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EFFECT OF CASING SOIL TYPE AND HUMIDITY ON GINGER BLOTCH DEVELOPMENT IN MUSHROOM CULTIVATION

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ABSTRACT

Pseudomonas 'gingeri' is the cause of ginger blotch disease of the white button mushrooms (*Agaricus bisporus*). The occurrence of the disease in the cultivation results in the appearance of ginger discolouration on the mushroom caps. Currently, there is no effective method of protecting the mushroom from bacterial infection. Therefore, the selection of appropriate substrates for mushroom cultivation and environmental cultivation conditions, such as relative humidity, are of high importance in controlling the disease. The aim of the study was to evaluate the effect, on the development of ginger blotch, of two types of peat-based casing soil, with different water holding capacity, and two different air relative humidities inside the mushroom growing chamber. The cultivation trials were artificially infected with two *P. 'gingeri'* isolates, at two different inoculation doses. The blotch disease incidence on the heavy casing soil, which characterised lower water holding capacity, was significantly higher than on the medium one, regardless of the number of bacterial cells and bacterial isolate. The results also demonstrated a significant correlation between higher levels of air humidity (90% in the cultivation chamber) and the ginger blotch prevalence. It was determined that the type of casing soil and the level of air humidity in the mushroom growing room are of crucial importance for efficient mushroom cultivation. These factors can also play a significant role in preventing against bacterial disease development.

Keywords: *Agaricus bisporus*, bacterial disease, crop conditions, cultivated mushrooms, *Pseudomonas 'gingeri'*

INTRODUCTION

The white button mushroom, *Agaricus bisporus*, is the most commonly cultivated mushroom around the world. For a many years, Poland has been the largest producer of mushrooms in Europe, as well as the largest global exporter of fresh mushrooms [Siwulski et al. 2022]. The cultivation of mushrooms is undertaken in conditions characterised by high levels of air humidity and temperature. The use of a limited range of plant protection products in mushroom cultivation increases the risk of bacterial infections [Gea et al. 2021]. The process of cultivating white button mushrooms involves the use of two substrates, i.e. compost colonised with mycelium and the layer of peat casing. This is essential to stimulate and enhance the development of mushroom sporophores [Noble et al. 2003, Pardo et al. 2002]. Peat casing soils that are available for use in the cultivation of mushrooms vary in their physicochemical properties, particularly with regard to their capacity for water retention, maximum humidity, pH level and ash content. The selection of an appropriate type of peat casing is as important as the high quality of the compost and the

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maintenance of the cultivation conditions [Dias et al. 2021, Noble et al. 2024].

Both media used in the cultivation of mushrooms are colonized by a broad range of bacteria, archaea and fungi. Among identified bacteria, some members of the genus *Pseudomonas* appear to be associated with the development of *A. bisporus*, i.e. *P. putida* [McGee 2018], but other with bacterial disease incidence, i.e. *P. 'gingeri'* or *P. tolaasii* [Paine 1919, Braat et al. 2022, Fletcher and Gaze 2008]. Bacterial diseases are responsible for discolouration and deformation of the mushroom caps. This has resulted in significant economic losses caused by reduced crop yield (i.e. pinhead death), deterioration in mushroom quality, and a reduction in shelf life post-harvest [Sapers et al. 2001].

Pseudomonas 'gingeri' was first reported to cause yellow-brown spots on *A. bisporus* in the UK in 1982 [Wong et al. 1982]. These blotch symptoms are only superficial and do not result in the formation of depressions on the caps. However, in the case of high severity of the disease, the fruiting bodies are susceptible to damage, with spots developing on the edges of the caps and eventually covering their entire surface [Soler-Rivas et al. 1999]. Gandy [1967] demonstrated a direct correlation between the development of the bacterial disease and the concentration of pathogen cells in the casing soil. Conversely, the findings reported by Taparia et al. [2021a] suggest that the symptoms exhibited by the disease may not be exclusively attributable to the presence of bacteria in the casing soil.

