

OCCURRENCE AND DISTRIBUTION OF SOME POTATO DISEASES AFTER WINTER STORAGE PERIOD

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Abstract. The paper aimed to present the evolution of twelve Romanian potato varieties (Cezarina, Marvis, Sarmis, Castrum, Ervant, Asinaria, Braşovia, Azaria, Darilena, Foresta, Christian) under the aspect of diseases developed after a period of storage. The experience took place in the years 2021-2022 to the National Institute for Research and Development for Potato and Sugar Beet Brasov. Incidence of some tuber diseases like, dry rot, silver scurf, common scab and black scurf were monitored. Considering the results, Braşovia variety is very sensitive to common scab (15.13%) but resistant to silver scurf (2.25%), meanwhile Christian variety is resistant to common scab (3%) and does not show any resistance to silver scurf (64.38%). To dry rot the most sensitive turned out to be the Asinaria variety (5.88%) and the least sensitive was the Sevastia variety (1.88%).

Keywords: diseases, potato, storage, tubers, varieties

INTRODUCTION

According to the International Potato Center (CIP) (2021), one hectare of potato can yield 2-4 times the food value of grain crops and produces more food per unit of water than any other major crop and being up to seven times more efficient in using water than cereals (Otieno, 2019).

Worldwide, roughly 70 diseases and physiological disorders have been reported to affect potato crop and cause severe damages, particularly in tubers (Stevenson, 2001). Some of the main symptoms of the diseases that affect tubers are spots, and rotting (Fiers et al., 2012), which may be caused sometimes by fungi and bacteria. There are also other factors that, aside from the physical appearance, can downgrade the quality of the tubers, leading to rejection from consumers; however, Fiers et al. (2010) mentioned that surface spots only affect the epidermis of the tubers, and do not alter their taste or nutritional properties (Jemison et al., 2008; García-Ávila et al., 2018).

Potato yield losses due to pest and disease attacks could be as high as 100% depending on crop tolerance level, climatic conditions, soil, type of pest and disease (Olanya et al., 2002).

Potato crop has huge production constraints in the field, in the storage and market (Masum et al., 2011), of which dry rot, potato scab, potato gangrene and hollow heart are of highest importance.

Most of the harvested potatoes are put into storage for a while before being used or distributed in the market (Ghazavi and Houshmand, 2010). The major objectives of storage are for the future consumption, future processing, and maintenance of seed reserves (Khanal and Bhattarai, 2020). Some diseases cause more serious damage and develop more quickly than others and can quickly lead to the spoilage of an entire storehouse potato mound.

The aim of this study was to determine the severity of some tubers diseases (common scab, silver scurf, black scurf and dry rot) that often results in production problems.

Fusarium sp. (dry rot) - it is one of the diseases that occur with the highest frequency during storage. It also infects planted tubers if they are cut or injured, and some species cause wilting of plants in the field. In warehouses, the symptoms appear after about a month, being characteristic of the end of the storage period. Therefore, harvesting must be started as soon as possible, the restrictive element being the suberification of the tuber skin (Hermeziu, 2022).

The delay in harvesting increases the risk of unfavorable weather and as temperatures drop, resistance to damage and fungal attack decreases. Sorting, transport and storage should be done before temperatures drop below 10°C.

Losses due to dry rot can also be accentuated by poor ventilation in warehouses, the consequences being the increase of condensation on the surface of tubers stored over the winter (Knowles and Plissey, 2008).

Streptomyces scabies (common scab). The disease is quite aggressive because it attacks all the underground organs of the plant: the stem, tubers, stolons and roots. Given the fact that it is polyphagous, the common scab parasite is found even in soils where potatoes have never been cultivated. The parasite lives for long periods on plant remains and manure, in the soil, on tubers, even during the winter (Boțoman and Ianoși, 2005).

Common scab does not spread during storage, but the pathogen can spread through soil adhering to the wheels of tractors and agricultural machinery, through water or even wind. Another factor that contributes to the spread of the disease could be the cultivation for several years of varieties susceptible to common scab on the same surface, thus increasing the level of infection in the soil.

In the potato for consumption in Romania, damages were recorded from the point of view of the commercial aspect of the tubers, the infection being much more evident in the case of washed tubers. The culinary quality remains unchanged, but there are losses during cleaning.

Helminthosporium solani (silver scurf) - has saprophytic capabilities and can survive inside potato warehouses between seasons, on waste, potato residues and other organic substrates. This may present an increased risk of infection for potatoes newly introduced into storage.

