

Study on the spread and development of diseases in public green spaces of Ulaanbaatar city

Результаты исследования распространения болезней в некоторых зелёных насаждениях города Улан-Батор

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Summary. In this study, the spread and development of diseases in the green spaces of Ulaanbaatar City were examined by conducting observations at the Asashoryu Garden, Khonkhtoi Garden, Uchral Garden, Bogd Khan Memorial Garden, and the National Garden in August 2024. Samples exhibiting disease symptoms were collected and analyzed in the laboratory. The study of the diseases in Ulaanbaatar's green spaces included 17 species from 11 families of trees and shrubs across five gardens, with a total of 2,212 individual plants studied. General epidemiological methods were applied to calculate the spread and development of diseases in the symptomatic samples. As a result of the study, the disease incidence showed that the most prevalent diseases in trees and shrubs were leaf blight 14.2–90.9% white spotting 27.3–72.5%, rust 33.3–100%, and pine shoot dieback 20.5–100%, as well as non-infectious disorders such as chlorosis and burn 4.7–66.6%.

Key words. Disease development, leaf blight, public green spaces, powdery mildew, tree disease.

Реферат. В данном исследовании было изучено распространение и развитие болезней в зелёных насаждениях города Улан-Батор путём проведения наблюдений в садах Асашорю, Хонхтой, Учрал, Мемориальном саду Богд-хана и Национальном саду в августе 2024 г. Образцы с признаками заболеваний были отобраны и проанализированы в лабораторных условиях. Исследование болезней в зелёных насаждениях Улан-Батора включало 17 видов деревьев и кустарников из 11 семейств в пяти садах, всего было изучено 2212 растений. Для расчёта распространения и степени развития болезней в образцах с симптомами были применены общие эпидемиологические методы. В результате исследования было установлено, что наиболее распространёнными заболеваниями деревьев и кустарников являются пятнистость листьев (14,2–90,9%), белая пятнистость (27,3–72,5%), ржавчина (33,3–100%) и отмирание побегов сосны (20,5–100%), а также неинфекционные заболевания, такие как хлороз и ожог (4,7–66,6%).

Ключевые слова. Болезни деревьев, городские зелёные насаждения, мучнистая роса, некроз листьев, развитие болезней.

Introduction. The activity of disease development is influenced by the pathogenic organism's ability to cause disease, the plant's resistance capacity, and environmental conditions. The interaction of the pathogen organism and other causes of disease leads to specific changes in the anatomy and morphological structure of the plant and its specialized organs.

Environmental factors act on pathogens and tree hosts independently and, as a consequence, disease incidence may increase or decrease due to environmental variability (Cobb, Metz, 2015). The bacterial, fungal, and viral infections, along with infestations by insects result in plant diseases and damage (Sankaran et al., 2010).

In 2018, researchers from the Institute of Plant Protection Research conducted a study on disease spread and development in the green spaces of Ulaanbaatar, covering 342,201 trees and shrubs in 12 streets and gardens. The results showed the spread of non-infectious diseases such as chlorosis and burn 5.5–13.5 %, pine

shoot dieback 4.0–28.5 %, brown leaf spot disease 7.0–26.0 %, and leaf blight 5.0–36.0 % (IPPR in Mongolia, 2018). In 2021, in Ulaanbaatar's green spaces, common tree species include conifers such as pine *Pinus* L. spruce *Picea* sp. and larch *Larix* sp. as well as broadleaf species like poplar *Populus* sp. elm *Ulmus* sp. rose *Rosae* sp. caragana *Caragana arborescens* and hawthorn *Crataegus* sp. Among these, shrub species are widely cultivated in the city's green spaces.

In this study, various tree and shrub species from different gardens in Ulaanbaatar were investigated for disease spread and development. The species observed in the **Asashoryu Garden** included *Ribes* L., *Lonicera altaica*, *Larix sibirica* Ledeb., *Populus* sp., *Picea obovata* Ledeb., *Malus pallasiana* Jiz., *Syringa vulgaris* L., *Pinus* L., *Ulmus* sp., *Caragana arborescens* Lam., *Betula platyphylla*, *Rosa* sp., and *Padus asiatica*; in the **Uchral Garden**, the species included *Ulmus* sp., *Caragana arborescens* Lam., *Armeniaca sibirica*, *Rosa* sp., *Elaeagnus moorcroftii*, *Ribes* L., *Lonicera altaica*, *Syringa vulgaris* L., *Pinus* L., *Larix sibirica* Ledeb., and *Picea obovata* Ledeb.; **Khonkhtoi Garden** featured species such as *Pinus* L., *Caragana arborescens* Lam., *Ulmus* sp., *Picea obovata* Ledeb., *Larix sibirica* Ledeb., *Ribes* L., *Rosa* sp., *Crataegus* sp., and *Padus asiatica*; in the **Bogd Khan Memorial Garden**, the species observed included *Ulmus* sp., *Populus* sp., *Syringa vulgaris* L., *Pinus* L., *Padus asiatica*, *Caragana arborescens* Lam., *Salix* L., *Rosa* sp., *Larix sibirica* Ledeb., and *Picea obovata* Ledeb.; in the **National Garden**, the species studied were *Picea obovata* Ledeb., *Betula platyphylla*, *Larix sibirica* Ledeb., *Populus* sp., *Ulmus* sp., *Caragana arborescens* Lam., *Salix* L., *Pinus* L., and *Rosa* sp. The spread and development of diseases in these species were assessed and calculated.