Therefore, it is challenging to establish a clear reason for the occurrence of bacterial disease in a crop. It appears that the peat casing may be a primary source of bacteria, but it does not appear to be the only source of infection. The transmission of bacteria occurs through exposure to contaminated environments, such as infected mushroom farms, equipment or infected fruiting bodies, through direct contact with workers [Wong and Preece 1982, Mamoun et al. 1999]. The literature suggests that a small number of bacteria in the casing soil can cause disease symptoms, however, introducing a particular number of cells into the casing soil does not always cause blotch symptoms on the mushrooms. Consequently, the occurrence of bacterial infection is largely caused by the crop conditions in the growing mushroom chamber, methods of cultivation, mushroom strain or other factors, such as the type of casing soil used in the cultivation [Moquet et al. 1996, Soler-Rivas et al. 1999, Szumigaj-Tarnowska and Uliński 2022].

The aim of the present study was to determine the effect of two types of peat-based casing soil and air humidity on the severity of ginger blotch symptoms caused by two *P. 'gingeri'* isolates, at two different inoculation doses.

MATERIAL AND METHODS

Bacterial isolates

In the present study, two isolates of *P. 'gingeri'* bacteria, refereed to MO and B7, were selected for experimental analysis. Isolates were obtained from mushrooms exhibiting symptoms of ginger blotch, originating from Polish mushroom farms. The species of the isolates was determined by conducting a comprehensive biochemical, molecular, and pathogenicity test. The identification process involved a detailed macroscopic and microscopic evaluation, in addition to biochemical tests, including API 20NE tests. These tests involved: Gram staining of bacteria [Beveridge 2001], the ability to produce fluorescent pigment [King et al. 1954] and the type of glucose metabolism [Hugh and Leifson 1953]. In addition, the activity of oxidase, catalase, the ability of the bacteria to hydrolyze gelatin and starch, to decompose nitrates, and to asimilate carbon from citrate [Lelliott et al. 1966] were examined. According to the key to bacterial identification [Buchanan and Gibbons 1974], the isolates were classified into the appropriate genus. In the final stage of identification, commercial API 20NE tests were performed, and a biotest of pathogenicity on mushroom tissue was used to confirm the pathogenicity of the isolates [Taparia et al. 2021b]. The experiments used 24-hour bacterial cultures activated at 24°C in Nutrient Broth liquid medium.

Cropping trials

The study involved a pair of distinct experiments. The initial experiment examined the impact of two types of peat casing, while the second study focused on the effect of relative air humidity, on the development of ginger blotch. The experiments were carried

out within controlled conditions in the growing house chambers in 22 cm diameter pots (surface area was 0.04 m^2) filled with 1.7 kg of phase III compost fully colonized with the *A. bisporus* strain Triple X (Sylvan).

The surface of the compost was then covered with a 4 cm peat casing layer. Two types of peat casing soil (hereafter refereed as heavy and medium casing) with different physicochemical properties (Table 1) were obtained from a local producer of peat casing for mushroom cultivation, which was located in Skierniewice, Poland. Casing soils had been prepared especially for the experimental research. The conditions in the mushroom growing chamber while incubation phase were maintained as in routine production, i.e., the temperature was 23–24°C, carbon dioxide concentration was 3000 mg L^{-1}, and relative humidity was 95%. After seven days, when the mycelium reached the surface of the casing, the temperature was lowered to 18°C, and the carbon dioxide concentration was reduced to 1000–1200 mg L^{-1}. Then the casing surface was sprayed with 10 ml of bacterial cells suspension, with different inoculum levels being used to achieve a population density of either 2.6×10^8 or 2.6×10^7 cfu m^{-2} of casing. Control trials were not infected by *P. 'gingeri'* cells [Wong and Preece 1982]. The crop was watered for four days at 10 L m^{-2} before the first flush and 8 L m^{-2} before the second flush. The amount of water used was calculated based on the amount of substrate per m^2 and its moisture level. It was determined that the optimal water dosage is approximately 20 L m^{-2}, assuming a substrate density of 90 kg m^{-2} and a humidity level of 64%. During the growth of the fruiting bodies and harvesting, the temperature in the growing chamber was maintained at 17.8 ±1.0°C, the carbon dioxide concentration was 1100–1200 mg L^{-1} and the relative humidity was 88%. The temperature of the substrate was 1.0–1.5°C higher than the air temperature, and no overheating of the mushroom substrate and peat casing was observed. The use of different peat casings did not affect the temperature in the casing layer.