The temperature and humidity commonly found in potato warehouses are favorable for the spread of the disease and the development of symptoms. The incidence and severity of silver scurf can increase significantly during storage. Potato warehouses that have had a problem with the disease should be periodically cleaned and disinfected (Merida and Loria, 1994).

Rhizoctonia solani (black scurf) - can be found on all the underground organs of the potato plant in the different phases of vegetation and results in a decrease in the quality of the potato and a decrease in production, with losses reaching up to 30% (Brewer and Larkin, 2005).

The fungus develops superficially on the tubers and thereafter dark chocolate-colored specks (sclerotia) are deposited on skin while flesh remains unaffected. Sclerotia can survive on infected tubers and persist in the soil for many years. The fungus is transmitted from the mother tuber to the stolons and progeny tubers. Sclerotia

germinate and invade stems or sprouts. Roots and stolons are invaded as they develop throughout the growing season. Sclerotia can develop on new tubers at any time. The sclerotia remain inactive during storage, but contribute to a less favorable presentation, reducing the commercial appearance. Tubers used as seed material should be treated with a fungicide (van den Brink and Wustman, 2014).

MATERIALS AND METHODS

The experiment was carried out to the National Institute of Research and Development for Potato and Sugar Beet Brasov, Romania in the field of Technology and good agricultural practices Department, between years 2021-2022. The pre-crop was wheat in both years and for fertilizer was used 1000 kg/ha N:P:K:15:15:15+S. Planting distance was 75 cm between rows and 30 cm between plants per row, having 4 rows with 21 plants each one. During the vegetation were applied the usual maintenance works (hilling, herbicides), including treatments for Colorado beetle and late blight (*Phytophthora infestans*) control.

Twelve potato varieties, Cezarina, Marvis, Sarmis, Castrum, Ervant, Asinaria, Braşovia, Azaria, Darilena, Foresta, Christian were planted in the field. The list of varieties with maturation, skin color, flesh color and tuber shape is shown in Table 1.

Table 1

List of varieties with specific characteristics

Variety	Maturation	Skin color	Flesh color	Tuber shape
Sevastia	mid-early	yellow	intense yellow	oval
Marvis	mid-early	yellow	light yellow	oval
Castrum	mid-early	light yellow	light yellow	round-oval
Asinaria	mid-early	yellow	cream colored	long-oval
Sarmis	mid-early	light yellow	yellow	oblong-oval
Brasovia	mid-early	yellow	yellowish white	round-oval
Cezarina	mid-early	yellow	medium yellow	short oval
Christian	mid-early	red	yellow	oval
Foresta	late	red	dark yellow	short oval
Darilena	mid-early	yellow	light yellow	oval
Ervant	mid-early	yellow	yellowish white	short oval
Azaria	mid-early	red	yellow	oval

Harvest and storage. Potatoes were harvested in 4 October 2021, respectively 19 September 2022 and stored in warehouse till 1 March 2021, respectively 28 February 2022.

Climatic conditions. The climatic conditions during potato growing and harvest affect potato storage, diseases like common scab been most prevalent in dry seasons, while black scurf appears especially in light soils and cold wet springs. In 2021 the summer months (June-August) recorded higher temperatures than the annual ones, with an average of almost 3°C higher in July. Also, the amount of precipitation was much lower (-28.7 mm/m²) in July, and in August, even if the monthly amount was exceeded, the precipitation was not uniform and balanced. The month of

September recorded a lower temperature by 1.2°C compared to the multiannual average and a lower volume of precipitation by 20.5 mm compared to the sum of the multiannual precipitation.

In 2022 the months of June, July and August recorded higher temperatures (by 2.5°C in the first two months and 2.7°C in August) than the multiannual averages and a very low volume of precipitation, especially in June and July (with 65, 1 mm, respectively 49.7 mm less), establishing the phenomenon of pedological drought. In September, during the harvest period, the temperatures were similar to the multiannual ones, and the precipitation even exceeded the average values by 13.1 m.

