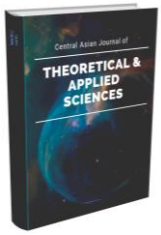

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Article

Integrated Management of Hawthorn Diseases: Development, Harm, and Control Measures

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Abstract: This study examines the primary diseases affecting hawthorn (Crataegus pontica K. Koch), addressing a significant gap in integrated pest management literature concerning these diseases' development and control. Utilizing a comprehensive approach, we combined field observations, laboratory analyses, and integrated pest management (IPM) techniques to assess the impact of diseases such as powdery mildew, brown spot, tracheomycosis, rust, white spot, and moniliosis. Our findings indicate that these diseases significantly impair hawthorn's growth and yield, with powdery mildew and brown spot being the most detrimental. Results demonstrate that implementing a combination of agrotechnical, biological, and chemical control measures effectively mitigates disease spread and damage. This study's implications underscore the importance of adopting an integrated management system to enhance hawthorn's viability and productivity, providing valuable insights for agricultural practices and future research in plant disease management.

Keywords: Crataegus, Phyllactinia Suffulta, Septoria, Diseases, Damage, Bioecology, Morphology, Combined Control Measures, Pesticide, Agrotechnical, Biological, Chemical.

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1. Introduction

Today, the issue of using fruits and berry plants in agriculture and medicine is of particular importance. Solving these issues is carried out by comprehensive study of local and introduced plants. Cultivation of species introduced to new natural and climatic conditions leads to changes in the rhythm of seasonal development of plants, the nature of fruiting, seeds and vegetative regeneration, and other biological characteristics. Medicinal properties of hawthorn have been used since the 16th century. In the 19th century, a tincture made from flowers and leaves was used as a blood purifier, and at first, hawthorn fruits and flowers were recommended as a medicine for heart and vascular diseases[1].

Hawthorn (Crataegus pontica K. Koch) is a tree belonging to the Rosaceae family. The height is 6-10 m, the thickness of the body is 40-50 cm. There are 890 species of hawthorn, of which 10 species grow in Uzbekistan. Widespread in China, Spain, Italy, Algeria, America and other countries. The edge of the leaf is divided into large teeth or feathers, and is arranged in a row on the stem. The flower is small, collected in a flower[2]. The fruit is 1-5 seeds. There are species of

hawthorn that are grown as an ornamental plant, such as C.turcestanica, C.songarica, C.orientalis. Hawthorn grows wild in the mountainous regions of Uzbekistan, at an altitude of 1000-1500 m above sea level, it often grows singly, sometimes small hawthorn groves are found. The fruits of some species are large and widely consumed. The flower of C.pontica is rich in nectar. Hawthorn blooms in May-June, ripens at the end of September, a 25-30-year-old tree yields 70-80 kg. The fruit contains 11.5-15.9% sugar, 8% oil, 0.67-0.88% malic acid. In folk medicine, it is used as an appetite suppressant. Fabrics can be dyed yellow and brown with a decoction of hawthorn leaves, bark and roots. Hawthorn is a good graft for apple, pear, and quince. Reproduction from seed, root, rhizome. the seed is very hard, it germinates in the 2nd or 3rd year after sowing. If it is soaked in sulfuric acid for 12 hours and kept in moist sand until spring, it will ripen in the first year. Hawthorn is resistant to cold and drought. Hawthorn is used to create green walls and hedgerows, to strengthen mountain slopes against erosion[3].

2. Materials and Methods

The methodology employed in this study to examine hawthorn (Crataegus pontica K. Koch) diseases and their management involved a multi-faceted approach integrating field observations, laboratory analyses, and integrated pest management (IPM) techniques. Initially, extensive field surveys were conducted across various hawthorn groves to identify and document the prevalence and severity of diseases such as powdery mildew, brown spot, tracheomycosis, rust, white spot, and moniliosis[4]. During these surveys, symptomatic samples were collected from different parts of the trees, including leaves, branches, flowers, and fruits. These samples were then subjected to laboratory analyses to accurately diagnose the pathogens responsible for the observed symptoms. Microscopic examination and culturing techniques were used to isolate and identify the fungal species. Concurrently, data on environmental conditions, such as temperature, humidity, and rainfall, were collected to understand their influence on disease development and spread[3].