In the study of the effect of relative humidity on the development of ginger blotch, a mixed peat was used as casing soil. Following the application of the peat casing, the crop was infected with a bacterial suspension, using the same methodology as in the experiment with different casing soils. During the growth of the fruiting bodies and harvesting, the temperature in the growing chamber was regulated to 17.8 ±1.0°C, the carbon dioxide concentration to 1100–1200 mg L^{-1} and the relative humidity to 86% or 90%, depending on the variant tested. The development of ginger blotch was assessed based on the yield of healthy and diseased mushrooms. The disease severity index (DSI) in the first and second flush of the mushroom was determined as the ratio of the yield of infected fruiting bodies to the total yield obtained in a given combination according

Table 1. The physicochemical properties of the peat casing soils used in the experiments

Type of peat casing soil	Measured parameters					
	bulk density (g mL^{-1})	water capacity** (%)	maximum humidity*** (%)	dry bulk density (g mL^{-1})	pH	ash (%)
Heavy peat casing soil with a predominance of low peat*	1.186	88.1	74.3	0.304	7.7	71.8
Medium peat casing soil from a mixture of low and high peat	1.09	92.2	84.8	0.185	7.6	47.3

* Peat soils are commonly used as a casing layer: low peat is characterized by a lower organic matter content compared to high peat and a lower water retention capacity; high peat contains a higher percentage of organic matter and is more fibrous. Its ability to hold water helps maintain a moisture environment for mushroom growth.

** water capacity (%) – ability of casing to absorb, retain and gradually release water to establish an optimal environment for mushroom growth; it plays a crucial role in maintaining humidity, aeration and microbial activity for appropriate mushroom growth

*** maximum humidity (%) – maximum water content that the casing can reach before becoming oversaturated and negatively affecting mushroom growth

Table 2. Average yield of healthy and infected mushrooms according to the number of *Pseudomonas 'gingeri'* cells and peat casing type over two flushes (1st experiment)

Number of bacteria cells (cfu m^{-2})		1st flush		2nd flush	
		type of peat casing soil			
		heavy	medium	heavy	medium
Yield of healthy mushrooms (kg m^{-2})					
Control (non-inoculated)		23.25 ±3.62 Aa	22.29 ±4.29 Aa	9.25 ±1.43 Aa	10.87 ±1.25 Aa
MO	2.6×10^8	7.45 ±0.79 Bc	13.56 ±2.24 Ac	4.73 ±1.22 Bb	7.78 ±2.61 Ab
	2.6×10^7	8.35 ±1.13 Bbc	19.32 ±2.51 Ab	6.06 ±2.15 Bb	8.35 ±2.33 Ab
B7	2.6×10^8	11.73 ±2.32 Bb	14.92 ±2.83 Ac	6.68 ±1.38 Ab	7.51 ±1.52 Ab
	2.6×10^7	10.11 ±1.73 Bbc	19.60 ±3.32 Ab	9.65 ±2.02 Aa	7.80 ±2.13 Ab
Mean		12.18 ±6.40 B	17.94 ±3.60 A	7.27 ±2.11 B	8.46 ±1.38 A
Yield of infected mushrooms (kg m^{-2})					
Control (non-inoculated)		0.0 ±0.0 Ab	0.0 ±0.0 Ac	0.0 ±0.0 Ab	0.0 ±0.0 Ab
MO	2.6×10^8	14.38 ±2.03 Aa	7.71 ±2.32 Ba	6.24 ±1.72 Aa	4.23 ±1.83 Aa
	2.6×10^7	15.38 ±3.23 Aa	2.93 ±0.85 Bb	2.21 ±0.93 Ab	1.11 ±0.86 Ab
B7	2.6×10^8	12.82 ±2.75 Aa	5.81 ±1.05 Bab	2.69 ±1.01 Ab	1.75 ±0.96 Ab
	2.6×10^7	13.18 ±3.28 Aa	3.27 ±1.28 Bb	2.83 ±1.31 Ab	1.05 ±0.69 Bb
Mean		11.15 ±6.32 A	3.94 ±2.94 B	2.79 ±2.24 A	1.63 ±1.58 B

Values are means of four samples ±standard deviation (SD); means in the same row, for each flush, with the same capital letter do not differ statistically ($P < 0.05$, Newman-Keuls test); means in the same column, within the particular yield, with the same lowercase letter do not differ statistically ($P < 0.05$, Newman-Keuls test)

to the formula: NC (%) = (Poc / Pc) × 100%, where: Poc – yield of diseased fruiting bodies, Pc – total yield (yield of healthy and diseased fruiting bodies).