Table 2

Air temperature and rainfalls during the vegetation period
(Meteorological Station in Ghimbav-Brasov)

Year	Month					Average
	May	June	July	August	September	
	Air temperature (°C)					
2021	12.3	17.3	21.0	18.5	12.8	16.4
2022	14.8	19.0	20.6	22.2	13.6	18.0
MMA	13.6	16.5	18.1	17.5	13.6	15.9
	Amount of rainfall (mm)					
2021	77.0	109.0	71.1	100.8	32.0	389.9
2022	48.3	31.6	50.1	50.4	65.6	246.0
MMA	82.0	96.7	99.8	76.4	52.5	407.4

Disease incidence of potato and loss estimation. From each variety were collected random sampling of 100 tubers and stored in bags.

After the storage period the total number of tuber and the number of infected tuber were counted to calculate the disease incidence.

% Tuber infection/Disease incidence = Number of infected tuber /Total number of tuber x 100

RESULTS AND DISCUSSIONS

In 2021, to the laboratory assessment, Sevastia variety presented very high percentage of attack with **common scab** (31%), follow by Cezarina (17.5%), Castrum (15%), Ervant (14.5%), Sarmis (12.75%), Brasovia (12.25%), Castrum (11.75%), Marvis (9%), Azaria (8.75%), Foresta (8%), Asinaria (6.5%), Darilena (5%), Christian (1.25%) presented a very low attack percentage.

The potato varieties with common scab symptoms in 2022 showed this way: Sevastia (14.5%), Cezarina (13.5%), Brasovia (12.25%), Castrum (11.75%), Sarmis (10.75%), Marvis (9%), Azaria (5.25%), Foresta (5.25%), Christian (4.75%), Asinaria (4.25%), Ervant (3%), Darilena (2.75%) (Figure 1).

The analysis shows that no varieties are completely immune to common scab, however Christian and Darilena can be considered resistant varieties.

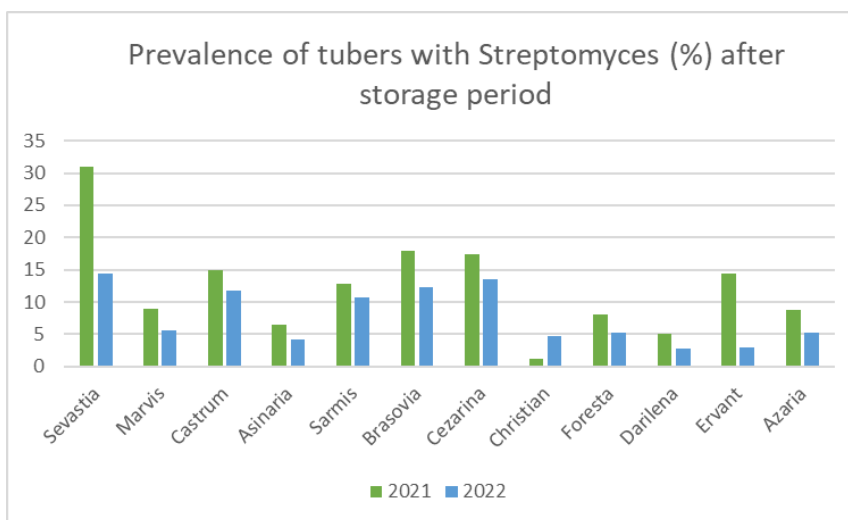


Figure 1. Tubers with common scab (%) after storage period

It is recommended to plant varieties that are less sensitive to the attack of common scab. The less sensitive varieties will reduce the risk of common scab appearing on soils where it was present in the past. Soils with a history of common scab should have the soil saturated with water during tuberization. As stated by other authors (Ismail, 2020), we consider that some natural and physical barriers, such as stomatal compaction, the color of the peel and its firmness, are key factors in suppressing the disease.

Silver scurf attacks only the tubers, which it can infect both in the field and in the warehouse. After a short time, the affected areas take on a grey-silver color which becomes much more obvious if the tubers are wet. The intensity of the coloring increases with the age of the lesions, and in varieties with red skin, the pigment is destroyed (Plămădeală, 1987) and the symptoms of the disease are much more obvious.