Material and methods.

Method for Calculating Disease Spread

To determine the spread of the disease, the method which was developed by M. E. Dementieva (1970) was used. The spread of the disease was expressed as the proportion of affected trees and shrubs in the surveyed gardens.

$$p = \frac{n * 100}{N}$$

p – Disease spread (%)

n – The number of plants showing disease symptoms in the surveyed plants

N – The total number of plants surveyed

Method for Determining the Degree of Disease Severity

The degree of disease severity is assessed based on the area of the affected parts of the plant, such as the leaves or fruit. To ascertain this, the proportion of the affected area (such as spots, coatings, etc.) relative to the total surface area of the plant is evaluated. The severity of the disease is typically expressed using a 5-point scale, where each point corresponds to a specific level of damage to the plant (Farooq et al., 2015)

The degree of damage to broadleaf trees and shrubs is determined using the following 5-point scale (Nicholls, Skilling, 1974).

Table 1. Evaluation of Disease Severity by Score

Score	Symptoms
0	No signs of disease
1	Up to 10 % of the plant leaf surface is affected
2	11–25 % of the plant leaf surface is affected
3	26–50 % of the plant leaf surface is affected
4	More than 51 % of the plan leaf surface is affected

The degree of damage to coniferous trees is determined using the following 5-point scale.

Table 2. Evaluation of Disease Severity by Score

Score	Symptoms
0	No signs of disease
1	Up to 5 % of the coniferous surface is affected
2	5-33% of the coniferous surface is affected
3	33-66% of the coniferous surface is affected
4	More than 66% of the coniferous surface is affected

Method for Calculating Disease Development

The development of the disease is determined using the methods of M. E. Dementieva where the average level of damage during the disease progression is expressed as a percentage. Disease development will be calculated using the following formula.

$$R = \Sigma (a \times b) \times 100 / n \times 4$$

- R – Development of disease, %
- a – Number of affected plants
- b – Disease severity score of affected plants
- n – Total number of plants considered in the calculation
- 4 – The highest severity score of the disease

Research results. The study was conducted on the trees and shrubs in the following 5 gardens during the plant growing season.

Table 3. Locations of the Gardens included in the Study

№	Name	Location	Coordinates
1	Asashoryu Garden	Chingeltei District	47°55′12.05″N 106°54′51.06″E
2	Uchral Garden	Chingeltei District	47°55′18.3″N 106°54′54.5″E
3	Khonkhtoi Garden	Sukhbaatar District	47°55′02.62″N 106°55′04.15″E
4	Bogd Khan Memorial Garden	Khan-Uul District	47°89′75.13″N 106°90′71.87″E
5	National Garden	Bayanzurkh District	47°90′47.5″N 106°95′25.1″E

Results of Spread and Development of Disease in Urban Green Spaces

The spread and development of the disease in the green spaces of the city were calculated for the samples showing symptoms of the disease in the gardens, using general epidemiological methods. The results are shown in Table 4.

Table 4. The Disease Spread and Development of Diseases in Urban Green Spaces, August 2024

№	Garden Name	Tree Species	Symptoms	Spread (%)	Development (%)
1	Asashoryu Garden	<i>Caragana arborescens</i>	Powdery mildew	90.9	65.9
		<i>Ulmus</i> sp.	White Spot	62.5	31.5
			Brown Spot	12.5	21.8
		<i>Betula platyphylla</i>	Rust	100	90
		<i>Rose</i> sp.	Powdery mildew	23	15.3
		<i>Larix</i> sp.	Shutte	50	40
		<i>Pinus</i> sp.	Shutte	100	90
		<i>Populus</i>	Non-infectious disease	4.7	3.5
		<i>Lonicera altaica</i>	Powdery mildew	79.1	31.25