Statistical methods

The experiments were conducted twice, with four replicates each. Each experiment had three distinct factors: the first factor was the type of peat casing soil or air humidity, the second was the bacterial isolate, and the third was the bacterial inoculum. The statistical analysis was conducted using the analysis of variance, and the differences between the means were compared according to the Newman-Keuls test at a significance level of $P < 0.05$. To evaluate the relationship between the disease severity and the type of peat casing soil or relative humidity, a t-Student test was used with a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Effect of different type of peat casing soil

The present study examined the prevalence of ginger blotch disease in relation to two different types of casing soils. The peat casing soils used differed in the following parameters: bulk density, water capacity and maximum humidity. It was found that the physical and chemical characteristics of the casing soil can determine the growth of mushroom mycelia and yield, or can even influence the susceptibility of mushrooms to infection by pathogens and the severity of the disease [Gea et al. 2013].

In the first experiment (Table 2) the infection of the crop by *P. 'gingeri'* caused a significant reduction in the yield of healthy mushrooms in the first flush on heavy casing soil, with the average yield of

Table 3. Average yield of healthy and infected mushrooms according to the number of *Pseudomonas 'gingeri'* cells and peat casing type over two flushes (2nd experiment)

Number of bacteria cells (cfu m^{-2})		Yield of healthy mushrooms (kg m^{-2})			
		1st flush		2nd flush	
		type of peat casing soil			
		heavy	medium	heavy	medium
Control (non-inoculated)		23.31 ±4.21 Aa	24.65 ±3.52 Aa	16.82 ±1.95 Aa	16.53 ±1.64 Aa
MO	2.6×10^8	20.18 ±4.15 Aab	20.60 ±4.26 Aa	9.89 ±1.31 Abc	11.33 ±2.50 Ab
	2.6×10^7	21.50 ±4.39 Aa	19.90 ±3.87 Aab	12.73 ±2.58 Ab	13.08 ±3.43 Aab
B7	2.6×10^8	18.19 ±3.36 Ab	16.95 ±3.74 Ab	8.08 ±2.25 Bc	13.48 ±3.27 Aab
	2.6×10^7	21.76 ±4.29 Aa	19.87 ±4.16 Aab	7.89 ±1.30 Bc	12.58 ±2.38 Aab
Mean		20.99 ±1.92 A	20.39 ±2.76 A	11.08 ±3.75 B	13.40 ±1.93 A
		Yield of infected mushrooms (kg m^{-2})			
Control (non-inoculated)		0.0 ±0.0 Ab	0.0 ±0.0 Ac	0.0 ±0.0 Ac	0.0 ±0.0 Ab
MO	2.6×10^8	5.81 ±1.38 Aa	3.35 ±3.39 Ab	2.26 ±1.12 Ab	1.88 ±1.31 Ab
	2.6×10^7	1.35 ±0.85 Ab	2.15 ±1.26 Abc	1.02 ±0.93 Abc	0.0 ±0.0 Ab
B7	2.6×10^8	8.04 ±1.52 Aa	6.67 ±2.35 Aa	6.95 ±2.26 Aa	5.08 ±2.13 Aa
	2.6×10^7	0.92 ±0.55 Ab	1.65 ±1.03 Abc	4.93 ±1.73 Aa	2.52 ±1.28 Bb
Mean		3.22 ±3.50 A	2.76 ±2.47 A	3.03 ±2.81 A	1.90 ±2.10 B

Explanations – see Table 2.

12.18 kg m^{-2}. The average yield of healthy fruiting bodies (17.94 kg m^{-2}) on the medium casing soil was significantly higher than the yield on the heavy one. A similar relationship was obtained in the second flush, as the average yield of healthy sporophores on medium casing soil was 8.46 kg m^{-2} and was significantly higher than on heavy casing. Furthermore, in the first and second flush, the average yield of infected mushrooms on the heavy casing soil was significantly higher than on the medium.