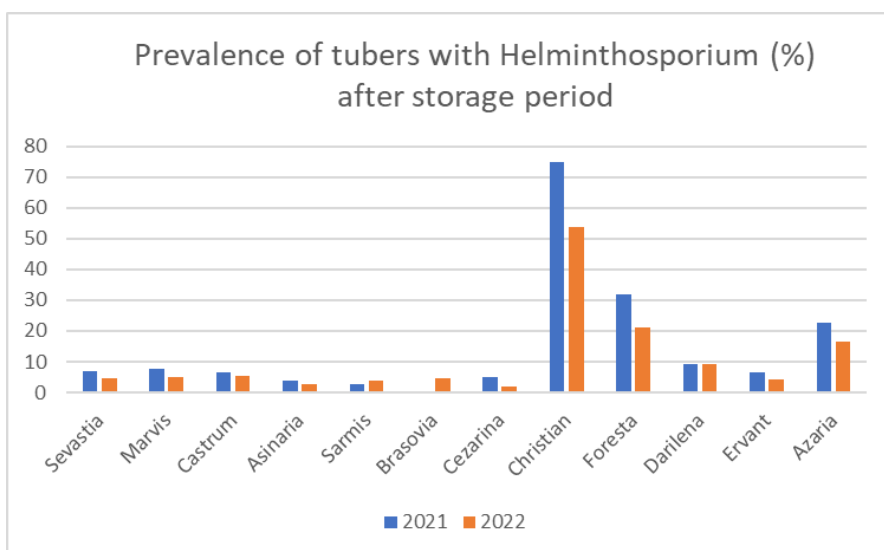


Figure 2. Tubers with silver scurf (%) after storage period

In both years, the percentage of attack by silver scurf was low in all varieties, except for those with red skin. On these, the symptoms were much more obvious and it was proven that the Christian variety does not show resistance to the attack of the pathogen. Also, the Foresta and Azaria varieties showed sensitivity in percentages of 32% and 22.5%, respectively in 2021 and 21.27% and 16.5%. respectively in 2022 (Figure 2).

The fungus has a saprophytic capacity and can survive in the warehouse in the absence of potatoes on possible plant residues, which represents an increased risk for a new harvest potato crop introduced into the warehouse. Control is difficult because the epidemiology of the disease is not clear and there are no resistant varieties (Hermeziu and Hermeziu, 2017).

On infested tubers the **black scurf** stage can be seen as small, black bodies (sclerotia). Sometimes these sclerotia may serve as sources of the disease when the tubers are used as seed but do not present a danger in storage. Sclerotia germinate and/or mycelium infects emerging potato sprouts, roots, stolons, and tubers as they develop through the growing season. Pathogenic *Rhizoctonia* populations may survive for long periods in potato fields by infecting or saprophytically infesting other crops.

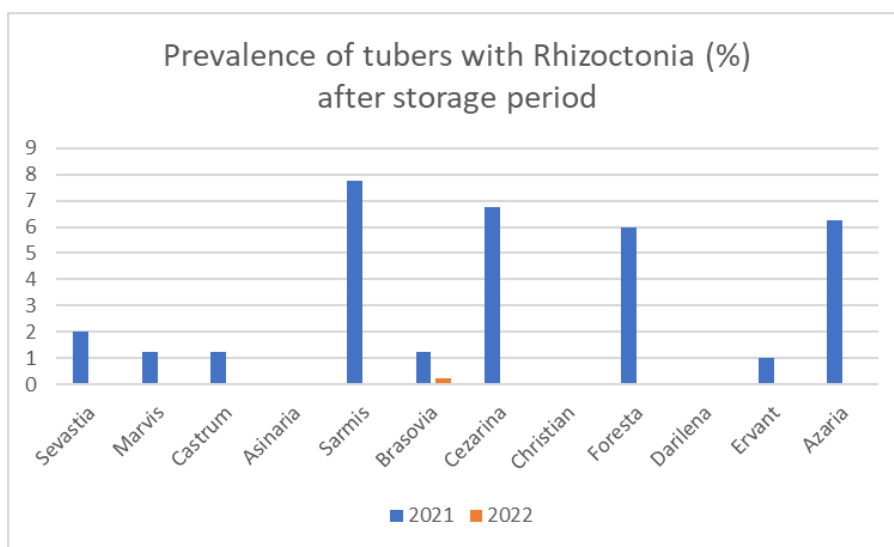


Figure 3. Tubers with black scurf (%) after storage period

Regarding the black scurf incidence in 2021, Sarmis variety presented the highest value (7,75%), followed by Cezarina (6,75%), Azaria (6,25%), Foresta (6%), Brasovia (1,25%), Marvis (1,25%), Castrum (1,25%), Ervant (1%). Christian, Asinaria and Darilena varieties.

In 2022 was found a decreasing trend, only Brasovia (0,25%) variety presented symptoms (Figure 3). The factors behind it could be a better soil (due to the rotation) and no rainfall during the crop period.