To develop effective control measures, the study applied integrated pest management principles, combining agrotechnical, biological, and chemical strategies. Agrotechnical measures included selecting disease-resistant hawthorn varieties, optimizing planting sites to ensure proper air circulation, and maintaining appropriate plant spacing. Biological control involved promoting natural predators and beneficial organisms through habitat management practices, such as planting companion crops like corn along field edges. Chemical control was implemented cautiously, focusing on targeted pesticide applications based on pest monitoring and economic thresholds. Fungicides were selected based on their efficacy against specific pathogens and were applied in accordance with recommended dosages and safety protocols. Regular monitoring and evaluation of disease incidence and severity were conducted throughout the growing season to assess the effectiveness of the implemented control measures. This comprehensive methodology ensured a holistic understanding of hawthorn diseases and facilitated the development of a robust integrated management system to mitigate their impact on hawthorn cultivation.[5]

3. Results

Hawthorn powdery mildew - Podosphaera oxyacanthae de. Barry. f.crataegi Jacz. and Phyllactinia suffulta Sacc. f.oxyacanthae Roum[6].

Powdery mildew damages leaves, petals and fruits, leaf and fruit bunches, branches and buds of trees. First, a white or light-gray powder appears on the underside of the leaves. Later, chlorotic spots develop on the upper side of the leaf, in front of the places where the powder appeared. Over time, the powdery mildew spreads to both sides of the leaf and can completely cover the leaves (fig.1). The leaves become twisted, boat-shaped, wrinkled, and become small (the size can be 1/3 of healthy leaves). They fall to the ground: in the middle of August, half of the leaves on the tree may fall[7].

Signs of damage. Damages leaves, branches, flowers and fruits. Infected leaves do not develop well and become boat-shaped. Fruiting trees and young seedlings are severely damaged by powdery mildew. Productivity may decrease by 30–50%. The impact of the disease on the crop is related to the weather, variety resistance and applied agrotechnical methods[8].

Development cycle. The source of the spread of the disease is the leaves on which the fungus has wintered. Sometimes (often in pears) it can overwinter on the branches. Although the most favorable temperature for the development of the disease is 18-20°C, spores can grow at 20-30°C. Spores are spread by wind and raindrops. Depending on the weather, the spread of spores can last up to 60 days, and the latent period of the disease can last 8-12 days.

Figure 1. Powdery mildew disease in hawthorn

The amount of infection stored until spring depends on how cold the winter was. In winter, 95% of the affected shoots will die if the temperature is -24 oC or lower[9]. Conidia appear on the overwintering mycelium, which serve as a source of primary infection when damaging young leaves, flowers and fruits. Mycelia and conidia developed in the affected organs ensure secondary and subsequent damage to leaves, young branches and fruits and spread the disease in the garden[30]. At 10-25oC (optimally 20-22 oC) temperature and 70% relative humidity on the leaf, 50% of conidia grow within 24 hours. Conidia almost do not grow in droplet moisture or at high temperature (30 oC and higher) [vitusltd.ru][10].

Brown spot disease - Septoria crataegicola Bond, et Tram[11].

Description of development stages. Brown spots spread very quickly along the surface of the leaf. Their shape varies from round to geometric. Due to damage, the leaves dry up and fall off. Harms various types of hawthorn. When the disease develops strongly, the tree loses its natural appearance, becomes blind, weak and resistant to adverse weather conditions[12].

Figure 2. Hawthorn leaf infected with brown spot disease.

Signs of damage. A large number of brown spots with a diameter of up to 6 mm, distinguished by thin dark lines, appear on the upper part of the leaves. Fruit bodies of the fungus with light brown spots are formed in them (fig. 2). Due to the disease, the leaves dried up early[13].

Development cycle. The source of the spread of the disease is the leaves and branches where the fungus has wintered. Although the most favorable temperature for the development of the disease is 18-20 °C, spores can grow at 20-30 °C. Spores are spread by wind and raindrops. Depending on the weather, the spread of spores can last up to 60 days, and the latent period of the disease can last 8-12 days[29].