In the second experiment the yield of healthy and diseased mushrooms in the first flush showed no significant difference between the casing soils that were tested (Table 3). In the second flush, a significantly higher average yield of healthy sporophores was found on the medium casing soil, which amounted to 13.40 kg m^{-2}, as opposed to the heavy one. The yield of infected mushrooms was significantly lower on the medium casing than on the heavy one.

According to Navarro et al. [2021] the appropriate physicochemical parameter of casing soil used in the mushroom cultivation has a great influence on the yield. The casing soils used in the study differed in their water holding capacity. In the case of the use of casing soil with a lower water holding capacity (i.e. heavy casing), the ability of the casing soil to absorb water is reduced. Consequently, after watering the crop, the casing layer can lead to the development of moist conditions, resulting in an increase in moisture within the casing and difficulty in evaporation of moisture from the mushroom surface. Such conditions are conducive to the development of bacterial diseases [Lomax 2007, Navarro et al. 2018, Navarro et al. 2021]. Taparia et al. [2021b] also demonstrated that the prevalence of ginger blotch varied according to the type of casing soil. Gea et al. [2013] observed that he incidence of dry bubble disease, caused by the fungus *Lecanicillium fungicola*, was more frequent on casing

Table 4. Statistical analysis of the relationship between the ginger blotch severity (%) and the type of peat casing soils in two flushes

Parameter	1st flush		2nd flush	
	heavy casing	medium casing	heavy casing	medium casing
Mean	38.69 A	18.79 B	34.34 A	14.74 B
Median	41.53	14.47	28.31	13.03
df	7	–	7	–
t Stat	4.946	–	12.782	–
Variation	406.67	–	59.067	–
SE	4.023	–	1.533	–
t-test ($p = 0.05$)	1.8945	–	1.8945	–

Means in the same rows, for particular flushes, with the same letter do not differ statistically ($P < 0.05$, *t*-Student test, n = 8).

soil, which was characterized by a lower water capacity, when compared to mineral soil with *Sphagnum* peat. Similar results were obtained by Carrasco et al. [2015] and Ślusarski et al. [2012], who studied the effect of different casing soils on the development of *Cladobotryum dendroides* in the mushroom cultivation. The casing layer with the lowest water holding capacity favored the development of the disease.

Regardless of the number of bacterial cells and bacterial isolate, an analysis of the relationship between the severity of ginger blotch (expressed as a percentage of the yield of diseased mushrooms) and the type of peat casing soils in two flushes is presented in Table 4. The results of analysis have demonstrated that in the first and the second flush the degree of disease incidence on the heavy casing was significantly higher than on the medium one. Furthermore, as shown in Figure 1, the values of bacterial blotch intensity obtained on the heavy casing were more dispersed than those obtained on the medium. A further analysis of the results revealed that on the heavy casing a greater frequency of disease incidence values were above

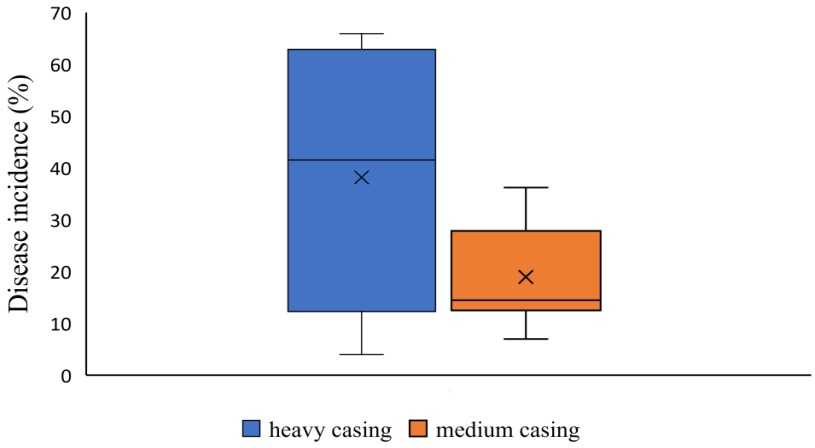

Fig. 1. Ginger blotch disease severity (%) according to the type of peat casing in the first flush in the mushroom cultivation infected with *P. 'gingeri'* cells (n = 8)