Ending Table 4

№	Garden Name	Tree Species	Symptoms	Spread (%)	Development (%)
2	Uchral Garden	<i>Caragana arborescens</i>	Powdery mildew	78.8	62.5
		<i>Ulmus</i> sp.	White Spot	72.5	60
		<i>Pinus</i> sp.	Shutte	47	24
		<i>Rose</i> sp.	Brown Spot	28.5	10
		<i>Armeniaca sibirica</i>	Non-infectious disease	8.3	5.8
		<i>Lonicera altaica</i>	Spotting	25	ND
		<i>Syringa vulgaris</i>	Non-infectious disease	14,2	7.5
3	Khonkhtoi Garden	<i>Caragana arborescens</i>	Powdery mildew	74.4	50
		<i>Ulmus</i> sp.	White Spot	65.3	54.1
		<i>Pinus</i> sp.	Shutte	20.5	25
		<i>Rose</i> sp.	Powdery mildew	16	23.3
		<i>Malus</i> sp.	Powdery mildew	14.2	25
4	Bogd Khan Memorial Garden	<i>Populus</i> sp.	Rust	73.8	60
		<i>Salix</i> sp.	Rust	33.3	29
		<i>Ulmus</i> sp.	White Spot	27.3	26.5
		<i>Caragana arborescens</i>	Powdery mildew	58.6	60
		<i>Pinus</i> sp.	Shutte	40.2	31
5	National Garden	<i>Betula platyphylla</i>	Rust	69	40
		<i>Larix</i> sp.	Shutte	76.9	ND
		<i>Populus</i> sp.	Rust	62.9	37.5
		<i>Ulmus</i> sp.	Brown Spot	31.8	21.6
		<i>Caragana arborescens</i>	Powdery mildew	75	52.5
		<i>Salix</i> sp.	Rust	60.6	44.1
		<i>Pinus</i> sp.	Shutte	50	ND
		<i>Rose</i> sp.	Non-infectious disease	66.6	61.6

Based on the examination of the disease spread across the gardens, the Asashoryu Garden had 119 trees and shrubs of 13 species from 9 families. The most common diseases were leaf spot disease, with a spread of 23–90.9 %, white blotch disease at 62.5 %, rust disease at 100 %, and shoot disease with a spread of 50–100 %. Nutrient deficiency or non-infectious diseases had a spread of 4.7 %.

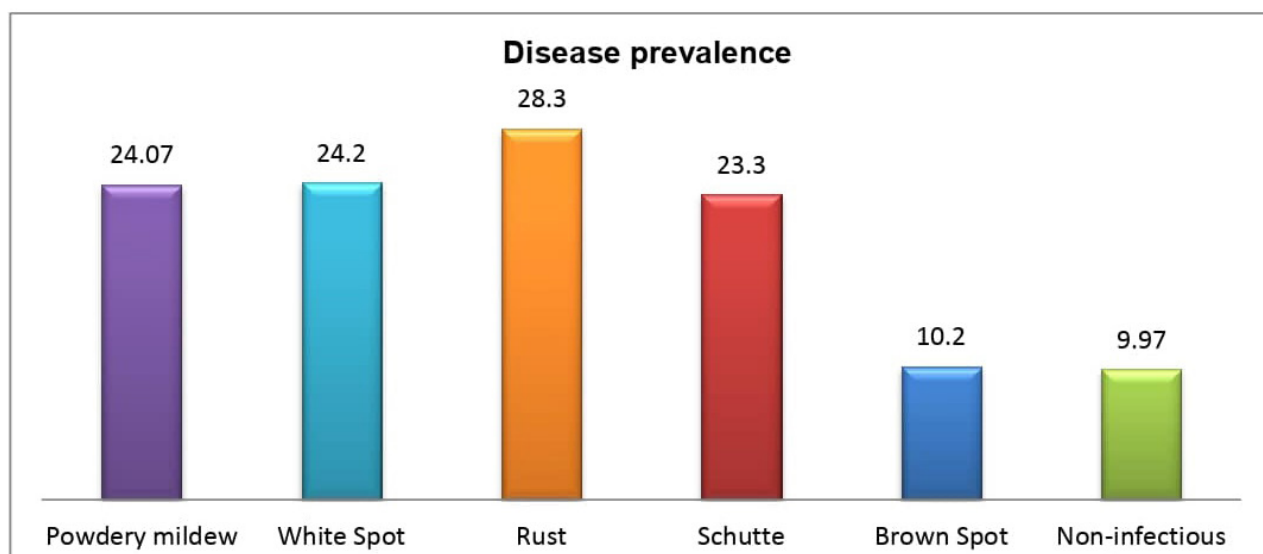


Fig. 1. Disease prevalence graph.