Tracheomycosis disease of hawthorn - Fusarium oxysporum.

Description of development stages. It is very common among various plants and is caused by fungi of the genus Fusarium. Fusarium oxysporum fungi living in the soil manifest themselves in hawthorn, especially in wet years and in places with stagnant water[14].

Signs of damage. The roots turn brown, then light gray spores appear. The mycelium then grows into the vascular system of the branches and trunk, where it blocks the path of the permeable tissue, resulting in impaired movement of nutrients and the death of the plant. The drying of the plant usually starts from the buds[28]. Spreading throughout the plant, the fungus first causes individual branches to die, and then the entire plant[15].

Hawthorn rust disease - Gymnosporangium clavariaeforme.

Description of development stages. It is a disease that manifests itself as brown growths on spots, pads, bark, leaves or shoots. The disease can be found in fruit, ornamental, broad-leaved cereals, flowers and vegetable crops. This fungus has 5 types of sporulation and therefore occurs in different forms. It affects the lower branches and fruits[16].

Signs of damage. In the summer, unbounded yellow spots appear on the upper part of the leaves, which later darken. In the lower part, instead of spots, orange pustules develop (fig. 3). Damaged leaves dry up prematurely and fall off.

Figure 3. Hawthorn rust disease

Hawthorn white spot disease - Septoria crataegi Kickx.

Description of development stages. In the summer, many spots appear, they are small, round, dark brown. Gradually, the center of the spots shines, and in autumn, the spots turn white, with a clear brown border (fig.4)[27]. Fruiting bodies of the fungus are formed in spots. The leaves of the affected plant turn brown and dry; severe infection may cause premature leaf drop[17].

Development cycle. The source of the spread of the disease is the leaves on which the fungus has wintered. Sometimes it can overwinter on the branches. Although the most favorable temperature for the development of the disease is 18-20 °C, spores can grow at 20-30 °C.

Figure 4. Hawthorn white spot disease

Moniliosis disease of hawthorn - Monilia fructigena.

Description of development stages. The fungus overwinters on dry, waxy fruit and other damaged parts. Fruits are infected by apple worm and other insects, birds, hail[18].

Signs of damage. Hawthorn fruits rot and become unusable. Fruits are affected by this disease not only on the plant, but also in storage (fig.5)[26].

Development cycle. Fruits turn brown after 3-5 days of infection, spores appear after 8-10 days. Cool air temperature and high humidity during the flowering period of trees in the spring cause widespread spread of the disease. Fungal spores develop rapidly when the air temperature is 24-28 °C, and the relative humidity is higher than 75%.

Figure 5. Hawthorn moniliosis disease

Disease Control

a. Protect seedlings from dense planting to limit disease spread.
b. It is recommended to clean the fields from the remnants of previously planted seedlings while preparing them for planting.
c. Weeds serving as alternative hosts in the field must be completely removed and burned[25].
d. It is necessary to use seed materials that have been neutralized with chemicals.
e. It is necessary to avoid planting crops in fields where the disease has been observed for a long time.
f. Carbendazim aqueous mixture should be sprayed when the disease first appears in the field[19].

Strategies For Combined Disease Management

Agrotechnical activities

a. Choosing a place for planting hawthorn groves is very important. In this case, it is necessary to choose sloping places as much as possible, and place the rows of trees so that the dominant directions of the wind blow well.
b. The field should be weeded at least 8-9 weeks before planting.
c. When choosing a variety, it is necessary to take into account their resistance to marssoninosis (to other dominant diseases and pests in the region).
d. When growing seedlings, when planting them in holes, it is necessary to ensure that the root neck is at the soil level and not buried in the soil.
e. In order to destroy the population of different stages of pathogens and phytonematodes in the soil, it is necessary to plow the land deeply in the summer.

f. observe sanitary rules - collect fallen leaves in the fall and bury them in the soil at a depth of 10-15 cm in a remote place
g. It is necessary to feed the trees on time and in the specified amount[20].

