Ph. p.**)	*Rh. s.**)	TOTAL
Previous crop - tomatoes	Tomatoes	25	75	1	1	0	2
	Peppers	65	35	1	1	0	2
	Eggplants	58	42	4	3	0	7
	Melons	4	96	0	0	0	0

*) complex of soil pathogens (*Pythium debaryanum, Phytophthora parasitica, Rhizoctonia solani, Fusarium* spp.)

CONCLUSIONS

Based on the general results of the study, it is concluded that: tomatoes, peppers, eggplants and melons plants emerged best in soil samples 6 (Dolj County, previous plant – cauliflower), where the average number of emerged plants was 94 %, 3 (Neamț County, previous plant – cauliflower), where the average was 74 % and 5 (Bucharest/Ilfov County, with eggplant as previous plant) where the average was 72 %.

The lowest number of rotten seeds was recorded in samples 6 (Dolj County, cauliflower as a previous with 8 %), 3 (Neamț County, cauliflower as a previous with 25 %) and 5 (Bucharest/Ilfov County, with eggplants as a previous with 28 %).

The lowest number of "fallen plants" was observed in samples 4 (Galați County, cabbage as a previous with 1 %), 5 (Bucharest/Ilfov County, eggplants as a previous with 1 %) and 6 (Dolj County, cauliflower as a previous with 2 %). The influence of the precursor plant, in this case the cauliflower species that somehow inhibits the development of soil fungi and their attack on the seeds during the germination process and damping-off .

However, the field evaluation of pathogens and their interaction with the species of care for the precursor plants constitute the future prospects of this study.

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