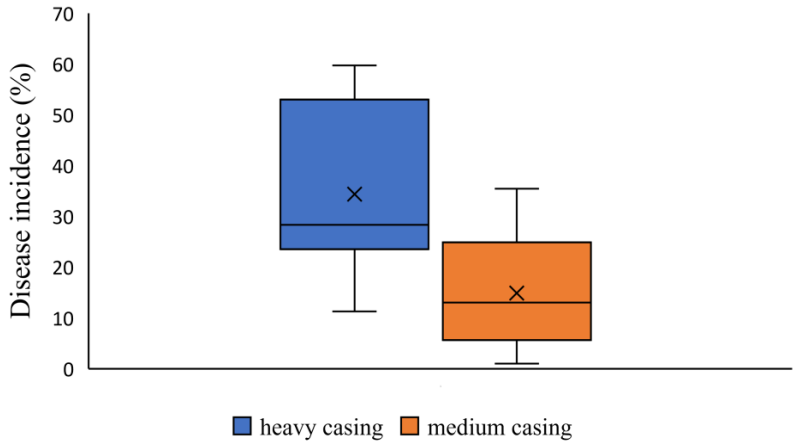

Fig. 2. Ginger blotch disease severity (%) according to the type of peat casing in the second flush in the mushroom cultivation infected with *P. 'gingeri'* cells (n = 8)

41.53%, while on the medium casing higher proportion of values were below 14.47% (Fig. 1). In the second flush on the heavy casing the disease symptom intensity levels were also higher than on the medium casing. What is more, the results indicated that on the heavy casing more values for disease incidence were below 28.31%, while on the medium casing the values were evenly spread around the median of 13.03% (Fig. 2).

Effect of relative humidity on bacterial blotch

Literature data suggest that the maintenance of adequate cultivation conditions can reduce the incidence of bacterial diseases [Mamoun et al. 1999, Navarro et al. 2018]. Moquet et al. [1996] found that the susceptibility of mushrooms to blotch disease is dependent on both the toxin secreted by the bacteria and other factors. The studies aimed to determine the effect of humidity on the development of bacterial disease. Analysis of the yield of healthy fruiting bodies in the control trials revealed no statistically significant differences between the humidity levels (Table 5). However, the infection by *P. 'gingeri'* isolates resulted in significant reduction in the yield of healthy fruiting bodies in the studied crops. The average yield of healthy mushrooms (16.17 kg m^{-2}) at 90% humidity was significantly lower than the yield (18.60 kg m^{-2}) at 86% humidity. In parallel the yield of infected fruiting bodies was found to be significantly higher at 90% humidity, reaching 6.33 kg m^{-2}, in contrast to the yield calculated at 3.24 kg m^{-2} at 86% humidity. Statistical analysis confirmed the interaction of two factors (number of bacterial cells and humidity) on the mushrooms yield. The remaining two-factor interactions (i.e. humidity and isolate, isolate and inoculum) and the three-factor interaction were found to be non-significant. In the second flush, the development of the bacterial disease was not observed, and the yield of healthy mushrooms did not differ between the variants of cultivation.

The bacterial blotch prevalence in relation to the number of bacteria cells and relative humidity is shown in Figure 3. It was shown that a higher number of bacterial cells (2.6×10^8 cfu m^{-2}) at 90% humidity resulted in a significant increase in disease incidence (DSI level was 40%) compared to 86% humidity (17%). The impact of humidity on the prevalence of bacterial diseases in the mushroom cultivation has been documented by Fletcher and Gaze [2008], and Navarro et al. [2018].

In the present study, no disease symptoms were observed in the second flush. A similar phenomenon was noted by Taparia et al. [2021b], who observed a reduction of ginger blotch disease symptoms in the second flush. In addition, Olivier et al. [1997] and Moquet et al. [1998] found that fruiting bodies from second flush exhibited higher resistance to bacterial blotch, as revealed by a reduced yield of mushrooms with disease symptoms.