Physical - mechanical measures

a. pruning old branches to rejuvenate trees
b. timely soil cultivation, feeding, watering
c. do not allow the branches to become too thick
d. In spring and fall, prune branches before leaf fall, burn or bury waste outside the garden
e. disinfect the cut areas with a 1% solution of milk of lime or a 3% solution of iron sulfate
f. collect and bury fruiting bodies of goiter fungi; it is recommended to dig out heavily infected trees and remove them from the garden.

Biological activities

It is possible to increase the number of predatory entomophagies (staphylinids, predatory wasps, etc.) by growing two rows of corn along the edge of the field planted with hawthorn seedlings[21].

Chemical control.

IPM (Integrated Pest Management) chemical control measures are based on the need for targeted use of pesticides, and it is important to use chemicals wisely and safely[24]. In order to make a decision on the use of chemical pesticides, it is necessary to carry out analysis and monitoring of pests with IZMM (criterion of amount of economic damage)[22].

The following suggestions are critical to the success of control measures in an IPM strategy:

a. Do not mix two or more insecticides
b. Repeated application of the same insecticide should be avoided
c. Insecticides such as pyrethroids should not be used
d. Natural phytochemical based formulas should be used more widely[23].

List of pesticides used for hawthorn diseases

	Pesticides	Spending standard, l/ha	
		L/ha	Concentration, %
	Fungicides used against diseases		
1.	Fungiosporin BF 1500 YeA/mg	3,0	0,3
2.	Bayleton 25% wet.pow.	0,75	0,075
3.	Zeroks k.s.e	1,0-2,0	0,1-0,2
4.	Alto Super 33% em.con.	0,17-0,2	0,017-0,02
5.	Altis Duo, 32,5 % sus.con.	0,375-0,5	0,0375-0,05
6.	Topsin-M, 70 % wet.pow.	1,0	0,1
7.	Miss xlorokisi, 85 % n.kuk.	4,0	0,4
8.	Sporagin s.e.k. 1500 YeA/g	4,0-6,0	0,4-0,6
9.	Skort, 25 % em.con.	0,5	0,05
10.	Tetris, 25% sus.con.	0,6-0,8	0,06-0,08
11.	Amistar top, 32,5% sus.con.	0,5-0,6	0,06-0,06

Note: *Used by specially trained persons using personal respiratory protective equipment following the instructions on the use of chemical agents.

4. Conclusion

The study successfully identified and documented the major diseases affecting hawthorn (Crataegus pontica K. Koch), including powdery mildew, brown spot, tracheomycosis, rust, white spot, and moniliosis. The findings reveal that these diseases significantly hinder hawthorn's growth and yield, with powdery mildew and brown spot being particularly destructive. Implementing an integrated management system comprising agrotechnical, biological, and chemical control measures proved effective in mitigating disease spread and damage. These results underscore the importance of adopting comprehensive pest management strategies to enhance hawthorn viability and productivity. The implications of this study are significant for agricultural practices, suggesting that integrated pest management (IPM) can be a viable approach to maintaining crop health and yield. Further research is recommended to refine these control measures and explore additional biological and chemical agents that could enhance the effectiveness of IPM strategies in diverse environmental conditions.

REFERENCES

[1] A. M. N. Al Shammari, "Biological Effects of Hawthorn Leaves Powder and its Extract on Biological and Biochemical Change of Induced Obese Rats," *Life Sci. J*, 2020, [Online]. Available: http://www.lifesciencesite.com/lsj/lsj170320/08_36102lsj170320_62_66.pdf

[2] D. F. Liu *et al.*, "Insight into Isolation and Characterization of Phenolic Compounds from Hawthorn (Crataegus pinnatifida Bge.) with Antioxidant, Anti-Acetylcholinesterase …," *Plant Foods for Human …*, 2022, doi: 10.1007/s11130-022-01004-y.