In the Uchral Garden, there were 710 trees and shrubs of 11 species from 8 families. Among them, nutrient deficiency or non-infectious diseases had a spread of 8.3–14.2 %, leaf spot disease affected 78.8 %, white blotch disease 72.5 %, shoot disease 47 %, and brown blotch disease ranged from 25–28.5 %. In the Khonkhtoi Garden, 556 trees and shrubs from 9 species of 5 families were included in the study. Of these, leaf spot disease had a spread of 4.2–74.4 %, white blotch disease 65.3 %, and shoot disease 20.5 %. In the Bogd Khan Memorial Garden, there were 679 trees and shrubs from 5 species of 5 families. Among them, rust disease had a spread of 33.3–73.8 %, white blotch disease 27.3 %, leaf spot disease 58.6 %, and shoot disease 40.2 %. In the National Garden, the study covered 149 trees and shrubs from 9 species of 7 families. Of these, rust disease spread at 60.6–69 %, shoot disease 50–76.9 %, brown blotch disease 31.8 %, and leaf spot disease had a spread of 75 %. Nutrient deficiency or non-infectious diseases had a spread of 66.6 %. The spread of six types of diseases detected in the trees and shrubs of the gardens is shown in the above graph. Powdery mildew in 24.07 %, white spot in 24.2 %, rust in 28.3 %, shutte in 23.3 %, brown spot in 10.2 %, and non-infectious diseases in 9.97 %, such as chlorosis, were likewise detected.

Discussion. According to our research conducted in 2024, a study of the green spaces in Ulaanbaatar, which included five public parks, identified the spread and development of diseases affecting trees and shrubs. Six types of diseases were found, including pine schutte, leaf powdery mildew, white spot, brown spot, rust, and non-infectious disease. The “225 Key Works in Urban and Public Services” report conducted in 2017 noted an increase in viral plant diseases affecting trees and shrubs. It was mentioned that leaf brown spotting, powdery mildew and schutte were dominant in species such as spruce, fir, poplar, and larch. The “Report on the Control of Plant Diseases and Pests in Ulaanbaatar’s Public Green Spaces” in 2018 stated that a study was conducted on the spread and development of diseases affecting a total of 342,201 trees and shrubs across 12 streets and parks. The research identified the presence of non-infectious disease, burning, schutte, brown spot, and powdery mildew.

The research on the disease between 2017 and 2018 shows that similar diseases have been recurring every year. This is further confirmed by the spread of the disease in 2024, which also identified the dominance of the same types of diseases.

Therefore, it is crucial to develop preventive measures and protective technologies to address the prevalent diseases in Ulaanbaatar’s green spaces.



Fig. 2. Elm (*Ulmus* sp.). White spot.



Fig. 3. Cargana (*Caragana arborescens* Lam.). Powdery mildew.



Fig. 4. *Salix* (*Salix* L.). Rust.



Fig. 5. Pine (*Pinus* L.). Schutte.

Conclusion. A study on the spread and development of diseases in the trees, shrubs, and bushes of Ulaanbaatar's green spaces was conducted in the first 10 days of August. A total of 2212 trees and shrubs from 17 species across 11 families were included in the study.

The study of Ulaanbaatar's green spaces revealed the presence of six types of diseases in the trees and shrubs: schutte, powdery mildew, white spot, brown spot, Rust, and non-infectious disease such as chlorosis. The most widespread diseases were gall disease, white spot, rust, and shoot blight. In terms of the spread of the disease among trees and shrubs, the most common diseases were powdery mildew 14.2–90.9 %, white spot 27.3–72.5 %, rust 33.3–100 %, schutte 20.5–100 %, and non-infectious disease 4.7–66.6 %. When calculating the development of diseases in the trees and shrubs of the parks, the highest disease progression was observed in powdery mildew 15.3–65.9 %, white spot 26.5–60 %, rust 29–90 %, and schutte 25–90 %.

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REFERENCES / ЛИТЕРАТУРА

- Cobb R. C., Metz M. R.** Tree diseases as a cause and consequence of interacting forest disturbances // *Forests Pathology and Plant Health*, 2017. – Vol. 8, № 5. – P. 147. <https://doi.org/10.3390/f8050147>
- Dementieva M. E.** *Phytopathology*. – Moscow, 1970. – 187 p.
- Dondov. B.** *Forest phytopathology*. – Ulaanbaatar, 2011. – P. 6.
- Farooq A., Ahanger Gh., Hassan Dar., Beig M. A., Sofi T. A.** Management of needle blight (*Lophodermium pinastri*) disease in Blue pine trees in Kashmir, India // *Journal of Forestry Research*, 2015. – P. 187. <https://doi.org/10.1007/s11676-015-0123-z>.
- IPPR in Mongolia** / Report of Green space. – Ulaanbaatar, 2018. – P. 13–20.
- Nicholls T. H., Skilling D. D.** Control of *Lophodermium* needle-cast disease in nurseries and Christmas tree plantations // *USDA Forest Service Research Paper NC*, 1974. – P. 11.
- Sankaran S., Mishra A., Ehsani R., Davis C.** A review of advanced techniques for detecting plant diseases // *Computers and electronics in Agriculture*, 2010. – Vol. 72, № 1. – P. 1–13.
- U. C. M. Office**, 225 Outstanding Works of the City and Public Works, 2017.