Table 5. Average yield of healthy and infected mushrooms according to the number of *Pseudomonas 'gingeri'* cells and relative humidity over two flushes

Number of bacteria cells (cfu m^{-2})		Yield of healthy mushrooms (kg m^{-2})			
		1st flush		2nd flush	
		relative humidity			
		86%	90%	86%	90%
Control (non-inoculated)		20.36 ±4.31 Aa	21.75 ±4.88 Aa	8.42±2.32 Aa	9.31 ±2.37 Aa
MO	2.6×10^8	14.87 ±3.73 Ac	8.57 ±3.13 Bc	8.33 ±3.73 Aa	7.76 ±3.81 Aa
	2.6×10^7	17.83 ±4.37 Ab	18.82 ±3.43 Aa	8.50 ±4.13 Aa	8.25±3.39 Aa
B7	2.6×10^8	19.77 ±4.21 Aab	13.03 ±2.45 Bb	7.75 ±3.64 Aa	7.85 ±2.67 Aa
	2.6×10^7	20.18 ±3.66 Aa	18.68 ±2.50 Aa	8.36 ±2.88 Aa	8.11 ±3.10 Aa
Mean		18.60 ±2.32 A	16.17 ±5.29 B	8.27 ±0.30 A	8.26 ±0.62 A
		Yield of infected mushrooms (kg m^{-2})			
Control (non-inoculated)		0.0 ±0.0 Ac	0.0 ±0.0 Ad	0.0 ±0.0 A	0.0 ±0.0 A
MO	2.6×10^8	7.38 ±3.28 Ba	14.23 ±4.33 Aa	0.0 ±0.0 Aa	0.0 ±0.0 Aa
	2.6×10^7	3.53 ±2.16 Ab	3.40 ±2.15 Ac	0.0 ±0.0 Aa	0.0 ±0.0 Aa
B7	2.6×10^8	3.62 ±2.41 Bb	9.85 ±3.14 Ab	0.0 ±0.0 Aa	0.0 ±0.0 Aa
	2.6×10^7	1.65 ±1.08 Ab	4.18 ±2.82 Ac	0.0 ±0.0 Aa	0.0 ±0.0 Aa
Mean		3.24 ±2.75 B	6.33 ±5.66 A	0.0 ±0.0 A	0.0 ±0.0 A

Explanations – see Table 2.

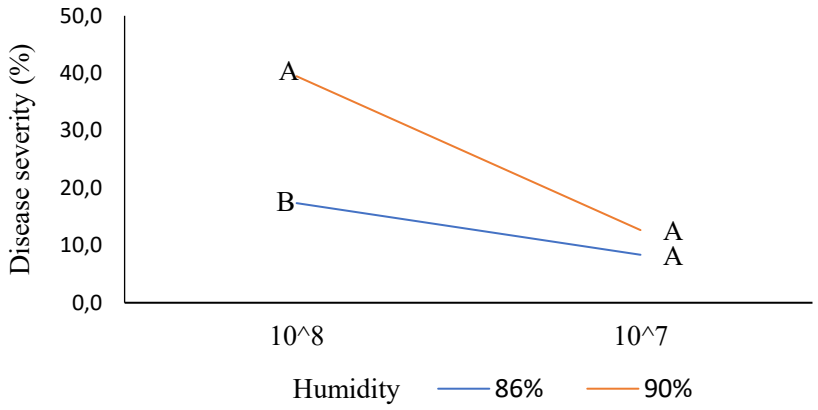

Fig. 3. Severity of ginger blotch (%) according to the relative humidity in the crop infected with *P. gingeri* at different number of cells. Means for the number of cells (i.e. 2.6×10^8 or 2.6×10^7 m^{-2}) with the same letter do not differ statistically ($P < 0.05$, *t*-Student test)

CONCLUSIONS

The present study has shown that the appropriate peat casing soil and air relative humidity levels in the mushroom growing chamber can influence of the reduction in bacterial blotch prevalence caused by *P. 'gingeri'*. Heavy casing soil used in the mushroom cropping trials, characterized by higher wet bulk density and maximum humidity as well as lower water capacity has been associated with an increase in the intensity of the ginger blotch disease. It was also revealed that higher levels of relative humidity in the cultivation chamber resulted in the manifestation of ginger blotch symptoms, particularly in the first flush. It was concluded that, in order to control of bacterial diseases in the mushroom cultivation, it would be necessary to use a mixed-peat casing soil, which would allow for the increased water capacity. Furthermore, an appropriate level of humidity in the growing chamber is crucial for efficient mushroom cultivation, as it can play an essential role in preventing the development of bacterial diseases.

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