[3] A. R. Valeeva, N. V Makarova, and ..., "Optimisation of conditions for extracting bioactive compounds exhibiting antioxidant properties from hawthorn fruit (Crataegus)," *… вузов. Прикладная химия …*, 2019, [Online]. Available: https://cyberleninka.ru/article/n/optimisation-of-conditions-for-extracting-bioactive-compounds-exhibiting-antioxidant-properties-from-hawthorn-fruit-crataegus

[4] C. Ornelas-Lim, F. J. Luna-Vázquez, and ..., "Development of a quantified herbal extract of hawthorn Crataegus mexicana leaves with vasodilator effect," *Saudi Pharmaceutical …*, 2021, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1319016421002048

[5] A. M. Rababa'h, O. N. Al Yacoub, T. El-Elimat, and ..., "The effect of hawthorn flower and leaf extract (Crataegus Spp.) on cardiac hemostasis and oxidative parameters in Sprague Dawley rats," *Heliyon*, 2020, [Online]. Available: https://www.cell.com/heliyon/fulltext/S2405-8440(20)31461-4

[6] C. Qin, T. Xia, G. Li, Y. Zou, Z. Cheng, and ..., "Hawthorne leaf flavonoids prevent oxidative stress injury of renal tissues in rats with diabetic kidney disease by regulating the p38 MAPK signaling pathway," *International Journal of …*, 2019, [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6949812/

[7] A. Witkowska, A. Gryn-Rynko, P. Syrkiewicz, and ..., "… Mulberry, Sea-Buckthorn, Garlic, Lily of the Valley, Motherwort, and Hawthorn as Potential Candidates for Managing

Cardiovascular Disease—In Vitro and Ex …," *Nutrients*, 2024, [Online]. Available: https://www.mdpi.com/2072-6643/16/9/1313

[8] J. Ding *et al.*, "Exploring the mechanism of hawthorn leaves against coronary heart disease using network pharmacology and molecular docking," *Frontiers in …*, 2022, doi: 10.3389/fcvm.2022.804801.

[9] M. Wu, L. Liu, Y. Xing, S. Yang, H. Li, and Y. Cao, "Roles and mechanisms of hawthorn and its extracts on atherosclerosis: a review," *Front Pharmacol*, 2020, doi: 10.3389/fphar.2020.00118.

[10] S. Dehghani, S. Mehri, and ..., "The effects of Crataegus pinnatifida (Chinese hawthorn) on metabolic syndrome: A review," *Iranian journal of basic …*, 2019, [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6556496/

[11] M. Cui *et al.*, "Traditional uses, phytochemistry, pharmacology, and safety concerns of hawthorn (Crataegus genus): A comprehensive review," *Journal of …*, 2023, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0378874123010991

[12] E. Kim, E. Jang, and J. H. Lee, "Potential roles and key mechanisms of hawthorn extract against various liver diseases," *Nutrients*, 2022, [Online]. Available: https://www.mdpi.com/2072-6643/14/4/867

[13] K. Y. Dokumacı, N. Uslu, and ..., "Determination of Some Physical and Chemical Properties of Common Hawthorn (Crataegus Monogyna Jacq. Var. Monogyna).," *Erwerbs …*, 2021, [Online]. Available: https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=00140309&AN=148629466&h=CPAm0xKW9Xxjiwms5MLJa%2F9qN810CBkupD346TSRSgt%2F1XaDRoQyZksEtDbctk9dkpPvC2%2BsKrQtC4NpbLD3hA%3D%3D&crl=c

[14] G. Ferri, L. R. Fernández, G. Di Mario, J. A. Palermo, and ..., "Host cell cAMP-Epac pathway inhibition by hawthorn extract as a potential treatment for Chagas disease," *bioRxiv*, 2023, doi: 10.1101/2023.01.26.525677.abstract.

[15] G. Rocchetti, B. Senizza, G. Zengin, and ..., "Untargeted metabolomic profiling of three Crataegus species (hawthorn) and their in vitro biological activities," *Journal of the …*, 2020, doi: 10.1002/jsfa.10216.