The sclerotia remain inactive in storage, but contribute to poor appearance and reduced marketability. Tubers used for seed should be treated with a fungicide, for sclerotia. Delayed harvest increase sclerotia size and number.

Also planting at a shallower depth will help to reduce black scurf infection.

Varieties differ in terms of sensitivity. Globally, very resistant commercial varieties have not been identified, despite attempts, including transgenic and intraspecific hybridization (Sedláková et al., 2013).

Fusarium spp. generally occurs during storage, causing tuber deterioration. Tubers and contaminated soil transport the fungus and are propagation vectors.

Due to its preservation form (chlamydospores), the fungus can be preserved in storage houses and on equipments.

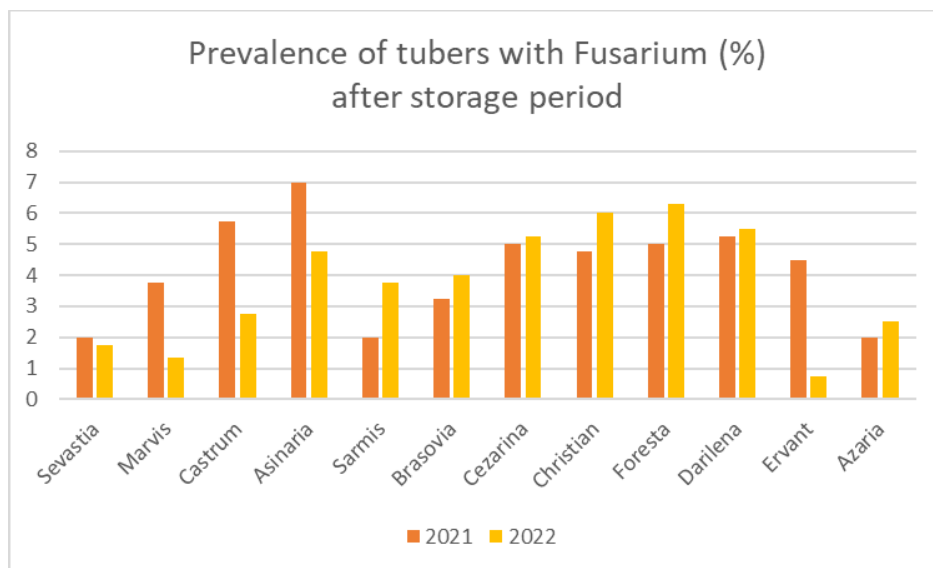


Figure 4. Tubers with to dry rot (%) after storage period

In 2021 after the storage period Asinaria variety showed maximum percent of infected tubers (7%), followed by Castrum (5.75%), Darilena (5.25%), Cezarina (5%), Foresta (5%), Christian (4.75%), Ervant (4.5%), Marvis (3.75%) and Brasovia (3.25%). Azaria (2%) and Sevastia (2%) showed the minimum disease percent.

In 2022 the highest level was rich by Foresta (6.31%), Christian (6%), Darilena (5.5%), Cezarina (5.25%), followed by Asinaria (4.75%), Brasovia (4%) and Sarmis (3.75%). Castrum (2.75%), Azaria (2.5%), Sevastia (1.75%), Marvis (1.33%), Ervant (0.75%) showed the smallest percent of disease attack (Figure 4).

The diagnosis of dry rot (*Fusarium* sp.) can be complicated by the presence of bacteria of the genus *Erwinia* (which causes wet rot), which often invade dry rot lesions, especially if the tubers have been stored at high humidity and condensation has appeared on their surface. Wet rot can very quickly engulf the entire tuber and mask the initial symptoms of dry rot.

CONCLUSIONS

To manage potato diseases remains a challenge, despite the current useful knowledge gathered on the biology and epidemiology of the pathogens. The study was made on 12 varieties of potato to evaluate their possibility to deal with some storage diseases. The varieties showed differences in the ability to respond to the attack of some diseases. Among the diseases analyzed, dry rot and common scab had the most

stable occurrence over the years. It is important to harvest in optimal conditions to avoid bad weather and to reduce mechanical injuries, so that the initial source of diseases (common scab, silver scurf) is as low as possible. Good storage conditions are necessary because most of disease organisms logarithmically increase their population growth at temperatures ranging from 5°C to 27°C. Lower temperatures lessen the possibility of disease incidence during storage.

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