[16] S. Y. Zhang, X. L. Sun, X. L. Yang, P. L. Shi, and ..., "Botany, traditional uses, phytochemistry and pharmacological activity of Crataegus pinnatifida (Chinese hawthorn): a review," *Journal of Pharmacy …*, 2022, [Online]. Available: https://academic.oup.com/jpp/article-abstract/74/11/1507/6732273

[17] S. Wang *et al.*, "Hawthorn extract alleviates atherosclerosis through regulating inflammation and apoptosis related factors: an experimental study," *Chinese journal of …*, 2019, doi: 10.1007/s11655-018-3020-4.

[18] J. L. Martínez-Rodríguez and ..., "… , Antihyperlipidemic and Radical Scavenging Activity of Hawthorn (Crataegus oxyacantha) and Rosemary (Rosmarinus officinalis) on Alcoholic Liver Disease.," *… Therapies in Health …*, 2019, [Online]. Available: https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=10786791&AN=137351663&h=cIMUpLRR9bydGFVMulfVy4om0xrNXSnH9cMA8%2BgdKcD1i68RSaM%2BYeZ1q9gOpazuGFFqdh9TUAoS2wdTVha5kw%3D%3D&crl=c

[19] Y. Xu, T. Deng, L. Xie, T. Qin, and T. Sun, "Neuroprotective effects of hawthorn leaf flavonoids in Aβ25–35-induced Alzheimer's disease model," *Phytotherapy Research*, 2023, doi: 10.1002/ptr.7690.

[20] I. Gheitasi, F. Savari, G. Akbari, and ..., "Molecular mechanisms of hawthorn extracts in multiple organs disorders in underlying of diabetes: a review," *International Journal …*, 2022, doi: 10.1155/2022/2002768.

[21] M. Lu, L. Zhang, J. Pan, H. Shi, M. Zhang, and C. Li, "Advances in the study of the vascular protective effects and molecular mechanisms of hawthorn (Crataegus anamesa Sarg.) extracts in cardiovascular diseases," *Food &Function*, 2023, [Online]. Available: https://pubs.rsc.org/en/content/articlehtml/2023/fo/d3fo01688a

[22] A. Borcean, O. Cotuna, V. Mircov, and ..., "Leaf spots, one of the most common diseases of hawthorn (Crataegus Monogyna) on the south-western part of Romania," *International …*, 2019, [Online]. Available: https://search.proquest.com/openview/cbf22b910d7ec6a82822d8ae26a58946/1?pq-origsite=gscholar&cbl=1536338

[23] Agrios, G. N. (2005). Plant Pathology (5th ed.). San Diego: Elsevier Academic Press.

[24] Carson, R. (2002). Silent Spring. Boston: Houghton Mifflin.

[25] Ehler, L. E. (2006). Integrated Pest Management (IPM): Definition, Historical Development and Implementation, and the Other IPM. Pest Management Science, 62(9), 787-789.

[26] Koul, O., & Dhaliwal, G. S. (2004). Integrated Pest Management: Principles and Practice. Springer Science & Business Media.

[27] Nafasov Z.N., Safarov A.A., Muminov M.Sh., Allayarov N.J. Scientific-practical guide to integrated pest management (IPM) of common walnut (Juglans regia L.). - Tashkent, 2022. - 76 p.

[28] Nafasov Z.N., Sulaymanov O.A., Allayarov N.J., Muminov M.Sh., Sulaymanova N.M. Guide to "Integrated Pest Management System (IPM) of Hawthorn (Crataegus)". - Tashkent. 2022. - 68 p.

[29] Pimentel, D. (2009). Pest Control and Pesticide Use. In C. W. Hall & H. H. Wang (Eds.), Biomass Energy Systems. Springer, Boston, MA.

[30] Radcliffe, E. B., Hutchison, W. D., & Cancelado, R. E. (2009). Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies. Cambridge University Press.

[31] Stern, V. M., Smith, R. F., van den Bosch, R., & Hagen, K. S. (1959). The Integrated Control Concept. Hilgardia, 29(2), 81-101.

[32] Yakhyaev H.Q., Nafasov Z.N. Automatizirovannaya sistema monitoringa razvitiya i rasprostraneniya vrednykh organizmov lesokozhyaystvennykh kultur. Society and innovation. - Tashkent, 2020. - #1. ISSN 2181-1415. - S.61-67.